



KCG

COLLEGE OF TECHNOLOGY
AFFILIATED TO ANNA UNIVERSITY | AUTONOMOUS

CURRICULUM AND SYLLABUS PG

(REGULATIONS 2021)

ACADEMIC YEAR 2024-2025

ANNA UNIVERSITY, CHENNAI
NON- AUTONOMOUS COLLEGES AFFILIATED ANNA UNIVERSITY
M.E. AERONAUTICAL ENGINEERING
REGULATIONS 2021
CHOICE BASED CREDIT SYSTEM
I TO IV SEMESTERS CURRICULA & SYLLABI

1. PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

I.	Graduates of the programme will acquire adequate knowledge both in practical and theoretical domains in the field of Aeronautical Engineering through rigorous post graduate education.
II.	Graduates of the programme will have successful technical and managerial career in Aeronautical Engineering industries and the allied management.
III.	Graduates of the programme will have innovative ideas and potential to contribute for the development and current needs of the Aviation industries.

2. PROGRAMME OUTCOMES (POs):

PO#	PROGRAMME OUTCOMES
1	An ability to independently carry out research/investigation and development work to solve practical problems
2	An ability to write and present a substantial technical report/document
3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program
4	Post Graduate will be trained towards developing and understanding the importance of design and development of Airplanes from system integration point of view.
5	Post Graduate will exhibit the awareness of contemporary issues focusing on the necessity to develop new materials, design and testing methods for the solution of problems related to aircraft industry..
6	An understanding of professional and ethical responsibility and also capable of doing doctoral studies in multidisciplinary areas.

Note: Program may add up to three additional Pos.

4. PEO/POMapping:

PEO	PO					
	1	2	3	4	5	6
I.	2		3		2	2
II.		2		3	2	3
III.	2	3	2	2	3	3
IV.						
V.						

Every programme objectives must be mapped with 1,2,3,-, scale against the correlation PO's

MAPPING–M.E. AERONAUTICAL ENGINEERING

		COURSE NAME	PO1	PO2	PO3	PO4	PO5	PO6
YEAR I	SEMESTER I	Advanced Mathematical Methods						
		Aerospace Propulsion	2.8	2	1.8	2	1.4	1.8
		Aircraft Structural Mechanics	0	0	3	2	2.4	1
		Flight Vehicle Aerodynamics	0	0	3	1	2	1
		Research Methodology and IPR						
		Professional Elective - I						
		Audit Course – I*						
		Low Speed and High Speed Aerodynamics Laboratory	3	1	2	0	3	1
		Jet Propulsion Laboratory	3	2	2	0	2	1
	SEMESTER II	Advanced Flight Dynamics	0	0	2	2.2	1.2	1
		CFD for Aerospace Applications	0.8	0	2.6	0	1.4	1
		Finite Element Analysis	1.4	0	2.8	0	2.6	1
		Analysis of Composite Structures	0.8	0	2	0	2.2	1
		Professional Elective-II						
		Professional Elective-III						
		Audit Course – II*						
		Structures Laboratory	3	0.8	2.4	0	0	1
		Computation Laboratory	3	0.8	2.4	0	0	1
Mini Project with Seminar								
YEAR II	SEMESTER III	Professional Elective-IV						
		Professional Elective-V						
		Open Elective						
		Project Work I	3	3	3	3	3	3
	SEMESTER IV	Project Work II	3	3	3	3	3	3

ANNA UNIVERSITY, CHENNAI
NON- AUTONOMOUS COLLEGES AFFILIATED TO ANNA UNIVERSITY
M.E. AERONAUTICAL ENGINEERING
REGULATIONS 2021
CHOICE BASED CREDIT SYSTEM
I TO IV SEMESTERS CURRICULA AND SYLLABUS

I SEMESTER

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	MA4153	Advanced Mathematical Methods	FC	4	0	0	4	4
2.	AO4101	Aerospace Propulsion	PCC	3	0	0	3	3
3.	AO4102	Aircraft Structural Mechanics	PCC	3	1	0	4	4
4.	AO4103	Flight Vehicle Aerodynamics	PCC	4	0	0	4	4
5.	RM4151	Research Methodology and IPR	RMC	2	0	0	2	2
6.		Professional Elective - I	PEC	3	0	0	3	3
7.		Audit Course – I*	AC	2	0	0	2	0
PRACTICAL								
8.	AO4111	Low Speed and High Speed Aerodynamics Laboratory	PCC	0	0	4	4	2
9.	AO4112	Jet Propulsion Laboratory	PCC	0	0	4	4	2
TOTAL				21	1	8	30	24

* Audit Course is optional.

II SEMESTER

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	AO4201	Advanced Flight Dynamics	PCC	3	0	0	3	3
2.	AO4202	CFD for Aerospace Applications	PCC	3	0	0	3	3
3.	AO4251	Analysis of Composite Structures	PCC	3	0	0	3	3
4.	AO4252	Finite Element Analysis	PCC	3	0	0	3	3
5.		Professional Elective-II	PEC	3	0	0	3	3
6.		Professional Elective-III	PEC	3	0	0	3	3
7.		Audit Course – II*	AC	2	0	0	2	0
PRACTICAL								
8.	AO4211	Structures Laboratory	PCC	0	0	4	4	2
9.	AO4212	Mini Project with Seminar	EEC	0	0	4	4	2
10.	AO4213	Computational Laboratory	PCC	0	0	4	4	2
TOTAL				20	0	12	32	24

* Audit Course is optional.

III SEMESTER

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.		Professional Elective-IV	PEC	3	0	0	3	3
2.		Professional Elective-V	PEC	3	0	0	3	3
3.		Open Elective	OEC	3	0	0	3	3
PRACTICAL								
4.	AO4311	Project Work I	EEC	0	0	12	12	6
TOTAL				9	0	12	21	15

IV SEMESTER

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
PRACTICAL								
1.	AO4411	Project Work II	EEC	0	0	24	24	12
TOTAL				0	0	24	24	12

TOTAL CREDITS TO BE EARNED FOR THE AWARD OF THE DEGREE: 75

FOUNDATION COURSES (FC)

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	MA4153	Advanced Mathematical Methods	4	0	0	4	1

PROGRAM CORE COURSES (PCC)

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	AO4101	Aerospace Propulsion	3	0	0	3	1
2.	AO4102	Aircraft Structural Mechanics	3	1	0	4	1
3.	AO4103	Flight Vehicle Aerodynamics	4	0	0	4	1
4.	AO4111	Low Speed and High Speed Aerodynamics Laboratory	0	0	4	2	1
5.	AO4112	Jet Propulsion Laboratory	0	0	4	2	1
6.	AO4201	Advanced Flight Dynamics	3	0	0	3	2
7.	AO4202	CFD for Aerospace Applications	3	0	0	3	2
8.	AO4251	Analysis of Composite Structures	3	0	0	3	2
9.	AO4252	Finite Element Analysis	3	0	0	3	2
10.	AO4211	Structures Laboratory	0	0	4	2	2
11.	AO4261	Computation Laboratory	0	0	4	2	2

RESEARCH METHODOLOGY AND IPR COURSE (RMC)

S. NO.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	RM4151	Research Methodology and IPR	2	0	0	2	1

PROFESSIONAL ELECTIVE COURSES (PEC)

SEMESTER I , ELECTIVE – I

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	AO4077	Theory of Vibrations	PEC	3	0	0	3	3
2.	AO4001	Rocketry and Space Mechanics	PEC	3	0	0	3	3
3.	AS4072	Computational Heat Transfer	PEC	3	0	0	3	3
4.	AO4002	Theory of Elasticity	PEC	3	0	0	3	3
5.	AO4003	Experimental Aerodynamics	PEC	3	0	0	3	3
6.	AO4004	Control Engineering	PEC	3	0	0	3	3

SEMESTER II, ELECTIVE – II

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	AO4005	Structural Dynamics	PEC	3	0	0	3	3
2.	AS4251	Hypersonic Aerodynamics	PEC	3	0	0	3	3
3.	AO4006	Advanced Propulsion Systems	PEC	3	0	0	3	3
4.	AS4071	Aerospace Materials	PEC	3	0	0	3	3
5.	AO4007	Airworthiness and Air Regulations	PEC	3	0	0	3	3
6.	AO4008	Experimental Methods of Stress Analysis	PEC	3	0	0	3	3

SEMESTER II, ELECTIVE – III

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	AO4009	Aeroelasticity	PEC	3	0	0	3	3
2.	AO4075	Theory of Boundary Layers	PEC	3	0	0	3	3
3.	AO4010	Combustion in Jet and Rocket Engines	PEC	3	0	0	3	3
4.	AO4011	Gas Dynamics	PEC	3	0	0	3	3
5.	AO4071	Fatigue and Fracture Mechanics	PEC	3	0	0	3	3

SEMESTER III , ELECTIVE – IV

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	AO4076	Vibration Isolation and Control	PEC	3	0	0	3	3
2.	AO4073	Non-Destructive Evaluation	PEC	3	0	0	3	3
3.	AO4012	Component Design of Aircraft Engines	PEC	3	0	0	3	3
4.	AO4013	Aircraft Systems Engineering	PEC	3	0	0	3	3
5.	AO4014	Aircraft Design	PEC	3	0	0	3	3
6.	AO4015	Composite Product Processing Methods	PEC	3	0	0	3	3

SEMESTER III, ELECTIVE – V

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	AO4016	Helicopter Aerodynamics	PEC	3	0	0	3	3
2.	AO4072	High Speed Jet Flows	PEC	3	0	0	3	3
3.	AO4074	Smart Materials and Structural Health Monitoring	PEC	3	0	0	3	3
4.	AO4091	Artificial Intelligence and Machine Learning	PEC	3	0	0	3	3
5.	AO4017	Aircraft Guidance and Control	PEC	3	0	0	3	3

AUDIT COURSES (AC)

Registration for any of these courses is optional to students

SL. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS
			L	T	P	
1.	AX4091	English for Research Paper Writing	2	0	0	0
2.	AX4092	Disaster Management	2	0	0	0
3.	AX4093	Constitution of India	2	0	0	0
4.	AX4094	நற்றமிழ் இலக்கியம்	2	0	0	0

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

SL. NO.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			L	T	P		
1	AO4212	Mini Project with Seminar	0	0	4	2	2
2	AO4311	Project Work I	0	0	12	6	3
3	AO4411	Project Work II	0	0	24	12	4

LIST OF OPEN ELECTIVES FOR PG PROGRAMMES

SL. NO.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS
			L	T	P	
1.	OCE431	Integrated Water Resources Management	3	0	0	3
2.	OCE432	Water, Sanitation and Health	3	0	0	3
3.	OCE433	Principles of Sustainable Development	3	0	0	3
4.	OCE434	Environmental Impact Assessment	3	0	0	3
5.	OIC431	Blockchain Technologies	3	0	0	3
6.	OIC432	Deep Learning	3	0	0	3
7.	OBA431	Sustainable Management	3	0	0	3
8.	OBA432	Micro and Small Business Management	3	0	0	3
9.	OBA433	Intellectual Property Rights	3	0	0	3
10.	OBA434	Ethical Management	3	0	0	3
11.	ET4251	IoT for Smart Systems	3	0	0	3
12.	ET4072	Machine Learning and Deep Learning	3	0	0	3
13.	PX4012	Renewable Energy Technology	3	0	0	3
14.	PS4093	Smart Grid	3	0	0	3
15.	CP4391	Security Practices	3	0	0	3
16.	MP4251	Cloud Computing Technologies	3	0	0	3
17.	IF4072	Design Thinking	3	0	0	3
18.	MU4153	Principles of Multimedia	3	0	0	3
19.	DS4015	Big Data Analytics	3	0	0	3
20.	NC4201	Internet of Things and Cloud	3	0	0	3
21.	MX4073	Medical Robotics	3	0	0	3
22.	VE4202	Embedded Automation	3	0	0	3
23.	CX4016	Environmental Sustainability	3	0	0	3
24.	TX4092	Textile Reinforced Composites	3	0	0	3
25.	NT4002	Nanocomposite Materials	3	0	0	3
26.	BY4016	IPR, Biosafety and Entrepreneurship	3	0	0	3

Summary

	Name of the Programme					
	Subject Area	Credits per Semester				Total Credits
		I	II	III	IV	
1.	FC	4				4
2.	PCC	15	16			31
3.	PEC	3	6	6		15
4.	RMC	2				2
5.	OEC			3		3
6.	EEC		2	6	12	20
7.	Non Credit/Audit Courses					
	Total Credit	24	24	15	12	75

ANNA UNIVERSITY
PROGRESS THROUGH KNOWLEDGE

COURSE OBJECTIVES:

- To attain the knowledge of solving Partial Differential Equations using Laplace transform.
- To apply Fourier Transform to solve boundary value problems.
- To achieve maxima and minima of a functional.
- To acquire knowledge on using conformal mapping to fluid flow and heat flow problems.
- To understand the tensor analysis as a tool to solve problems arising in engineering disciplines.

UNIT I LAPLACE TRANSFORM TECHNIQUES FOR PARTIAL DIFFERENTIAL EQUATIONS 12

Laplace transform : Definitions – Properties – Transform error function – Bessel’s function - Dirac delta function – Unit step functions – Convolution theorem – Inverse Laplace transform : Complex inversion formula – Solutions to partial differential equations : Heat equation – Wave equation.

UNIT II FOURIER TRANSFORM TECHNIQUES FOR PARTIAL DIFFERENTIAL EQUATIONS 12

Fourier transform: Definitions – Properties – Transform of elementary functions – Dirac delta function – Convolution theorem – Parseval’s identity – Solutions to partial differential equations : Heat equation – Wave equation – Laplace and Poisson’s equations.

UNIT III CALCULUS OF VARIATIONS 12

Concept of variation and its properties – Euler’s equation – Functional dependant on first and higher order derivatives – Functionals dependant on functions of several independent variables – Variational problems with moving boundaries – Isoperimetric problems – Direct methods – Ritz and Kantorovich methods.

UNIT IV CONFORMAL MAPPING AND APPLICATIONS 12

Introduction to conformal mappings and bilinear transformations – Schwarz Christoffel transformation – Transformation of boundaries in parametric form – Physical applications : Fluid flow and heat flow problems.

UNIT V TENSOR ANALYSIS 12

Summation convention – Contravariant and covariant vectors – Contraction of tensors – Inner product – Quotient law – Metric tensor – Christoffel symbols – Covariant differentiation – Gradient - Divergence and curl.

TOTAL : 60 PERIODS

COURSE OUTCOMES:

After completing this course, students should demonstrate competency in the following skills:

- Application of Laplace and Fourier transforms to initial value, initial–boundary value and boundary value problems in Partial Differential Equations.
- Maximizing and minimizing the functional that occur in various branches of Engineering Disciplines.
- Construct conformal mappings between various domains and use of conformal mapping in studying problems in physics and engineering particularly to fluid flow and heat flow problems.
- Understand tensor algebra and its applications in applied sciences and engineering and develops ability to solve mathematical problems involving tensors.
- Competently use tensor analysis as a tool in the field of applied sciences and related fields.

REFERENCES :

1. Andrews L.C. and Shivamoggi, B., "Integral Transforms for Engineers", Prentice Hall of India Pvt. Ltd., New Delhi, 2003.
2. Elsgolc, L.D., "Calculus of Variations", Dover Publications Inc., New York, 2007.
3. Mathews, J. H., and Howell, R.W., "Complex Analysis for Mathematics and Engineering", 6th Edition, Jones and Bartlett Publishers, 2012.
4. Kay, D. C., "Tensor Calculus", Schaum's Outline Series, Tata McGraw Hill Edition, 2014.
5. Naveen Kumar, "An Elementary Course on Variational Problems in Calculus ", Narosa Publishing House, 2005.
6. Saff, E.B and Snider, A.D, "Fundamentals of Complex Analysis with Applications in Engineering, Science and Mathematics", 3rd Edition, Pearson Education, New Delhi, 2014.
7. Sankara Rao, K., "Introduction to Partial Differential Equations", 3rd Edition, Prentice Hall of India Pvt. Ltd., New Delhi, 2010.
8. Spiegel, M.R., "Theory and Problems of Complex Variables and its Applications", Schaum's Outline Series, McGraw Hill Book Co., 2009.
9. Ramaniyah. G. "Tensor Analysis", S. Viswanathan Pvt. Ltd., 1990.

AO4101

AEROSPACE PROPULSION

L T P C
3 0 0 3

COURSE OBJECTIVES:

This course will enable the students

1. To gain knowledge on fundamental principles of aircraft and rocket propulsion.
2. To describe various types of propulsion system with their merits and challenges.
3. To gain adequate knowledge on propellers and its characteristics.
4. To be familiar with the working concept of inlets, nozzles and combustion chamber with their applications in a propulsion system.
5. To gain sufficient information about compressors and turbines. Students also will get an exposure on electric propulsion methods

UNIT I ELEMENTS OF AIRCRAFT PROPULSION 9

Classification of power plants – Methods of aircraft propulsion – Propulsive efficiency – Specific fuel consumption – Thrust and power- Factors affecting thrust and power- Illustration of working of piston engines and Gas turbine engines – Characteristics of piston engine, turboprop, turbofan and turbojet engines, Ram jet, Scram jet – Methods of Thrust augmentation.

UNIT II PROPELLER THEORY 9

Momentum theory, Blade element theory, combined blade element and momentum theory, propeller power losses, propeller performance parameters, prediction of static thrust- and in flight, negative thrust, prop fans, ducted propellers, propeller noise, propeller selection, propeller charts.

UNIT III INLETS, NOZZLES AND COMBUSTION CHAMBERS 9

Subsonic and supersonic inlets – Relation between minimum area ratio and external deceleration ratio – Starting problem in supersonic inlets –Modes of inlet operation, jet nozzle – Efficiencies – Over expanded, under and optimum expansion in nozzles – Thrust reversal. Classification of Combustion chambers – Combustion chamber performance – Flame tube cooling – Flame stabilization.

UNIT IV AXIAL FLOW COMPRESSORS, FANS AND TURBINES 9

Introduction to centrifugal compressors- Axial flow compressor- geometry- twin spools- three spools- stage analysis- velocity polygons- degree of reaction – radial equilibrium theory- performance maps- axial flow turbines- geometry- velocity polygons- stage analysis- performance maps- thermal limit of blades and vanes.

UNIT V ROCKET AND ELECTRIC PROPULSION 9

Introduction to rocket propulsion – Reaction principle – Thrust equation – Classification of rockets based on propellants used – solid, liquid and hybrid – Comparison of these engines with special reference to rocket performance – electric propulsion – classification- electro thermal – electro static – electromagnetic thrusters- geometries of Ion thrusters- beam/plume characteristics – hall thrusters.

TOTAL: 45 PERIODS**COURSE OUTCOMES:**

Upon completion of this course, students will

- CO1:** Get exposure with the different types of propulsive devices used for jet and rocket propulsion.
- CO2:** Have knowledge on propeller theory and its performance parameters.
- CO3:** Be able to distinguish different types of inlets and their performance trends in subsonic and supersonic flows.
- CO4:** Be able to describe the process of combustion and the parameters that affect combustion in jet engines.
- CO5:** Be able to acquire knowledge on the basic concepts of various types of electric propulsion systems.

REFERENCES:

1. Cohen, H, Saravanamuttoo, HIH., Rogers, GFC, Paul Straznicky and Andrew Nix , “Gas Turbine Theory”, Pearson Education Canada; 7th edition, 2017.
2. Gill,WP, Smith,HJ & Ziurys,JE, “Fundamentals of Internal Combustion Engines as applied to Reciprocating, Gas turbine & Jet Propulsion Power Plants”, Oxford & IBH Publishing Co., 1980.
3. Hill, PG. & Peterson, CR. “Mechanics & Thermodynamics of Propulsion” Pearson education, 2nd edition, 2014.
4. Oates, GC, “Aerothermodynamics of Aircraft Engine Components”, AIAA Education Series, 2007.
5. Sutton,GP, “Rocket Propulsion Elements”, John Wiley & Sons Inc., New York, 9th Edition, 2017.
6. J Seddon & E L Goldsmith. “ Intake Aerodynamics”, AIAA education series. 1999.

CO	PO1	PO2	PO3	PO4	PO5	PO6
	1	2	3	4	5	6
CO1	3	2	2	2	1	2
CO2	3	2	2	2	1	2
CO3	3	2	2	2	2	2
CO4	3	2	2	2	2	2
CO5	2	2	1	2	1	1
	2.8	2	1.8	2	1.4	1.8

COURSE OBJECTIVES:

This course will enable the students

1. To gain important technical aspects on the theory of bending of structures.
2. To learn the key aspects of shear flow in open and closed sections.
3. To study the stability problems in structures with various modes of loading.
4. To analyse aircraft structural components under various forms of loading.
5. To have basic idea about the importance of flight envelope.

UNIT I BENDING OF BEAMS**9+3**

Elementary theory of pure bending – Stresses in beams of symmetrical and unsymmetrical sections – Box beams – Generalized theory of bending – Methods of bending stress determination – Principal axes method – Neutral axis method – 'k' method – Deflection of unsymmetrical beams – Stresses in Composite Beams – Idealization of cross-section – Wing spar sizing

UNIT II SHEAR FLOW IN THIN-WALLED SECTION**9+3**

General stress, strain and displacement relationships for open section thin-walled beams – Concept of shear flow – Shear flow in thin walled open sections – Determinations of the shear centre – Symmetrical and unsymmetrical cross-sections – Shear flow due to bending in open sections – Torsion of thin-walled open section members & determination of stresses – Design of thin-walled members

UNIT III SHEAR FLOW IN CLOSED SECTIONS**9+3**

Shear flow in thin-walled closed sections – Symmetrical and unsymmetrical sections – Flexural shear flow in two flange, three flange and multi-flange box beams – Determinations of the shear centre – Bredt-Batho theory – Torsional shear flow in multi-cell tubes – Shear flow due to combined bending and torsion – Stress analysis of aircraft components – Tapered wing spar – Introduction to shear lag

UNIT IV STABILITY PROBLEMS**9+3**

Stability problems of thin walled structures – Buckling of sheets under compression, shear, and combined loads – Plate buckling coefficient – Inelastic buckling of plates – Sheet-stiffener panels – Effective width – Failure stress in plates and stiffened panels – Crippling stress estimation – Local Buckling – Wagner beam theory – Experimental determination of critical load for a flat plate – Principles of stiffener/web construction

UNIT V ANALYSIS OF AIRCRAFT STRUCTURAL COMPONENTS**9+3**

Aircraft Loads – Symmetric manoeuvre loads – Load factor determination – Inertia loads – Aerodynamic loads & Schrenk's curve – The flight envelope – Shear force, bending moment and torque distribution along the span of the wing and fuselage – Structural parts of wing and fuselage and their functions – Analysis of rings and frames — Introduction to aeroelasticity and shells.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

At the end of this course, students will be able to

- CO1:** Apply the concept of normal stress variation in unsymmetrical sections subject to bending moments.
- CO2:** Find the shear flow variation in thin walled open sections with skin effective and ineffective in bending.
- CO3:** Evaluate the shear flow variation in single cell and multi-cell tubes subjected to shear and torque loads.
- CO4:** Analyse the behaviour of buckling of simply supported plates and also to know the effective width of sheet stringers combination.
- CO5:** Analyse and design structural members subject to compression.

REFERENCES:

1. Bruce. K. Donaldson, "Analysis of Aircraft Structures: An Introduction", Cambridge University Press, 2nd edition, 2012.
2. Bruhn. EF, " Analysis and Design of Flight Vehicle Structures", Tristate Offset Co., 1980.
3. Megson, TMG, "Aircraft Structures for Engineering Students", Elsevier, Aerospace Engineering, Series, 7th Edition, 2021.
4. Peery, DJ. And Azar, JJ, "Aircraft Structures", 2nd Edition, McGraw-Hill, New York, 1993.
5. Rivello, R.M, "Theory and Analysis of Flight structures", McGraw-Hill, N.Y., 1993.
6. Sun. CT, "Mechanics of Aircraft Structures", Wiley publishers, 2nd edition, 2006.

CO	PO1	PO2	PO3	PO4	PO5	PO6
	1	2	3	4	5	6
CO1			3	2	2	1
CO2			3	2	3	1
CO3			3	2	3	1
CO4			3	2	2	1
CO5			3	2	2	1
	0	0	3	2	2.4	1

PROGRESS THROUGH KNOWLEDGE

AO4103

FLIGHT VEHICLE AERODYNAMICS

L T P C

4 0 0 4

COURSE OBJECTIVES:

This course will enable the students

1. To gain insights into the basics of fluid flow, its model and tool to solve the fluid flow problems.
2. To be familiar with the conservation laws of fluid dynamics, and how to apply them to practical fluid flows.
3. To gain knowledge on elementary flows to combine and form realistic flows with suitable assumptions.
4. To analyse incompressible flow over three-dimensional bodies like wing and so on.
5. To gain knowledge on the basic concepts of viscous flows, boundary layers to practical flows.

UNIT I INTRODUCTION TO AERODYNAMICS 12

Aerodynamic force and moments, lift and Drag coefficients, Centre of pressure and aerodynamic centre, Coefficient of pressure, moment coefficient, Continuity and Momentum equations, Point source and sink, doublet, Free and Forced Vortex, Uniform parallel flow, combination of basic flows, Pressure and Velocity distributions on bodies with and without circulation in ideal and real fluid flows, Magnus effect

UNIT II INCOMPRESSIBLE FLOW THEORY 12

Conformal Transformation, Karman ,Trefftz profiles, Kutta condition, Kelvin's Circulation Theorem and the Starting Vortex, Thin aerofoil Theory and its applications. Vortex line, Horse shoe vortex, Biot– Savart law, lifting line theory, effect of aspect ratio.

UNIT III COMPRESSIBLE FLOW THEORY 13

Compressibility, Isentropic flow through nozzles, Normal shocks, Oblique and Expansion waves, Moving shock waves, Rayleigh and Fanno Flow, Potential equation for compressible flow, Small perturbation theory, Prandtl- Glauert Rule, Linearized supersonic flow, Method of characteristics.

UNIT IV AIRFOILS, WINGS AND AIRPLANE CONFIGURATION IN HIGH SPEED FLOWS 11

Critical Mach number, Drag divergence Mach number, Shock stall, super critical airfoils, transonic area rule, Swept wings (ASW and FSW), Supersonic airfoils, Shock-Expansion Theory, Wave drag, Delta wings.

UNIT V VISCOUS FLOW THEORY 12

Basics of viscous flow theory, Boundary Layer,Flow separation, Displacement, momentum and Energy Thickness, Laminar and Turbulent boundary layers ,Boundary layer over flat plate, Blasius Solution, Estimation of skin friction drag in laminar and turbulent flow, The Reference Temperature Method.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

Upon completion of this course, students will

- CO1:** Comprehend the behaviour of airflow over bodies with particular emphasis on airfoil sections in the incompressible flow regime.
- CO2:** Be able to solve inviscid, incompressible and irrotational flows.
- CO3:** Be able to apply the conservation equations for fluid flows.
- CO4:** Be provided with the knowledge on thermodynamic state of the gas behind normal shock waves, oblique shock waves and expansion waves.
- CO5:** Be provided with adequate knowledge on the basic concepts of laminar and turbulent boundary layers.

REFERENCES:

1. J.D. Anderson, Fundamentals of Aerodynamics, McGraw-Hill Education, 6th edition, 2017.
2. Rathakrishnan.E., Gas Dynamics, Prentice Hall of India, 7th edition, 2020.
3. Shapiro, AH, "Dynamics & Thermodynamics of Compressible Fluid Flow", Ronald Press, 1982.
4. Houghton, EL and Caruthers, NB,"Aerodynamics for Engineering Students", Butterworth-Heinemann series, 7th edition 2017.
5. Zucrow, M.J, and Anderson, J.D, "Elements of gas dynamics" McGraw-Hill Book Co., New York, 1989.
6. Rae, WH and Pope, A, "Low speed Wind Tunnel Testing", John Wiley Publications, 3rd edition, 1999.

CO	PO1	PO2	PO3	PO4	PO5	PO6
	1	2	3	4	5	6
CO1			3	1	3	1
CO2			3	1	2	1
CO3			3	1	2	1
CO4			3	1	1	1
CO5			3	1	2	1
	0	0	3	1	2	1

RM4151

RESEARCH METHODOLOGY AND IPR

L T P C
2 0 0 2

UNIT I RESEARCH DESIGN

6

Overview of research process and design, Use of Secondary and exploratory data to answer the research question, Qualitative research, Observation studies, Experiments and Surveys.

UNIT II DATA COLLECTION AND SOURCES

6

Measurements, Measurement Scales, Questionnaires and Instruments, Sampling and methods. Data - Preparing, Exploring, examining and displaying.

UNIT III DATA ANALYSIS AND REPORTING

6

Overview of Multivariate analysis, Hypotheses testing and Measures of Association. Presenting Insights and findings using written reports and oral presentation.

UNIT IV INTELLECTUAL PROPERTY RIGHTS

6

Intellectual Property – The concept of IPR, Evolution and development of concept of IPR, IPR development process, Trade secrets, utility Models, IPR & Bio diversity, Role of WIPO and WTO in IPR establishments, Right of Property, Common rules of IPR practices, Types and Features of IPR Agreement, Trademark, Functions of UNESCO in IPR maintenance.

UNIT V PATENTS

6

Patents – objectives and benefits of patent, Concept, features of patent, Inventive step, Specification, Types of patent application, process E-filing, Examination of patent, Grant of patent, Revocation, Equitable Assignments, Licences, Licensing of related patents, patent agents, Registration of patent agents.

TOTAL : 30 PERIODS

REFERENCES

1. Cooper Donald R, Schindler Pamela S and Sharma JK, "Business Research Methods", Tata McGraw Hill Education, 11e (2012).
2. Catherine J. Holland, "Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets", Entrepreneur Press, 2007.
3. David Hunt, Long Nguyen, Matthew Rodgers, "Patent searching: tools & techniques", Wiley, 2007.
4. The Institute of Company Secretaries of India, Statutory body under an Act of parliament, "Professional Programme Intellectual Property Rights, Law and practice", September 2013.

AO4111

**LOW SPEED AND HIGH SPEED AERODYNAMICS
LABORATORY**

L T P C
0 0 4 2

COURSE OBJECTIVES:

This laboratory course will enable the students

1. To gain knowledge on the principles of subsonic and supersonic wind tunnel and their operation.
2. To acquire practical knowledge on various aerodynamic principles related to inviscid incompressible fluids.
3. To calculate various aerodynamic characteristics of various objects.
4. To characterize laminar and turbulent flows.
5. To get practical exposure on flow visualization techniques pertaining to subsonic flows.

LIST OF EXPERIMENTS:

1. Calibration of subsonic wind tunnel.
2. Pressure distribution over a smooth cylinder.
3. Pressure distribution over a rough cylinder.
4. Pressure distribution over a symmetric aerofoil section.
5. Pressure distribution over a cambered aerofoil section.
6. Pressure distribution over a wing of cambered aerofoil section.
7. Study on Force and moment measurements by using strain gauge.
8. Wake measurements behind a bluff body.
9. Velocity boundary layer measurements over a flat plate.
10. Force and moment measurements on aircraft model by using strain gauge.
11. Force and Moment measurements using wind tunnel balance.
12. Calibration of supersonic wind tunnel.
13. Subsonic flow visualization studies.

Any 10 experiments may be conducted.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

At the end of this course, students will be

- CO1:** Able to operate and calibrate subsonic and supersonic wind tunnel.
- CO2:** Able to analyse the pressure distribution over the streamlined and bluff bodies.
- CO3:** Able to carry out measurement of force and moments on aircraft models.
- CO4:** Capable of measuring boundary layer thickness over various models.
- CO5:** Able to carry out flow visualization at subsonic speeds.

LABORATORY EQUIPMENTS REQUIRED

1. Subsonic wind tunnel
2. Rough and smooth cylinder
3. Symmetrical and Cambered aerofoil
4. Wind tunnel balance
5. Schlieren system
6. Pressure Transducers
7. Supersonic wind tunnel
8. Blower
9. Testing models like flat plate, bluff body

CO	PO1	PO2	PO3	PO4	PO5	PO6
	1	2	3	4	5	6
CO1	3	1	2		3	1
CO2	3	1	2		3	1
CO3	3	1	2		3	1
CO4	3	1	2		3	1
CO5	3	1	2		3	1
	3	1	2	0	3	1

AO4112

JET PROPULSION LABORATORY

L T P C
0 0 4 2

COURSE OBJECTIVES:

This course will enable the students

1. To gain knowledge on wall pressure distribution on subsonic and supersonic inlets and nozzles.
2. To perform testing on compressor blades.
3. To interpret the experimental data using software.
4. To get practical exposure on flow visualization techniques pertaining to supersonic jets.
5. To gain basic knowledge on cold flow studies.

LIST OF EXPERIMENTS:

1. Wall pressure measurements of a subsonic diffuser.
2. Cascade testing of compressor blades.
3. Pressure distribution on a cavity model.
4. Wall pressure measurements on non-circular combustor.
5. Wall pressure measurements on converging nozzle.
6. Wall pressure measurements on convergent-divergent nozzle.
7. Total pressure measurements along the jet axis of a circular subsonic jet.
8. Total pressure measurements along the jet axis of a circular supersonic jet.
9. Total pressure measurements in the radial direction of the subsonic jet.
10. Total pressure measurements in the radial direction of the supersonic jet.
11. Cold flow studies of a wake region behind flame holders.
12. Wall pressure measurements on supersonic inlets.
13. Flow visualization on supersonic jets.
14. Prediction of flow angles using angle probe.

Any 10 experiments may be conducted.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

At the end of the course, students will be

CO1: Able to perform wall pressure distribution on subsonic and supersonic nozzles.

CO2: Able to acquire knowledge on fundamental concepts of low speed and high speed jets and experimental techniques pertains to measurements.

CO3: Provided with adequate knowledge on pressure distribution on cavity models.

CO4: Able to perform wake survey methods.

CO5: Able to carry out flow visualization on supersonic jets.

LABORATORY EQUIPMENTS REQUIRED

1. Subsonic wind tunnel
2. High speed jet facility
3. Blower
4. Pressure scanner
5. Schlieren system
6. Nozzle and cavity models

CO	PO1	PO2	PO3	PO4	PO5	PO6
	1	2	3	4	5	6
CO1	3	2	2		2	1
CO2	3	2	2		2	1
CO3	3	2	2		2	1
CO4	3	2	2		2	1
CO5	3	2	2		2	1
	3	2	2	0	2	1

AO4201

ADVANCED FLIGHT DYNAMICS

L T P C
3 0 0 3

COURSE OBJECTIVES:

This course will enable students

1. To gain in depth knowledge on aircraft performance in level, climbing, gliding flight modes.
2. To get familiarize the equations of motion in accelerated flight modes.
3. To impart knowledge on the basic aspects of stability and control of an airplane about three axis.
4. To provide adequate knowledge on various parameters that decide the stability level of an airplane.
5. To be familiar with the aspects of control in longitudinal, lateral and directional modes.

UNIT I STEADY FLIGHT PERFORMANCE

9

Overview of Aerodynamics and ISA – Straight and level flight: thrust and power required/available, differences of propeller-driven and jet-powered airplanes, maximum speed, effects of altitude – Climb and Descent performance: climb angle and rate of climb, descent angle and rate of descent – Range, endurance of propeller driven and jet powered airplanes.

UNIT II MANEUVER PERFORMANCE 9

Level turn – maximum producible load factor – fastest and tightest turn – Vertical maneuver: pull-up and pull-out, pull-down – gust V-n diagram –Take off and landing performance.

UNIT III STATIC LONGITUDINAL STABILITY AND CONTROL 9

Static equilibrium and stability – Pitch stability of conventional and canard aircraft – control fixed neutral point and static margin – effect of fuselage and running propellers on pitch stability – control surface hinge moment – control free neutral point – limit on forward CG travel –maneuver stability: Pull – up & level turn – control force and trim tabs – control force for maneuver– measurement of neutral point and maneuver point by flight tests.

UNIT IV STATIC LATERAL, DIRECTIONAL STABILITY AND CONTROL 9

Yaw and side slip, effect of wing sweep, wing dihedral and vertical tail on directional stability – rudder fixed and rudder free – yaw control – rudder sizing – pedal force - dihedral effect: contribution of various components- roll control.

UNIT V AIRCRAFT DYNAMICS 9

Rigid body equations of motion - Axes systems and their significance – Euler angles – linearization of longitudinal equations – force and moment derivatives – short period and phugoid approximations – pure pitching motion – linearization of equations for lateral – directional motion – roll, spiral and dutch roll approximations- Pure rolling- Pure yawing – Inertia coupling.

L : 45, TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, students will

- CO1:** Be able to assess the performance of aircraft in steady and maneuver flights.
- CO2:** Have thorough knowledge in order to perform preliminary design computations to meet static stability and trim requirements of aircrafts.
- CO3:** Be able to determine the fixed neutral point and the stick fixed static margin.
- CO4:** Be able to describe the effect of change in CG on the aircraft stability.
- CO5:** Apply the small disturbance equations of motion, and identify longitudinal and lateral sets of equations, construct state space models for longitudinal and lateral aircraft dynamics.

CO	PO1	PO2	PO3	PO4	PO5	PO6
	1	2	3	4	5	6
CO1			2	2		1
CO2			2	2	2	1
CO3			2	2	3	1
CO4			2	2	1	1
CO5			2	3		1
	0	0	2	2.2	1.2	1

REFERENCES:

1. Anderson,JD, “Aircraft Performance & Design”, First edition, Mc Graw Hill India, 2010.
2. McCormick, BW, “Aerodynamics, Aeronautics, & Flight Mechanics”, 2nd edition, John Wiley & Sons, 1995.
3. Michael V. Cook, “Flight Dynamics Principles”, Second edition, Elsevier, 2007.
4. Nelson, RC, “Flight Stability & Automatic Control”, Second edition, McGraw-Hill, 2017.
5. Perkins CD &Hage, RE, “Airplane performance, stability and control”, Wiley India Pvt Ltd, 2011.
6. Brain else stephsnos, Frank loie aircraft simulation and control, AIAA

COURSE OBJECTIVES:

This course will make the students

1. To get familiarize with the procedure to obtain numerical solution to fluid dynamic problems.
2. To gain knowledge on the important aspects of grid generation for practical problems.
3. To get exposure on time dependant and panel methods.
4. To learn the techniques pertaining to transonic small perturbation force.
5. To make use of commercial CFD software for aerospace applications.

UNIT I NUMERICAL SOLUTIONS OF SOME FLUID DYNAMICAL PROBLEMS 9

Basic fluid dynamics equations, Equations in general orthogonal coordinate system, Body fitted coordinate systems, mathematical properties of fluid dynamic equations and classification of partial differential equations - Finding solution of a simple gas dynamic problem, Local similar solutions of boundary layer equations, Numerical integration and shooting technique. Numerical solution for CD nozzle isentropic flows and local similar solutions of boundary layer equations- Panel methods.

UNIT II GRID GENERATION 9

Need for grid generation – Various grid generation techniques – Algebraic, conformal and numerical grid generation – importance of grid control functions – boundary point control – orthogonality of grid lines at boundaries. Elliptic grid generation using Laplace's equations for geometries like aerofoil and CD nozzle. Unstructured grids, Cartesian grids, hybrid grids, grid around typical 2D and 3D geometries – Overlapping grids – Grids around multi bodies.

UNIT III TIME DEPENDENT METHODS 9

Stability of solution, Explicit methods, Time split methods, Approximate factorization scheme, Unsteady transonic flow around airfoils. Some time dependent solutions of gas dynamic problems. Numerical solution of unsteady 2-D heat conduction problems using SLOR methods.

UNIT IV FINITE VOLUME METHOD 9

Introduction to Finite volume Method - Different Flux evaluation schemes, central, upwind and hybrid schemes - Staggered grid approach - Pressure-Velocity coupling - SIMPLE, SIMPLER algorithms- pressure correction equation (both incompressible and compressible forms) - Application of Finite Volume Method -artificial diffusion.

UNIT V CFD FOR INDUSTRIAL APPLICATIONS 9

Various levels of approximation of flow equations, turbulence modelling for viscous flows, verification and validation of CFD code, application of CFD tools to 2D and 3D configurations. CFD for kinetic heating analysis – Coupling of CFD code with heat conduction code, Unsteady flows – Grid movement method, Oscillating geometries, Computational aeroelasticity – Coupling of CFD with structural model – Aeroelasticity of airfoil geometry, Introduction to commercial CFD software for aerospace applications, High performance computing for CFD applications – Parallelization of codes –domain decomposition.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

At the end of this course, students will be able

CO1: To arrive at the numerical solutions to boundary layer equations.

CO2: To perform numerical grid generation and have knowledge about the mapping techniques.

CO3: To familiarise himself/herself with high performance computing for CFD applications.

CO4: To implement the explicit time dependent methods and their factorization schemes.

CO5: To do the stability analysis and linearization of the implicit methods.

CO	PO1	PO2	PO3	PO4	PO5	PO6
	1	2	3	4	5	6
CO1			2		1	1
CO2			3		2	1
CO3	2		3		1	1
CO4			3		2	1
CO5	2		2		1	1
	0.8	0	2.6	0	1.4	1

REFERENCES:

1. Bose. TK, "Numerical Fluid Dynamics", Narosa Publishing House, 2001.
2. Chung. TJ, "Computational Fluid Dynamics", Cambridge University Press, 2010.
3. Hirsch, AA, "Introduction to Computational Fluid Dynamics", McGraw-Hill, 1989.
4. John D. Anderson, "Computational Fluid Dynamics", McGraw Hill Education, 2017.
5. Sedat Biringen & Chuen-Yen Chow, "Introduction to Computational Fluid Dynamics by Example", Wiley publishers, 2nd edition, 2011.
6. Wirz, HJ & Smeldern, JJ, "Numerical Methods in Fluid Dynamics", McGraw-Hill & Co., 1978.

AO4251

ANALYSIS OF COMPOSITE STRUCTURES

L T P C
3 0 0 3

COURSE OBJECTIVES:

This course will make students

1. To impart knowledge on the macro mechanics of composite materials.
2. To determine stresses and strains in composites and also imparts an idea about the manufacturing methods of composite materials.
3. To get an idea on failure theories of composites.
4. To provide the basic knowledge on the properties of fibre and matrix materials used in commercial composites as well as some common manufacturing techniques.
5. To gain knowledge on the basic concepts of acoustic emission technique.

UNIT I FIBERS, MATRICES, AND FABRICATION METHODS

9

Production & Properties of Glass, Carbon and Aramid Fibers – Thermosetting and Thermoplastic Polymers – Polymer Properties of Importance to the Composite, Summary of Fabrication Processes – Scope of Composite Materials for Various Aerospace Application.

- UNIT II MICROMECHANICS OF A UNIDIRECTIONAL COMPOSITE 9**
 Volume and Weight Fractions in a Composite Specimen – Longitudinal Behaviour of Unidirectional Composites – Load Sharing – Failure Mechanism and Strength – Factors Influencing Longitudinal Strength and Stiffness – Transverse Stiffness and Strength – Prediction of Elastic Properties Using Micromechanics – Typical Unidirectional Fiber Composite Properties – Minimum and Critical Fiber Volume Fractions.
- UNIT III MACROMECHANICS APPROACH 9**
 Stress Analysis of an Orthotropic Lamina-Hooke's Law-Stiffness and Compliance Matrices - Specially Orthotropic Material-Transversely Isotropic Material & Specially Orthotropic Material under Plane Stress-Determination of E_x , E_y , G_{xy} -Stress & Strain Transformations- Transformation of Stiffness and Compliance Matrices-Strengths of an Orthotropic Lamina Using Different Failure Theories.
- UNIT IV ANALYSIS OF LAMINATED COMPOSITES 10**
 Laminate Strains - Variation of Stresses in a Laminate - Resultant Forces and Moments - Synthesis of Stiffness Matrix - Laminate Description System - Construction and Properties of Special Laminates - Symmetric Laminates – Balanced Laminate - Cross-Ply, and Angle-Ply Laminates - Quasi-isotropic Laminates - Determination of Laminae Stresses and Strains – Determination of Hygrothermal Stresses - Analysis of Laminates after Initial Failure.
- UNIT V ANALYSIS OF LAMINATED PLATES AND BEAMS 8**
 Governing Equations For Laminated Composite Plates -- Governing Equations for Laminated Beams -Application of Theory – Bending, Buckling and Vibration of Laminated Beams and Plates repair-Analysis of sandwich construction-AE technique.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of this course, students will be able

- CO1:** To calculate the elastic and strength properties of unidirectional laminates using micromechanics theory.
- CO2:** To analyze a composite laminate using the different failure theories.
- CO3:** To select the most appropriate manufacturing process for fabricating composite components.
- CO4:** To demonstrate understanding of the different materials (fibres, resins, cores) used in composites.
- CO5:** To gain knowledge on non-destructive inspection (NDI) and structural health monitoring of composites.

CO	PO1	PO2	PO3	PO4	PO5	PO6
	1	2	3	4	5	6
CO1	2		2		3	1
CO2	2		2		3	1
CO3			2		2	1
CO4			2		2	1
CO5			2		1	1
	0.8	0	2	0	2.2	1

REFERENCES:

1. Agarwal, BD and Broutman, LJ, "Analysis and Performance of Fibre Composites", John Wiley & Sons, 3rd edition, 2006.
2. Allen Baker, "Composite Materials for Aircraft Structures", AIAA Series, 2nd Edition, 2004.
3. Autar K Kaw, "Mechanics of Composite Materials", CRC Press, 2nd edition, 2005.
4. Calcote, LR, "The Analysis of laminated Composite Structures", Von – Nostrand Reinhold Company, New York, 1998.
5. Isaac M. Daniel &Orilshai , "Mechanics of Composite Materials", OUP USA publishers, 2nd edition, 2005.
6. Lubing, "Handbook on Advanced Plastics and Fibre Glass", Von Nostran Reinhold Co., New York, 1989.

AO4252

FINITE ELEMENT ANALYSIS

L T P C

3 0 0 3

COURSE OBJECTIVES:

This course will enable the students

1. To learn the concepts of finite element methods and the various solution schemes available.
2. To impart knowledge to solve plane stress and plane strain problems.
3. To solve heat transfer and fluid mechanics problems using Finite element methods.
4. To formulate mass and stiffness element matrices for vibration problems.
5. To be familiar in obtaining solutions to fluid flow problems.

UNIT I INTRODUCTION

9

Review of various approximate methods – Rayleigh-Ritz, Galerkin and Finite Difference Methods – Problem Formulation – Application to Structural Elements & Practical Problems – Derivation of Stiffness and Flexibility Matrices – Spring Systems – Role of Energy Principles – Basic Concepts of Finite Element Method – Interpolation, Nodes, Degrees of Freedom – Solution Schemes.

UNIT II DISCRETE ELEMENTS

9

Finite Element Structural Analysis Involving 1-D Bar and Beam Elements – Tapered Bar – Temperature Effects – Static Loading – Formulation of the Load Vector for 1-D Elements – Methods of Stiffness Matrix Formulation – Interpolation & Shape Functions – Boundary Conditions – Determination of Displacements & Reactions – Constitutive Relations – Determination of Nodal Loads & Stresses.

UNIT III CONTINUUM ELEMENTS

9

Plane Stress & Plane strain Loading – CST Element – LST Element – Element Characteristics – Problem Formulation & Solution Using Finite Elements – Axisymmetric Bodies & Axisymmetric Loading – Consistent and Lumped Load Vectors – Use of Local, Area and Volume Co-ordinates – Isoparametric Formulation – Shape Functions – Role of Numerical Integration – Load Consideration – Complete FE Solution.

UNIT IV VIBRATION & BUCKLING**9**

Formulation of the Mass and Stiffness Element Matrices for Vibration Problems – Bar and Beam Elements – Derivation of the Governing Equation – Natural Frequencies and Modes – Damping Considerations – Harmonic Response – Response Calculation Using Numerical Integration – Buckling of Columns – Problem Formulation – Solution – Determination of Buckling Loads and Modes.

UNIT V HEAT TRANSFER & FLUID MECHANICS PROBLEMS**9**

One Dimensional Heat Transfer Analysis – Formulation of the Governing Equations in Finite Element Form – Equivalent Load Vector – Solution & Temperature Distribution – Finite Element Formulation & Solution for Sample Problems Involving Fluid Mechanics .

TOTAL: 45 PERIODS**COURSE OUTCOMES:**

At the end of this course, students will have

CO1: An ability to frame governing equations involving different type of finite elements.

CO2: Knowledge on the general finite element methodology for a variety of practical problems.

CO3: An ability to solve simple 1-D and 2-D problems using the finite element method.

CO4: Knowledge on how to apply numerical integration techniques effectively in finite elements solutions.

CO5: An ability to frame and solve heat transfer and fluid mechanics problems using the FE method.

REFERENCES:

1. Bathe, KJ & Wilson, EL, Numerical Methods in Finite Elements Analysis, Prentice Hall of India Ltd., 1983.
2. Dhanaraj, R & K. Prabhakaran Nair, K, Finite Element Method, Oxford university press, India, 2015.
3. Krishnamurthy, CS, Finite Elements Analysis, Tata McGraw – Hill, 1987.
4. Rao, SS Finite Element Method in Engineering, Butterworth, Heinemann Publishing, 3rd Edition, 1998.
5. Robert D. Cook, David S. Malkus, Michael E. Plesha and Robert J. Witt, Concepts and Applications of Finite Element Analysis, John Wiley & Sons, 4th Edition, 2002.
6. Segerlind, LJ, Applied Finite Element Analysis, , John Wiley and Sons Inc., New York, 2nd Edition, 1984.
7. Tirupathi R. Chandrupatla & Ashok D. Belegundu, Introduction to Finite Elements in Engineering, Prentice Hall, 2002.

CO	PO1	PO2	PO3	PO4	PO5	PO6
	1	2	3	4	5	6
CO1	1		3		2	1
CO2	1		2		2	1
CO3	2		3		3	1
CO4	1		3		3	1
CO5	2		3		3	1
	1.4	0	2.8	0	2.6	1

COURSE OBJECTIVES:

This laboratory course enables the students

1. To get practical knowledge on calibration of photoelastic materials.
2. To gain practical exposures on calculating shear centre locations for closed and open sections.
3. To provide with the basic knowledge of fabricating a composite laminate.
4. To have basic knowledge on unsymmetrical bending of beams.
5. To design and conduct different types of practical tests involving various aircraft structural components.

LIST OF EXPERIMENTS

1. Calibration of photo elastic materials
2. Experimental modal analysis
3. Forced vibration testing
4. Fabrication and static testing of composite laminates
5. Non-destructive evaluation of defects in composite laminates using acoustic emission
6. Non-destructive evaluation of defects in composite laminates using ultrasonics.
7. Whirling of composite shafts
8. Design, Fabrication and testing of a 3-D printed specimen.
9. Unsymmetrical bending of beams
10. Determination of influence coefficients and flexibility matrix
11. Shear centre location for open & closed thin-walled sections
12. Buckling of columns with different end conditions
13. Experimental verification of the Wagner beam theory

NOTE: Any 10experiments will be conducted out of 15.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

At the end of the course, students will be able

CO1: To conduct tests and interpret data involving strain gauges.

CO2: To get exposure on experimental methods in photoelasticity.

CO3: To design an experimental evaluation technique for a given application.

CO4: To comprehend non-destructive testing methods.

CO5: To fabricate of composite laminates and characterizes it.

CO	PO1	PO2	PO3	PO4	PO5	PO6
	1	2	3	4	5	6
CO1	3	2	3			1
CO2	3		2			1
CO3	3	2	2			1
CO4	3		2			1
CO5	3		3			1
	3	0.8	2.4	0	0	1

LABORATORY EQUIPMENTS REQUIRED

1. Electrical resistance strain gauges installation kit.
2. Circuit board with resistors, wires, clips, etc, and strain gauges.
3. Column testing set-up (with provision for different end conditions)
4. Unsymmetrical beam bending set-up.
5. Dial gauges & travelling microscope.
6. Experimental setup for location of shear centre (open & closed sections)
7. Whirling of shafts demonstration unit.
8. Photo-elastic models.
9. Equipment for the fabrication of composite laminates.
10. Testing instruments and equipment for acoustic emission testing.
11. Testing instruments and equipment for ultrasonics testing.
12. Diffuser transmission type polariscope with accessories
13. Experimental setup for vibration of beams & vibration measuring instruments.
14. Universal Testing Machine.
15. 3-D printing machine.
16. Wagner beam & accessories.

AO4212

MINI PROJECT WITH SEMINAR

L T P C
0 0 4 2

Seminar is to be given by the student after the completion of a mini project chosen by the student. Topics for the mini projects can be from the aeronautical engineering and allied fields. The mini project can be based on either numerical or analytical solution or design or fully experimental; or a combination of these tasks.

AO4213

COMPUTATIONAL LABORATORY
(Consists of FEM & CFD experiments)

L T P C
0 0 4 2

COURSE OBJECTIVES:

1. This course is intended to make students familiar with different types of structural analysis using finite element software
2. This course helps students to correctly interpret the results of simulation.
3. To equip with the knowledge base essential for application of computational fluid dynamics to engineering flow problems.
4. To provide the essential numerical background for solving the partial differential equations governing the fluid flow.
5. To develop students' skills of using a commercial software package

EXPERIMENTS IN FEM

LIST OF EXPERIMENTS:

1. Grid generation methods and geometry clean up techniques.
2. Static analysis of a uniform bar subject to different loads -1-D element
3. Thermal stresses in a uniform and tapered member – 1-D element
4. Static analysis of trusses / frames under different loads
5. Stress analysis & deformation of a beam using 1-D element & 2-D – incorporation of
7. discrete, distributed, and user-defined loads
6. Static analysis of a beam with additional spring support
7. Stress concentration in an infinite plate with a small hole
8. Bending of a plate with different support conditions
9. Stability analysis of a plate under in-plane loads
10. Buckling of solid and thin-walled columns under different end conditions
11. Free vibration analysis of a bar / beam
12. Forced response of a bar / beam under harmonic excitation
13. Heat transfer analysis using 1-D & 2-D elements – conduction and convection
14. Modelling and analysis of a laminated plate
15. Impact analysis of a laminated plate.

Minimum of 6 Experiments to be performed by using FEM Software tools

EXPERIMENTS IN CFD

LIST OF EXPERIMENTS:

1. Numerical simulation of 1-D diffusion and conduction in fluid flows
2. Numerical simulation of 1-D convection-diffusion problems
3. Numerical simulation of 2-D unsteady state heat conduction problem
4. Numerical simulation of 2-D diffusion and 1-D convection combined problems
5. Structured grid generation over airfoil section 3-D numerical simulation of flow through CD nozzles
6. 3-D numerical simulation of flow development of a subsonic and supersonic jets
7. Numerical simulation of boundary layer development
8. Numerical simulation of subsonic combustion in a ramjet combustor
9. Numerical simulation of transonic flow over airfoils

Minimum of 6 Experiments to be performed by using CFD Software tools

TOTAL: 60 PERIODS

COURSE OUTCOMES:

At the end of this course, students will be able

CO1: To get solution of aerodynamic flows.

CO2: To perform stability analysis of structural components.

CO3: To define and setup flow problem properly within CFD context, performing solid modelling using CAD package and producing grids via meshing tool.

CO4: To comprehend both flow physics and mathematical properties of governing Navier-Stokes equations and define proper boundary conditions for solution.

CO5: To use CFD software to model relevant engineering flow problems.

CO	PO1	PO2	PO3	PO4	PO5	PO6
	1	2	3	4	5	6
CO1	3		2			1
CO2	3		2			1

CO3	3	2	3			1
CO4	3	2	3			1
CO5	3		2			1
	3	0.8	2.4	0	0	1

LABORATORY EQUIPMENTS REQUIREMENTS

1. Desktop computers
2. MS visual C++
3. CFD software

AO4311

PROJECT WORK I

L T P C
0 0 12 6

COURSE OBJECTIVES:

1. A research project work must be carried out completed with reference to the published literatures or from the creative ideas of the students themselves in consultation with their project supervisor.
2. To improve the student research and development activities.

EVALUATION:

Project work evaluation is based on Regulations of Credit system of Affiliated Institutions - Post graduate programmes of Anna University.

TOTAL : 90 PERIODS

COURSE OUTCOME:

The students' would apply the knowledge gained from theoretical and practical courses in solving problems, so as to give confidence to the students to be creative, well planned, organized, coordinated project outcome of the aimed work.

AO4411

PROJECT WORK II

L T P C
0 0 24 12

COURSE OBJECTIVES:

1. The objective of the research project work is to produce factual results of their applied research idea in the field of Aeronautical Engineering, developed from Project Work- I or may be a new concept with innovation.
2. The progress of the project is evaluated based on a minimum of three reviews.
3. The review committee may be constituted by the Head of the Department.

4. A project report is required at the end of the semester. The project work is evaluated jointly by external and internal examiners constituted by the Head of the Department based on oral presentation and the project report.
5. To improve the student research and development activities.

EVALUATION:

Project work evaluation is based on Regulations of Credit system of Affiliated Institutions - Post graduate programmes of Anna University.

TOTAL : 180 PERIODS

COURSE OUTCOME:

The students' would apply the knowledge gained from theoretical and practical courses in solving problems, so as to give confidence to the students to be creative, well planned, organized, coordinated project outcome of the aimed work.

AO4077

THEORY OF VIBRATIONS

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

This course will enables students

1. To get insight into the basic aspects of vibration theory.
2. This course presents the principles of dynamics and energy methods pertaining to structures.
3. This course provides a platform for better understanding of the approximate methods for aerospace structures.
4. To get insight into the dynamic responses of the large systems.
5. To get insight into the basic aspects of aero-elasticity.

UNIT I SINGLE DEGREE OF FREEDOM SYSTEMS 9

Simple harmonic motion, definition of terminologies, Newton's Laws, D'Alembert's principle, Energy methods. Free and forced vibrations with and without damping, base excitation, and vibration measuring instruments.

UNIT II MULTI-DEGREES OF FREEDOM SYSTEMS 9

Two degrees of freedom systems, Static and dynamic couplings, eigen values, eigen vectors and orthogonality conditions of eigen vectors, Vibration absorber, Principal coordinates, Principal modes. Hamilton's Principle, Lagrange's equation and its applications.

UNIT III VIBRATION OF ELASTIC BODIES 9

Transverse vibrations of strings, Longitudinal, Lateral and Torsional vibrations. Approximate methods for calculating natural frequencies.

UNIT IV EIGEN VALUE PROBLEMS & DYNAMIC RESPONSE OF LARGE SYSTEMS 9

Eigen value extraction methods – Subspace hydration method, Lanczos method – Eigen value reduction method – Dynamic response of large systems – Implicit and explicit methods.

UNIT V ELEMENTS OF AEROELASTICITY**9**

Aeroelastic problems – Collar’s triangle of forces – Wing divergence – Aileron control reversal – Flutter.

TOTAL: 45 PERIODS**REFERENCES**

1. Timoshenko, S. “Vibration Problems in Engineering”, John Wiley & Sons, Inc., 2018.
2. Meirovitch, L. “Elements of Vibration Analysis”, New Delhi, McGraw-Hill Education, 2014.
3. Thomson W.T, Marie Dillon Dahleh, “Theory of Vibrations with Applications”, Harlow, Essex Pearson 2014
4. F.S. Tse., I.F. Morse and R.T. Hinkle, “Mechanical Vibrations”, Prentice-Hall of India, 1985.
5. Rao.J.S. and Gupta.K. “Theory and Practice of Mechanical Vibrations”, New Delhi, New Age International, 1999.
6. Fung, Y.C., “An Introduction to the Theory of Aeroelasticity”, Dover Publications., Mineola, N.Y., 2008.

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	2	3	3	-
CO2	3	-	2	3	3	-
CO3	3	-	2	3	3	-
CO4	3	-	2	3	3	-
CO5	3	-	2	3	3	-

AO4001**ROCKETRY AND SPACE MECHANICS****L T P C****3 0 0 3****COURSE OBJECTIVES:**

1. This course presents the fundamental aspects of rocket motion along with detailed estimation of rocket trajectories.
2. This course also imparts knowledge on optimization of multistage rockets.
3. This course provides the basics of space mechanics required for an aeronautical student
4. This course helps students to provide with the basics of orbit transfer of satellites.
5. This course will help students to gain knowledge on various control methods of rockets.

UNIT I ORBITAL MECHANICS**9**

Description of solar system – Kepler’s Laws of planetary motion – Newton’s Law of Universal gravitation – Two body and Three-body problems – Jacobi’s Integral, Librations points – Estimation of orbital and escape velocities.

UNIT II SATELLITE DYNAMICS**9**

Geosynchronous and geostationary satellites- factors determining life time of satellites – satellite perturbations – orbit transfer and examples – Hohmann orbits – calculation of orbit parameters– Determination of satellite rectangular coordinates from orbital elements- satellite epipermis.

UNIT III ROCKET MOTION**9**

Principle of operation of rocket motor – thrust equation – one dimensional and two dimensional rocket motions in free space and homogeneous gravitational fields – Description of vertical, inclined and gravity turn trajectories– determinations of range and altitude – simple approximations to burnout velocity.

UNIT IV ROCKET AERODYNAMICS 9

Description of various loads experienced by a rocket passing through atmosphere – drag estimation – wave drag, skin friction drag, form drag and base pressure drag – Boat-tailing in missiles – performance at various altitudes – rocket stability – rocket dispersion – launching problems.

UNIT V STAGING AND CONTROL OF ROCKET VEHICLES 9

Need for multi staging of rocket vehicles – multistage vehicle optimization – stage separation dynamics and separation techniques- aerodynamic and jet control methods of rocket vehicles – SITVC.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of this course, students will be able

- CO1:** To knowledge on the fundamental laws of orbital mechanics with particular emphasis on interplanetary trajectories.
- CO2:** To calculate orbital parameters and perform conceptual trajectory designs for geocentric or interplanetary missions.
- CO3:** To familiarize themselves with trajectory calculations for planar motion of rockets.
- CO4:** To determine forces and moments acting on airframe of a missile.
- CO5:** To acquire knowledge on the need for staging and stage separation dynamics of rocket vehicles.

REFERENCES:

1. Cornelisse,JW, “Rocket Propulsion and Space Dynamics”, J.W. Freeman & Co., Ltd., London, 1982.
2. Parker,ER,“Materials for Missiles and Spacecraft”, McGraw-Hill Book Co., Inc., 1982.
3. Suresh. B N & Sivan. K, “Integrated Design for Space Transportation System”, Springer India, 2016.
4. Sutton,GP, Biblarz,O, “Rocket Propulsion Elements”, John Wiley & Sons Inc., New York, 9th Edition, 2017.
5. Van de Kamp, “Elements of Astromechanics”, Pitman Publishing Co., Ltd., London, 1980.

CO	PO1	PO2	PO3	PO4	PO5	PO6
	1	2	3	4	5	6
CO1	3		2			1
CO2	3		2	2	3	1
CO3	3		3	2	3	1
CO4	3		2			1
CO5	3		3	2	2	1
	3	0	2.4	1.2	1.6	1

COURSE OBJECTIVES:

This course will enable students

1. To get insights into the basic aspects of various discretization methods.
2. To provide basic ideas on the types of PDE's and its boundary conditions to arrive at its solution.
3. To impart knowledge on solving conductive, transient conductive and convective problems using computational methods.
4. To solve radiative heat transfer problems using computational methods.
5. To provide a platform for students in developing numerical codes for solving heat transfer problems.

UNIT I INTRODUCTION 9

Finite Difference Method-Introduction-Taylor's series expansion-Discretization Methods Forward, backward and central differencing scheme for first order and second order Derivatives – Types of partial differential equations-Types of errors-Solution to algebraic equation-Direct Method and Indirect Method-Types of boundary condition-FDM – FEM – FVM.

UNIT II CONDUCTIVE HEAT TRANSFER 9

General 3D-heat conduction equation in Cartesian, cylindrical and spherical coordinates. Computation (FDM) of One –dimensional steady state heat conduction –with Heat generation-without Heat generation- 2D-heat conduction problem with different boundary conditions-Numerical treatment for extended surfaces- Numerical treatment for 3D- Heat conduction-Numerical treatment to 1D-steady heat conduction using FEM.

UNIT III TRANSIENT HEAT CONDUCTION 9

Introduction to Implicit, explicit Schemes and Crank-Nicolson Schemes Computation(FDM) of One– dimensional un-steady heat conduction –with heat Generation-without Heat generation – 2D-transient heat conduction problem with different boundary conditions using Implicit, explicit Schemes-Importance of Courant number- Analysis for 1-D,2-D transient heat Conduction problems.

UNIT IV CONVECTIVE HEAT TRANSFER 9

Convection- Numerical treatment (FDM) of steady and unsteady 1-D and 2-d heat convection-diffusion steady-unsteady problems- Computation of thermal and Velocity boundary layer flows. Upwind scheme-Stream function-vorticity approach-Creeping flow.

UNIT V RADIATIVE HEAT TRANSFER 9

Radiation fundamentals-Shape factor calculation-Radiosity method- Absorption Method – Monte Carlo method-Introduction to Finite Volume Method- Numerical treatment of radiation enclosures using finite Volume method. Developing a numerical code for 1D, 2D heat transfer problems.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of this course, Students will

CO1: Have an Idea about discretization methodologies for solving heat transfer problems.

CO2: Be able to solve 2-D conduction and convection problems.

CO3: Have an ability to develop solutions for transient heat conduction in simple geometries.

CO4: Be capable of arriving at numerical solutions for conduction and radiation heat transfer problems.

CO5: Have knowledge on developing numerical codes for practical engineering heat transfer problems.

REFERENCES:

1. Chung,TJ, "Computational Fluid Dynamics", Cambridge University Press, 2002.
2. Holman,JP, "Heat Transfer", McGraw-Hill Book Co, Inc., McGraw-Hill College; 10thedition, 2017.
3. John D. Anderson, "Computational Fluid Dynamics", McGraw Hill Education, 2017.
4. John H. Lienhard, "A Heat Transfer", Text Book, Dover Publications, 5th edition, 2020.
5. Richard H. Pletcher, John C. Tannehill & Dale Anderson, "Computational Fluid Mechanics and Heat Transfer", 4th edition, CRC Press, 2021
6. Sachdeva,SC, "Fundamentals of Engineering Heat & Mass Transfer", New age publisher, 4th edition Internationals, 2017.

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	2	3	3	-
CO2	3	-	2	3	3	-
CO3	3	-	2	3	3	-
CO4	3	-	2	3	3	-
CO5	3	-	2	3	3	-

AO4002

THEORY OF ELASTICITY

L T P C
3 0 0 3

COURSE OBJECTIVES:

This course will enable students

1. To learn the basic concepts and equations of elasticity.
2. To provide with the concepts of plain stress and strain related problems.
3. To gain knowledge on equilibrium and stress-strain equations of polar coordinates.
4. Will be exposed to axisymmetric problems.
5. To get insight into the basic concepts of plates and shells.

UNIT I BASIC EQUATIONS OF ELASTICITY 9

Definition & sign convention for stress and strain – Hooke's law – Relation between elastic constants – Equilibrium and compatibility equations – Analysis of stress, strain and deformation – Stress and strain transformations equations – Cauchy's formula – Principal stress and principal strains in 2D & 3D – Octahedral stresses and its significance – Boundary conditions.

UNIT II APPLIED CONCEPTS 9

Plane stress and plane strain problems – Airy stress function – Biharmonic equation – Compatibility equation in terms of stress – Solution of bar and beam problems using the elasticity approach – Torsion of bars – Determination of stresses, strain and displacements – Warping of cross-sections – Prandtl's stress function approach – St. Venant's method.

UNIT III POLAR COORDINATES 9

Strain-displacement relations in polar coordinates – Equilibrium and stress-strain equations in polar coordinates – Infinite plate with a small central hole – Stress concentration – Bending of a curved beam (Winkler-Bach theory) – Deflection of a thick curved bar – Stresses in straight and curved beams due to thermal loading – Thermal stresses in cylinders and spheres – Stress concentration in bending.

UNIT IV AXISYMMETRIC PROBLEMS 9

Equilibrium and stress-strain equations in cylindrical coordinates – Lamé’s problem – Thick-walled cylinders subject to internal and external pressure – Application of failure theories – Stresses in composite tubes – Shrink fitting – Stresses due to gravitation – Analysis of a rotating disc of uniform thickness – Discs of variable thickness – Rotating shafts and cylinders.

UNIT V PLATES AND SHELLS 9

Classical plate theory – Assumptions, governing equations and boundary conditions – Navier’s method of solution – Levy’s method of solution – Rectangular and circular plates – Solution techniques – Analysis of a shell – Membrane Theory – Deformation and stresses due to applied loads.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of this course, students will

CO1: Have knowledge of basic elasticity relationships and equations.

CO2: Know how to carry out stress analysis in 2-D and 3-D.

CO3: Get exposure on the formulation of constitutive and governing equations for basic problems in cartesian and cylindrical coordinates.

CO4: Be able to analyse and solve practical problems in cartesian and cylindrical coordinates.

CO5: Be able to determine the stress, strain and displacement field for common axisymmetrical members.

REFERENCES:

1. Harry Kraus, “Thin Elastic Shells”, John Wiley and Sons, 1987.
2. Flugge, W, “Stresses in Shells”, Springer – Verlag, 1990.
3. Timoshenko, S.P. and Gere, J.M, “Theory of Elastic Stability”, McGraw Hill Book Co. 2010.
4. Timoshenko, S.P. Winowsky. S., and Kreger, “Theory of Plates and Shells”, McGraw Hill Book Co., 2nd edition, 2015.
5. Varadan, TK and Bhaskar, K, “Analysis of plates-Theory and problems”, Narosha Publishing Co., 2001.

CO	PO1	PO2	PO3	PO4	PO5	PO6
	1	2	3	4	5	6
CO1	1		2			1
CO2	3		2		2	1
CO3	1		2			1
CO4	3		2		3	1
CO5	2		2		2	1
	2	0	2	0	1.4	1

COURSE OUTCOMES:

Upon completion of this course, students will

- CO1:** Have knowledge on measurement of flow properties in wind tunnels and their associated instrumentation.
- CO2:** Be able to demonstrate and conduct experiments related to subsonic and supersonic flows.
- CO3:** Gain idea on flow visualization of subsonic and supersonic flows.
- CO4:** Be familiar with calibration of transducers and other devices used for flow measurement.
- CO5:** Be able to estimate errors and to perform uncertainty analysis of the experimental data.

REFERENCES:

1. Allan Pope and Kenneth L Goin, "High Speed Wind Tunnel Testing", Krieger Publishing Company, 1978.
2. Jewel B. Barlow, William H. Rae and Allan Pope, "Low-Speed Wind Tunnel Testing", Wiley-Interscience, 3rd edition, 1999.
3. Rathakrishnan, E, "Instrumentation, Measurements, and Experiments in Fluids", CRC Press –Taylor & Francis, 2020.
4. Robert B Northrop, "Introduction to Instrumentation and Measurements", Second Edition, CRC Press, Taylor & Francis, 2017.

CO	PO1	PO2	PO3	PO4	PO5	PO6
	1	2	3	4	5	6
CO1	1	2	2		1	1
CO2	3	3	2		3	1
CO3	2	2	2		2	1
CO4	3	3	2		3	1
CO5	3	2	2		3	1
	2.4	2.4	2	0	2.4	1

AO4004**CONTROL ENGINEERING**

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

1. To introduce the mathematical modeling of systems, open loop and closed loop systems and analyses in time domain and frequency domain.
2. To impart the knowledge on the concept of stability and various methods to analyze stability in both time and frequency domain.
3. To introduce sampled data control system.

UNIT I INTRODUCTION**9**

Historical review, Simple pneumatic, hydraulic and thermal systems, Series and parallel system, Analogies, mechanical and electrical components, Development of flight control systems.

UNIT II OPEN AND CLOSED LOOP SYSTEMS**9**

Feedback control systems – Control system components - Block diagram representation of control systems, Reduction of block diagrams, Signal flow graphs, Output to input ratios.

UNIT III CHARACTERISTIC EQUATION AND FUNCTIONS**9**

Laplace transformation, Response of systems to different inputs viz., Step impulse, pulse, parabolic and sinusoidal inputs, Time response of first and second order systems, steady state errors and error constants of unity feedback circuit.

UNIT IV CONCEPT OF STABILITY**9**

Necessary and sufficient conditions, Routh-Hurwitz criteria of stability, Root locus and Bode techniques, Concept and construction, frequency response.

UNIT V SAMPLED DATA SYSTEMS**9**

Z-Transforms Introduction to digital control system, Digital Controllers and Digital PID controllers

TOTAL: 45 PERIODS**COURSE OUTCOMES:**

1. Ability to apply mathematical knowledge to model the systems and analyse the frequency domain
2. Ability to check the stability of the both time and frequency domain
3. Ability to solve simple pneumatic, hydraulic and thermal systems, Mechanical and electrical component analogies based problems.
4. Ability to solve the Block diagram representation of control systems, Reduction of block diagrams, Signal flow graph and problems based on it.
5. Ability to understand the digital control system, Digital Controllers and Digital PID Controllers.

REFERENCES:

1. Azzo, J.J.D. and C.H. Houpis, "Feed back control system analysis and synthesis", McGraw-Hill international 3rs Edition, 1998.
2. OGATO, Modern Control Engineering, Pearson, New Delhi, 2016.

CO	PO1	PO2	PO3	PO4	PO5	PO6
	1	2	3	4	5	6
CO1	1		2	1	1	1
CO2	1		2	1	1	1
CO3	1		2	1	1	1
CO4	1		2	1	1	1
CO5	1		2	1	1	1
	1	0	2	1	1	1

COURSE OBJECTIVES:

1. This course imparts knowledge on the force deflection properties of structures and natural modes of vibration.
2. This course also presents the principles of dynamics and energy methods pertaining to structures.
3. This course will make students to realise the importance of natural modes of vibration.
4. This course will provide in-depth knowledge on natural vibrations of beams and plates.
5. This course also provides a platform for better understanding of the approximate methods for aerospace structures.

UNIT I	FORCE DEFLECTION PROPERTIES OF SYSTEMS	9
Constraints and Generalized coordinates – Virtual work and generalized forces – Force – Deflection influence functions – stiffness and flexibility methods.		
UNIT II	PRINCIPLES OF DYNAMICS	9
Free and forced vibrations of systems with finite degrees of freedom – Response to periodic excitation – Impulse Response Function – Convolution Integral		
UNIT III	NATURAL MODES OF VIBRATION	9
Equations of motion for Multi degree of freedom Systems – Solution of Eigen value problems – Normal coordinates and orthogonality Conditions. Modal Analysis		
UNIT IV	ENERGY METHODS	9
Rayleigh's principle – Rayleigh – Ritz method – Coupled natural modes – Effect of rotary inertia and shear on lateral vibrations of beams – Natural vibrations of beams and plates.		
UNIT V	APPROXIMATE METHODS	9
Approximate methods of evaluating the Eigen frequencies and eigen vectors by reduced, subspace, Lanczos, Power, Matrix condensation and QR methods.		
TOTAL: 45		
PERIODS		

COURSE OUTCOMES:

At the end of this course, students will

- CO1:** Be able to solve the equation of motion of a linear system and use this solution to analyse the vibrational behaviour of the system.
- CO2:** Be capable to relate the results of a modal analysis relate to the vibration of a structure.
- CO3:** Acquire knowledge on equation of motion of a lumped MDOF mass-spring-damper system.
- CO4:** Have knowledge on vibration characteristics of continuous system such as strings, bar, shafts and beams.
- CO5:** Be able to assess the fundamental frequency of MDOF systems using approximate methods.

CO	PO1	PO2	PO3	PO4	PO5	PO6
	1	2	3	4	5	6
CO1	2		2	2	2	1
CO2			2	2		1
CO3			3	2	2	1
CO4			3	2		1
CO5			2	2		1

REFERENCES:

1. Hurty,WC and Rubinstein,MF,“Dynamics of Structures”, Prentice Hall of India Pvt.Ltd.,New Delhi 1987.
2. Ramamurthi,V, “Mechanical Vibration Practice and Noise Control”, Narosa Publishing House Pvt. Ltd, 2008.
3. Timoshenko,SP and Young,DH,“Vibration Problems in Engineering”, John Willey & Sons Inc., 1984.
4. Tse.FS, Morse, IE and Hinkle,HT,“Mechanical Vibrations: Theory and Applications”, Prentice Hall of India Pvt. Ltd, New Delhi, 2004.
5. Vierck,RK,“Vibration Analysis”, 2ndEdition, Thomas Y. Crowell/ Harper & Row Publishers, New York, U.S.A. 1989.

AS4251

HYPERSONIC AERODYNAMICS

L T P C
3 0 0 3

COURSE OBJECTIVES:

This course will enables students

1. To realise the importance of studying the peculiar hypersonic speed flow characteristics pertaining to flight vehicles.
2. To provide knowledge on various surface inclination methods for hypersonic inviscid flows.
3. To arrive at the approximate solution methods for hypersonic flows.
4. To impart knowledge on hypersonic viscous interactions.
5. To impart knowledge on the effect on aerodynamic heating on hypersonic vehicles.

UNIT I INTRODUCTION TO HYPERSONIC AERODYNAMICS

9

Peculiarities of Hypersonic flows - Thin shock layers – entropy layers – low density and high density flows – hypersonic flight similarity parameters – shock wave and expansion wave relations of inviscid hypersonic flows – velocity vs altitude map for hypersonic vehicles.

UNIT II SURFACE INCLINATION METHODS FOR HYPERSONIC INVISCID FLOWS

8

Local surface inclination methods – modified Newtonian Law – Newtonian theory – tangent wedge tangent cone and shock expansion methods – Calculation of surface flow properties – practical application of surface inclination methods – hypersonic independence principle.

UNIT III APPROXIMATE METHODS FOR INVISCID HYPERSONIC FLOWS 10

Assumptions in approximate methods hypersonic small disturbance equation and theory – Maslen’s theory– blast wave theory – hypersonic equivalence principle- entropy effects - rotational method of characteristics - hypersonic shock wave shapes and correlations.

UNIT IV VISCOUS HYPERSONIC FLOW THEORY 10

Peculiarities of hypersonic boundary layers - boundary layer equations r – hypersonic boundary layer theory and non similar hypersonic boundary layers – hypersonic aerodynamic heating and entropy layers effects on aerodynamic heating – heat flux and skin friction estimation.

UNIT V VISCOUS INTERACTIONS AND TRANSITION 8

Strong and weak viscous interactions – hypersonic shockwaves and boundary layer interactions – Parameters affecting hypersonic boundary layer transition - Estimation of hypersonic boundary layer transition- Role of similarity parameter for laminar viscous interactions in hypersonic viscous flow.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, students will

- CO1:** Be able to arrive at the solution for problems involving inviscid and viscous hypersonic flows.
- CO2:** Have thorough knowledge on high temperature effects in hypersonic aerodynamics.
- CO3:** Be able to arrive at various solution methods to overcome aerodynamic heating problem on hypersonic vehicles.
- CO4:** To gain ideas on the design issues associated with hypersonic vehicles.
- CO5:** Able to realize the importance and use of the relevant equations for viscous hypersonic flows.

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓	✓	✓	✓	✓	
CO2	✓	✓	✓	✓		
CO3	✓	✓	✓	✓	✓	
CO4	✓	✓	✓	✓	✓	
CO5	✓	✓	✓	✓		

REFERENCES:

1. Anderson, JD, “Hypersonic and High Temperature Gas Dynamics”, AIAA Education Series, 2nd edition, 2006.
2. Anderson, JD, “Modern compressible flow: with Historical Perspective”, McGraw Hill Education, 3rd edition, 2017.
3. William H. Heiser and David T. Pratt, Hypersonic Air Breathing propulsion, AIAA Education Series, 1994.
4. John T. Bertin, Hypersonic Aerothermodynamics, AIAA Education Series, 1993.

COURSE OBJECTIVES:

1. This course will cover the basic aspects of thermodynamic cycle analysis of air-breathing propulsion systems.
2. This course is intended to impart knowledge on advanced air breathing propulsion systems like air augmented rockets.
3. This course will give the knowledge on the basic aspects of scramjet propulsion system.
4. This course will provide in-depth knowledge about the nozzle performance.
5. This course also presents vast knowledge on the operating principles of nuclear, electric and ion propulsion.

UNIT I THERMODYNAMIC CYCLE ANALYSIS OF AIR-BREATHING PROPULSION SYSTEMS 9

Air breathing propulsion systems like Turbojet, turboprop, ducted fan, Ramjet and Air augmented rockets – Thermodynamic cycles – Pulse propulsion – Combustion process in pulse jet engines – inlet charging process – Subcritical, Critical and Supercritical charging.

UNIT II RAMJETS AND AIR AUGMENTED ROCKETS 8

Preliminary performance calculations – Diffuser design with and without spike, Supersonic inlets – combustor and nozzle design – integral Ram rocket.

UNIT III SCRAMJET PROPULSION SYSTEM 10

Fundamental considerations of hypersonic air breathing vehicles – Preliminary concepts in engine airframe integration – calculation of propulsion flow path – flow path integration – Various types of supersonic combustors – fundamental requirements of supersonic combustors – Mixing of fuel jets in supersonic cross flow – performance estimation of supersonic combustors.

UNIT IV NUCLEAR PROPULSION 9

Nuclear rocket engine design and performance – nuclear rocket reactors – nuclear rocket nozzles – nuclear rocket engine control – radioisotope propulsion – basic thruster configurations – thruster technology – heat source development – nozzle development – nozzle performance of radioisotope propulsion systems.

UNIT V ELECTRIC AND ION PROPULSION 9

Basic concepts in electric propulsion – power requirements and rocket efficiency – classification of thrusters – electrostatic thrusters – plasma thruster – Fundamentals of ion propulsion – performance analysis – ion rocket engine.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, students will be

CO1: Able to Analyse in detail the thermodynamics cycles of air breathing propulsion systems.

CO2: Able to gain idea on the concepts of supersonic combustion for hypersonic vehicles and its performance.

CO3: Able to demonstrate the fundamental requirements of supersonic combustors.

CO4: Capable of estimating performance parameters of nuclear and electrical rockets.

CO5: Able to acquire knowledge on the concepts of engine-body installation on hypersonic vehicles.

CO	PO1	PO2	PO3	PO4	PO5	PO6
	1	2	3	4	5	6
CO1	3		2	2	3	1
CO2	3		2		2	1
CO3	3		3		2	1
CO4			3		3	1
CO5	2		2		2	1

REFERENCES:

1. Cumpsty, "Jet propulsion", Cambridge University Press, 2003.
2. Fortescue and Stark, "Spacecraft Systems Engineering", Wiley, 4th edition, 2011.
3. Sutton, GP, "Rocket Propulsion Elements", John Wiley & Sons Inc., New York, 1998.
4. William H. Heiser and David T. Pratt, "Hypersonic Air breathing propulsion", AIAA Education Series, 2001.

AS4071

AEROSPACE MATERIALS

L T P C
3 0 0 3

COURSE OBJECTIVES:

This course will enable students

1. To get insights into the basic aspects of material science.
2. To provide basic idea on the mechanical behaviour of materials.
3. To impart knowledge on the macro mechanics of composite materials,
4. To gain knowledge on the analysis and manufacturing methods of composite materials.
5. To learn about the sandwich construction.

UNIT I MATERIAL SCIENCE 9

Crystallography of metals & metallic alloys – Imperfections – Dislocations in Different Crystal Systems – Effect on plasticity – Strengthening Mechanisms Due to Interaction of Dislocations with Interfaces – Other Strengthening Methods – Dislocation Generation Mechanisms

UNIT II MECHANICAL BEHAVIOUR 9

Stress-strain curve and mechanical behaviour of materials – linear elasticity and plasticity – failure of ductile and brittle materials – use of failure theories – maximum normal stress and maximum shear stress failure theories – importance of the octahedral stress failure theory – failure theories based on strain energy – cyclic loading and fatigue of materials – the S-N curve

UNIT III METALLIC ALLOYS 9

Metals and alloys used for different aerospace applications – Properties of conventional and advanced aerospace alloys – Effect of alloying elements – Summary of conventional and state-of-the-art manufacturing processes – Types of heat treatment and their effect – other processing parameters – Materials for aerospace application – Design requirements & standards

UNIT IV HIGH TEMPERATURE MATERIALS 9

Carbon-Carbon Composites and Ceramic Materials For High Temperature Aerospace Application – Manufacturing Technologies & Controlling Parameters – Mechanical and Thermal Properties of These Material Systems – Thermal Protection Material System for a Re-Entry Vehicle – Use of Superalloys – Metal Matrix Composites & Cermets – Properties and Applications – Mechanical and Thermal Fatigue

UNIT V SMART MATERIALS**9**

Introduction to smart materials-shape memory effects-shape memory alloys-shape memory polymers-electro-rheological fluids-energy harvesting materials-self healing polymers.

TOTAL : 45 PERIODS**COURSE OUTCOMES:**

Upon completion of this course, students will

CO1: Be able to investigate the physical and mechanical behaviour of different materials.

CO2: Have exposure on dislocation theories and their importance.

CO3: Have general knowledge of the properties of different aerospace materials

CO4: Be able to apply failure theories appropriately.

CO5: Be able to select good materials for a specific aerospace application.

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓		✓			
CO2	✓	✓	✓		✓	✓
CO3	✓	✓	✓		✓	✓
CO4	✓	✓	✓		✓	
CO5	✓		✓			✓

REFERENCES

1. Adrian Mouritz, "Introduction to Aerospace Materials", Woodhead Publishing, 1st edition, 2012.
2. Jones. R M, "Mechanics of Composite Materials", 2nd Edition, CRC Press, Taylor & Francis Group, 1998.
3. Prasad, N. Eswara, Wanhill, RJH, "Aerospace Materials and Material Technologies Volume 1: Aerospace Materials", Springer Singapore, 2017.
4. Sam Zhang & Dongliang Zhao, "Aerospace Materials Handbook", CRC Press, Taylor & Francis Group, 2012.
5. Brain culshaw, smart structures and materials, Artech house, 2000.

AO4007**AIRWORTHINESS AND AIR REGULATIONS****L T P C****PROGRESS THROUGH KNOWLEDGE****3 0 0 3****COURSE OBJECTIVES:**

This course will make students

1. To get insight into the basic aspects of aircraft rules.
2. To gain knowledge on the basic concepts of airworthiness.
3. To learn the basic aspects on certification and publication procedures.
4. To impart knowledge on licensing and material selections.
5. To provide with the concepts of case studies and civil aviation requirements.

UNIT I INTRODUCTION TO AIRCRAFT RULES**8**

Airworthiness requirements for civil and military aircraft – CAA, FAA, JAR and ICAO regulations – Defence standards – Military standards and specifications.

UNIT II BASIC CONCEPTS OF AIRWORTHINESS**9**

Privileges and responsibilities of various categories of AME license and approved persons – Knowledge of mandatory documents like certificate of Registration – Certificate of Airworthiness – Conditions of issue and validity – Export certificate of Airworthiness – Knowledge of Log Book, Journey Log Book, Technical Log Book etc.

UNIT III CERTIFICATION AND PUBLICATION PROCEDURES 10

Procedure for development and test flight and Certification – Certificate of Flight release – Certificate of Maintenance – Approved Certificates – Technical Publications – Aircraft Manual – Flight Manual – Aircraft Schedules – Registration Procedure, Certification, Identification and Marking of Aircraft.

UNIT IV LICENSING AND MATERIAL SELECTIONS 9

Modifications – Concessions – Airworthiness directives – Service bulletins – Crew training and their licenses – approved inspection – Approved materials – Identification of approved materials – Bonded and quarantine stores.

UNIT V CASE STUDIES AND CIVIL AVIATION REQUIREMENTS 9

Storage of various aeronautical products like rubber goods and various fluids – Accident investigation procedures – Circumstances under which C of A is suspended – ICAO and IATA regulations – Chicago and Warsaw conventions – Familiarization of recent issues of Advisory Circulars – Civil Aviation Requirements Section 2 – Airworthiness.

TOTAL: 45 PERIODS**COURSE OUTCOMES:**

Upon completion of this course, students will be able

CO1: To realise the importance of aircraft rules.

CO2: To get exposure on the basic concepts of airworthiness.

CO3: To develop test flight and Certification.

CO4: To carry out inspections and can identify the approved materials.

CO5: To analyse the case studies and realise the importance of civil aviation requirements.

CO	PO1	PO2	PO3	PO4	PO5	PO6
	1	2	3	4	5	6
CO1			2	3	3	1
CO2			2	3	3	1
CO3			2	3	3	1
CO4			2	3	3	1
CO5			2	3	3	1

REFERENCES:

1. Civil Airworthiness Requirements (www.dgca.nic.in), 2016.
2. Civil Aircraft Airworthiness Information and Procedures (CAP 562).
3. Civil Aviation Requirements Section 2 - Airworthiness.
4. Gran E L and Richard Levenworth, Statistical Quality Control, 7th Edition McGraw Hill, 1997
5. Manual of Civil Aviation/ Organisation Manual DGCA, 2017.
6. The Indian Aircraft Act and the Rules(www.dgca.nic.in), 2008.

COURSE OBJECTIVES:

1. This course introduces the basic principles and methods of experimental stress analysis.
2. This course helps to learn the principles and techniques of photoelastic measurements.
3. This course presents the principles and techniques of moire analysis.
4. This course helps to gain knowledge of the principles and a technique of strain gage measurements is presented.
5. This course also enables the students to learn basic principles of operation of electrical resistance strain gauges, interferometric techniques, and non destructive methods.

UNIT I BASIC CONCEPTS 9

Stresses, Strains and Displacements – Determination of Principal Values of Stresses and Strains in 2-D & 3-D – Maximum Shear Stress – Strain Measurement Using Mechanical Extensometers – Principles of Measurements – Basic Characteristics and Requirements of a Measuring System – Sources of error – Statistical Analysis of Experimental Data – Non-Contact Measurement.

UNIT II ELECTRICAL-RESISTANCE STRAIN GAGES 9

Strain Sensitivity in Metallic Alloys –Gage Construction –Gage Sensitivities and Gage Factor – Performance Characteristics of Foil Strain Gages – Environmental Effects –The Three-Element Rectangular Rosette –Corrections for Transverse Strain Effects – Other Types of Strain Gages – Semiconductor Strain Gages – Grid & Brittle Coating Methods of Strain Analysis.

UNIT III STRAIN-GAGE CIRCUITS & INSTRUMENTATION 9

The Potentiometer Circuit and Its Application to Strain Measurement – Variants From The Basic Potentiometer Circuit – Circuit Output – The Wheatstone Bridge Constant Current and Constant Voltage Circuits – Circuit Sensitivity – Calibrating Strain-Gage Circuits –Effects of Lead Wires and Switches – Electrical Noise Reduction – Strain Measurement in Bars, Beams and Shafts.

UNIT IV PHOTOELASTIC METHODS OF STRESS ANALYSIS 9

Introduction – Stress-Optic Law – Effects of a Stressed Model in a Plane Polariscope– Effects of a Stressed Model in a Circular Polariscope– Tardy Compensation – Two-Dimensional Photoelastic Stress Analysis – Fringe Multiplication and Fringe Sharpening – Properties of Commonly Employed Photoelastic Materials – Material Calibration – Introduction to Three-Dimensional Photoelasticity and digital photo elasticity.

UNIT V NON-DESTRUCTIVE TESTING 8

Different types of NDT Techniques – Acoustic Emission Technique – Ultrasonic – Pulse-Echo – Through Transmission – Eddy Current Testing – X-Ray Radiography – Challenges in Non-Destructive Evaluation – Non-Destructive Evaluation in Composites – Concepts of Image Processing Theory.

TOTAL: 45 PERIODS**COURSE OUTCOMES:**

Upon completion of this course, Students will have

- CO1:** Knowledge of different methods of strain measurement.
CO2: Knowledge on electrical resistance strain gage.
CO3: An ability to design experiments for strain measurements.
CO4: Acquired knowledge on photo elastic methods of stress analysis.
CO5: Exposure to non-destructive testing methods.

CO	PO1	PO2	PO3	PO4	PO5	PO6
	1	2	3	4	5	6
CO1			2	2		1
CO2			2	2		1
CO3	2		3			1
CO4			3	2		1
CO5			2	3		1

REFERENCES:

1. Albert S. Kobayashi, "Handbook on Experimental Mechanics", Prentice Hall Publishers, 1987.
2. James W. Dally & William F. Riley, "Experimental Stress Analysis", McGraw-Hill College, 1991.
3. James F. Doyle & James W. Phillips, "Manual on Experimental Stress Analysis", 5th Edition, Society for Experimental Mechanics, 1989.
4. Sharpe Jr & William N, Springer, "Handbook of Experimental Solid Mechanics", Springer, 2008.
5. Utpa. S.S & Patrick O. Moore, "Non-destructive Testing Handbook", Electromagnetic Testing, Third Edition: Volume 5, 2004.
6. Ramesh, IIT Madras

AO4009

AEROELASTICITY

L T PC

30 03

COURSE OBJECTIVES:

1. This course provides the basic knowledge on aero elastic phenomena and its impact on aircraft design.
2. This course will make students to illustrate the aeroelastic phenomena using simplified aerodynamic and structural models
3. This course provides insight into both static and dynamic aeroelastic phenomena and possible prevention methods.
4. This course imparts knowledge on the flutter phenomena in detail.
5. This course provides the basic knowledge on prevention and control of aeroelastic instabilities.

UNIT I AEROELASTIC PHENOMENA

8

Stability versus response problems – introduction to aeroelasticity and aeroelastic phenomena – Examples of aeroelastic phenomena – Galloping of transmission lines – Flow induced vibrations of tall slender structures – Instability of suspension bridges – Fluid structure interaction – The aero-elastic triangle of forces – Prevention of aeroelastic instabilities

UNIT II MODELLING OF AEROELASTIC PHENOMENA

9

Influence and stiffness co-efficients – illustration of aeroelastic phenomena using simplified aerodynamic and structural models – different subsonic and supersonic aerodynamic models for aeroelastic analysis – modelling techniques – aeroelastic models in state-space format Flexure – torsional oscillations of beams – Governing differential equation of motion and its solution

UNIT III STATIC AEROELASTIC PHENOMENA 10

Simple two dimensional idealisation – Strip theory – Exact solutions for simple rectangular wings – ‘Semirigid’ assumption and approximate solutions – Successive approximation method – Numerical approximations using matrix equations – Divergence of 2-D airfoil and Straight Wing – Aileron efficiency & reversal – Control Effectiveness – Wing deformations of swept wings

UNIT IV FLUTTER CALCULATIONS 10

Flutter analysis – Two dimensional thin airfoils in steady incompressible flow –Quasi-steady aerodynamic derivatives – Galerkin method for critical flutter speed – Stability of disturbed motion – Solution of the flutter determinant – Methods of determining the critical flutter speeds – Flutter Calculation – U-g Method – P-k Method – Exact Treatment of Bending –Torsion Flutter of a Uniform Wing – Flutter Analysis by Assumed Mode Method

UNIT V PREVENTION AND CONTROL 8

Stiffness criteria – dynamic mass balancing – dimensional similarity – effect of elastic deformation on static longitudinal stability – introduction to aeroelastic control – aeroelastic aspects in the design of aircraft – Panel flutter and its control – Prevention of tail buffeting – Aeroelastic instabilities in helicopter and engine blades and prevention methods

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of this course, students will

- CO1:** Have knowledge of the role of aeroelasticity in aircraft design.
- CO2:** Interpret the use of semi-rigid body assumptions and numerical methods in airplane design.
- CO3:** Arrive at the solutions for steady state aeroelastic problem.
- CO4:** Be knowledge with the concept of flutter analysis of aircraft wings.
- CO5:** Have knowledge on practical examples of aeroelastic problems.

CO	PO1	PO2	PO3	PO4	PO5	PO6
	1	2	3	4	5	6
CO1			2			1
CO2	3		2	3	2	1
CO3	3		2		2	1
CO4			2			1
CO5			2	3		1

REFERENCES:

1. Bisplinghoff,RL, Ashley,H and Halfmann,RL, “Aeroelasticity”, 2nd Edition, Addison Wesley Publishing Co., Inc., 1996.
2. Blevins, RD, “Flow Induced Vibrations”, Krieger Pub Co., 2001.
3. Broadbent,EG, “Elementary Theory of Aeroelasticity”, Bun Hill Publications Ltd., 1986.
4. Fung, YC, “An Introduction to the Theory of Aeroelasticity”, John Wiley & Sons Inc., New York, 2008.
5. Scanlan, RH and R.Rosenbaum, “Introduction to the study of Aircraft Vibration and Flutter”, Macmillan Co., New York, 1981.

COURSE OBJECTIVES:

1. This course imparts knowledge to students on growth of boundary layer and its effect on the aerodynamic design of airframe of flight vehicles.
2. This course will introduce them the solution methods for boundary layer problems.
3. This course enables the students to understand the importance of viscosity and boundary layer in fluidflow.
4. This course also introduces the theory behind laminar and turbulent boundary layers.
5. This course will make students to learn the concepts of boundary layer transition and separation.

UNIT I THEORY OF VISCOUS FLOW 8

Fundamental equations of viscous flow, Conservation of mass, Conservation of Momentum-Navier-Stokes equations, Energy equation, Mathematical character of basic equations, Dimensional parameters in viscous flow, Non-dimensionalising the basic equations and boundary conditions, vorticity considerations, creeping flow, boundary layer flow.

UNIT II INCOMPRESSIBLE VISCOUS FLOWS AND BOUNDARY LAYER 10

Solutions of viscous flow equations, Couette flows, Hagen-Poiseuille flow, Flow between rotating concentric cylinders, Combined Couette-Poiseuille Flow between parallel plates, Creeping motion, Stokes solution for an immersed sphere, Development of boundary layer, Displacement thickness, momentum and energy thickness.

UNIT III LAMINAR BOUNDARY LAYER THEORY 10

Laminar boundary layer equations, Flat plate Integral analysis of Karman – Integral analysis of energy equation – Laminar boundary layer equations – boundary layer over a curved body-Flow separation- similarity solutions, Blasius solution for flat-plate flow, Falkner-Skan wedge flows, Boundary layer temperature profiles for constant plate temperature –Reynold's analogy, Integral equation of Boundary layer – Pohlhausen method – Thermal boundary layer calculations.

UNIT IV THEORY OF TURBULENT BOUNDARY LAYER 9

Turbulence-physical and mathematical description, Two-dimensional turbulent boundary layer equations — Velocity profiles – The law of the wall – The law of the wake – Turbulent flow in pipes and channels – Turbulent boundary layer on a flat plate – Boundary layers with pressure gradient, Eddy Viscosity, mixing length , Turbulence modelling.

UNIT V BOUNDARY LAYER TRANSITION AND SEPARATION 8

Boundary layer control in laminar flow-Methods of Boundary layer control: Motion of the solid wall-Acceleration of the boundary layer-Suction- Injection of different gas-Prevention of transition-Cooling of the wall-Boundary layer suction-Injection of a different gas.

TOTAL: 45 PERIODS**COURSE OUTCOMES:**

Upon completion of this course, students will be able

- CO1:** To apply proper governing equations for various types of viscous flows in engineering applications.
- CO2:** To obtain solutions for various viscous flow problems in engineering.
- CO3:** To estimate skin friction over solid surfaces, over which laminar boundary layer persists.
- CO4:** To arrive at the solutions for turbulent boundary layer and the resulting drag.
- CO5:** To gain insights on the techniques for boundary layer control.

CO	PO1	PO2	PO3	PO4	PO5	PO6
	1	2	3	4	5	6
CO1			2	2	3	1
CO2			2	3	3	1
CO3			2	3	3	1
CO4			2	2	3	1
CO5			2	1	3	1

REFERENCES:

1. White, F. M., Viscous Fluid Flow, McGraw-Hill & Co., Inc., New York, 2008.
2. Schlichting, H., Boundary Layer Theory, McGraw-Hill, New York, 1979.
3. Reynolds, A, J., Turbulent Flows Engineering, John Wiley and Sons, 1980.

AO4010

COMBUSTION IN JET AND ROCKET ENGINES

L T P C

3 0 0 3

COURSE OBJECTIVES:

1. This course provides the basic principles of combustion, types of flames and also familiarizes the combustion process in gas turbine, ramjet, scram jet and rocket engines.
2. This course explains the concept of thermochemistry, enthalpy, adiabatic flame temperature, combustion products and their application to combustion related problems.
3. This course presents the concept of chemical rates of reaction, collision theory and Arrhenius equation for analysing the different types of reactions.
4. This course gives an idea to compare the properties and characteristics of different type of flames and apply the same to combustion phenomenon in rocket motors and its exhaust.
5. This course also imparts knowledge to interpret the various combustion processes that take place in chemical rockets.

UNIT I THERMODYNAMICS OF COMBUSTION

8

Stoichiometry – absolute enthalpy- enthalpy of formation- enthalpy of combustion- laws of thermochemistry- pressure and temperature effect on enthalpy of formation, adiabatic flame temperature, chemical and equilibrium products of combustion.

UNIT II PHYSICS AND CHEMISTRY OF COMBUSTION

9

Fundamental laws of transport phenomena, Conservations Equations, Transport in Turbulent Flow. Basic Reaction Kinetics, Elementary reactions, Chain reactions, Multistep reactions, simplification of reaction mechanism, Global kinetics.

UNIT III PREMIXED AND DIFFUSED FLAMES

10

One dimensional combustion wave, Laminar premixed flame, Burning velocity measurement methods, Effects of chemical and physical variables on Burning velocity, Flame extinction, Ignition, Flame stabilizations, Turbulent Premixed flame. Gaseous and diffusion flame - Examples - Differences between premixed flame and diffusion.

UNIT IV COMBUSTION IN GAS TURBINE, RAMJET AND SCRAMJET 9

Combustion in gas turbine chambers, recirculation, combustion efficiency, flame holders, subsonic combustion in ramjet, supersonic combustion in scramjet. Subsonic and supersonic combustion controlled by diffusion mixing and heat convection – peculiarities of supersonic combustion.

UNIT V COMBUSTION IN CHEMICAL ROCKET 9

Combustion in liquid propellant rockets. Combustion of solid propellants- application of laminar flame theory to the burning of homogeneous propellants, Combustion in hybrid rockets.combustion instability in rockets.

TOTAL: 45 PERIODS**COURSE OUTCOMES:**

At the end of this course, students will be able to

CO1:Apply the basic concept of thermochemistry to combustion related problems

CO2:Demonstrate the concept of chemical kinetics in combustion reactions.

CO3:Differentiate between deflagration and detonation process and interpret the concept for computation and analysis of the transition phenomenon.

CO4:Demonstrate the peculiarities of supersonic combustion.

CO5:Evaluate the combustion processes taking place in different types of chemical rockets.

CO	PO1	PO2	PO3	PO4	PO5	PO6
	1	2	3	4	5	6
CO1			2	3	2	1
CO2			2	2	3	1
CO3	2		3	2	3	1
CO4			3	3	2	1
CO5	2		2	3	3	1

REFERENCES:

1. Kuo, KK, "Principles of Combustion", John Wiley and Sons, 2005.
2. Mishra, DP, "Fundamentals of Combustion", Prentice Hall of India, New Delhi, 2008.
3. Mukunda, HS, "Understanding Combustion", 2nd edition, Orient Blackswan,2009.
4. Warren C. Strahle, "An Introduction to Combustion", Taylor & Francis, 1993.

AO4011**GAS DYNAMICS****L T P C****3 0 0 3****COURSE OBJECTIVES:**

This course will enable the students

1. To gain insights into the steady one-dimensional fluid flow, its model and tool to solve the fluid flow problems.
2. To acquire knowledge about the normal shock waves.
3. To acquire knowledge about the oblique shock and expansion waves.
4. To gain knowledge about the basic measurements involved in compressible flows.
5. To acquire basic knowledge about the rarefied and high temperature gas dynamics.

UNIT I STEADY ONE-DIMENSIONAL FLOW 10
 Thermodynamics of Fluid Flow – First Law of Thermodynamics - The Second Law of Thermodynamics - Thermal and Calorical Properties – Perfect Gas - Wave Propagation – Velocity of Sound - Subsonic and Supersonic Flows – Fundamental Equations - Discharge from a Reservoir – Stream tube Area-Velocity Relation - De Laval Nozzle – Supersonic Flow Generation – Diffusers - Dynamic Head Measurement in Compressible Flow - Pressure Coefficient.

UNIT II NORMAL SHOCK WAVES 10
 Introduction – Equations of Motion for a Normal Shock Wave - The Normal Shock Relations for a Perfect Gas - Change of Stagnation or Total Pressure across the Shock- Hugoniot Equation - The Propagating Shock Wave - Reflected Shock Wave - Centered Expansion Wave - Shock Tube.

UNIT III OBLIQUE SHOCK AND EXPANSION WAVES 10
 Introduction – Oblique Shock Relations - Relation between θ and β - Shock Polar – Supersonic Flow over a Wedge - Weak Oblique Shocks – Supersonic Compression - Supersonic Expansion by Turning - The Prandtl-Meyer Expansion - Simple and Non-simple Regions.

UNIT IV MEASUREMENTS IN COMPRESSIBLE FLOW 10
 Introduction - Pressure Measurements – Temperature Measurements - Velocity and Direction - Density Problems - Compressible Flow Visualization - High-Speed Wind Tunnels - Instrumentation and Calibration of Wind Tunnels.

UNIT V INTRODUCTION TO RAREFIED AND HIGH TEMPERATURE GAS DYNAMICS 5
 Knudsen Number - Slip Flow Transition and Free Molecule Flow - Importance of High-Temperature Flows - Nature of High-Temperature Flows.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of this course, students will

- CO1:** Be able to solve the steady one dimensional compressible fluid flow problems.
- CO2:** Be provided with the knowledge on thermodynamic state of the gas behind normal shock waves.
- CO3:** Be provided with the knowledge on thermodynamic state of the gas behind oblique shock waves and expansion waves.
- CO4:** Be provided with the adequate knowledge on compressible flow measurements.
- CO5:** Be provided with the basic knowledge on rarefied and high temperature gas dynamics.

REFERENCES:

1. J.D. Anderson, Fundamentals of Aerodynamics, McGraw-Hill Education, 6th edition, 2017.
2. Rathakrishnan. E., Gas Dynamics, Prentice Hall of India, 7th edition, 2020.
3. Shapiro, AH, “Dynamics & Thermodynamics of Compressible Fluid Flow”, Ronald Press, 1982.
4. Houghton, EL and Caruthers, NB, “ Aerodynamics for Engineering Students”, Butterworth-Heinemann Series, 7th Edition 2017.
5. Zucrow, M.J, and Anderson, J.D, “Elements of gas dynamics” McGraw-Hill Book Co., New York, 1989.
6. Rae, WH and Pope, A, “Low speed Wind Tunnel Testing”, John Wiley Publications, 3rd edition, 1999.

CO	PO1	PO2	PO3	PO4	PO5	PO6
	1	2	3	4	5	6
CO1	2		3	2	2	2
CO2	2		3	2	2	2
CO3	2		3	2	2	2
CO4	2		3	2	2	2
CO5			3	2	2	2
	1.6	0	3	2	2	2

AO4071

FATIGUE AND FRACTURE MECHANICS

L T P C

3 0 0 3

COURSE OBJECTIVES:

This course will make students

1. To learn the fundamentals aspects of fatigue & fracture mechanics.
2. To gain knowledge on the statistical aspects of fatigue behaviour of materials.
3. To get insights into the physical aspects of fatigue.
4. To evaluate the strength of the cracked bodies.
5. To provide knowledge on fatigue design and testing of aerospace structures.

UNIT I BASIC CONCEPTS & OVERVIEW 9

Historical Perspective – Case Studies – Review of Material Behaviour – Linear & Non-Linear Response – Temperature and Strain Rate Effect – Strain Hardening – Different Mechanisms of Failure – Typical Defects & Elements of Dislocation Theories – Atomic View of Fracture – Fractographic Examination of Failure Surfaces of Different Materials – Overview of Design Approach – Safe Life Design.

UNIT II FATIGUE OF STRUCTURES 9

S.N. curves – Endurance limit – Effect of mean stress – Goodman, Gerber and Soderberg relations and diagrams – Notches and stress concentrations – Stress concentration factors – Notched S-N curves – Low cycle and high cycle fatigue – Coffin-Manson's relation – Transition life – Cyclic Strain hardening and softening – Load History Analysis – Cycle counting techniques – Cumulative damage theory

UNIT III PHYSICAL ASPECTS OF FATIGUE 9

Fracture mechanism in metals - Phase in fatigue life – Crack source – Cleavage initiation – Crack growth – Ductile-brittle transition – Final fracture – Dislocations – Fatigue fracture surface of inter and intra-granular fracture – Environmental effects – Terminology and classification – Corrosion principles – Stress corrosion cracking – Hydrogen embrittlement – Influencing parameters on crack behaviour

UNIT IV LINEAR ELASTIC FRACTURE MECHANICS 9

Stress analysis and strength of a cracked body – Stress concentration – potential energy and surface energy – Energy release rate – Griffith’s theory – Irwin extension of Griffith’s theory to ductile materials – Plastic zone shape – Effect of thickness on fracture toughness – Stress intensity factors for typical geometries – Instability of the R-curve – K-controlled fracture – Plane strain fracture toughness – Mixed mode – Interaction of cracks – Limitations of the linear elastic fracture theory

UNIT V FRACTURE TOUGHNESS TESTING 9

General considerations for metallic specimens – Specimen configuration – Stress intensity factors – Pre-cracking – Grooving – ASTM E-399 and similar standards – K-R curve – J-testing on metals – Determination of crack parameters – CTOD testing – Testing of metals in the ductile-brittle transition region – Quantitative toughness tests – Charpy & Izod tests – Mathematical modelling concepts

TOTAL: 45 PERIODS**COURSE OUTCOMES:**

Upon completion of this course, students will be able

- CO1:** To identify and describe the basic fracture and fatigue mechanisms and apply that knowledge to failure analysis.
- CO2:** To correctly apply linear elastic fracture to predict material failure.
- CO3:** To predict lifetimes for fatigue and environmentally assisted cracking.
- CO4:** To demonstrate fatigue design and testing of structures.
- CO5:** To realise the importance of composite materials in Aerospace structures.

CO	PO1	PO2	PO3	PO4	PO5	PO6
	1	2	3	4	5	6
CO1	1	1	1	1	1	1
CO2	2	2	1	2	2	1
CO3	3	2	1	3	3	1
CO4	2	2	1	2	2	1
CO5	2	2	1	2	2	1
	2	1.8	1	2	2	1

REFERENCES:

- Barrois, W & Ripley, L, "Fatigue of Aircraft Structures", Pergamon Press, Oxford, 1983.
- Brock, D, "Elementary Engineering Fracture Mechanics", Noordhoff International Publishing Co., London, 1994.
- Knott, JF, "Fundamentals of Fracture Mechanics", Butterworth & Co. Ltd., London, 1983.
- Sih, CG, "Mechanics of Fracture, Vol.1", Sijthoff and Noordhoff International Publishing Co., Netherland, 1989.

COURSE OBJECTIVES:

This course will enable students

1. To get insight into the basic aspects of vibration theory.
2. To get in-depth knowledge on different types of isolators and its effectiveness.
3. To provide the basic knowledge on dynamic vibration absorber.
4. To realize the importance of materials selection for appropriate applications.
5. To get knowledge on the principles of active vibration control.

UNIT I BASIC VIBRATION THEORY 9

Free Vibration Theory – Determination of Natural Frequency of a Single Degree Of Freedom – System– Response of a Damped Single Degree of Freedom System – Role of Damping – Forced Vibrations of Discrete Systems – Continuous Systems – Vibrations of Beams and Shafts – Idealization of a Real System Into a Discrete Model – Resonance – An Overview of the Different Methods of Vibration Control

UNIT II VIBRATION ISOLATION 9

Transmissibility – Numerical Examples – Necessity of Vibration Isolation – Vibration Reduction at Source – System Redesign – Different Types of Isolators & Their Effectiveness – Pneumatic Suspension – Excitation Reduction at Source and Factors Affecting Vibration Level – Source Classification – Control of Flow Induced & Self-Excited Systems

UNIT III DYNAMIC VIBRATION ABSORBER 9

Dynamic Vibration Neutralizers – Self-tuned Pendulum Neutralizer - Optimum Design of Damped Absorbers – Absorber with ideal spring and viscous dashpot – Gyroscopic vibration absorbers – Impact Absorbers – Absorbers attached to continuous systems – Field Balancing of Rotors – Resonance: Detuning and Decoupling – Remedial Measures

UNIT IV SELECTION OF MATERIALS 9

Dynamic Properties of Viscoelastic Material – Selection of Materials – Damping-Stress Relationship – Selection Criteria for Linear Hysteretic Material – Design for enhanced material damping – Linear Viscoelastic Model – Constrained Layer Damping – Relaxation – Frequency and Temperature Dependence of the Complex Modulus – Overview and Role of Smart Materials

UNIT V PRINCIPLES OF ACTIVE VIBRATION CONTROL 9

Conceptual Understanding – Shape Memory Actuators for Vibration Control – Shape Memory Materials – Tuned Vibration Absorbers using SMA – Basics of Electro-and Magneto-Rheological Fluids – Active Vibration Isolation using ERF and MRF – Methods of Active Vibration Control Using Piezoelectric Materials – Derivation of Governing Equations – Response of the Structure.

TOTAL: 45 PERIODS**COURSE OUTCOMES:**

At the end of this course, students will be able

CO1: To realise the importance of vibration theory & its practical applications

CO2: To work out response calculations

CO3: To analyse and compare the different methods of vibration control

CO4: To exposure on vibration control using smart materials

CO5: To design a vibration control unit.

CO	PO1	PO2	PO3	PO4	PO5	PO6
	1	2	3	4	5	6
CO1	2	2	2	2	2	1
CO2	2	2	2	2	2	1
CO3	3	3	3	3	3	1
CO4	1	1	1	1	1	1
CO5	3	3	3	3	3	3
	2.2	2.2	2.2	2.2	2.2	1.4

REFERENCES:

1. Malcolm J. Crocker, "Handbook of Noise and Vibration Control", Wiley; 1st edition, 2007.
2. Mallik, AK, "Principles of Vibration Control", Affiliated East-West Press, India, 1990.
3. Mead, DJ, "Passive Vibration Control", Wiley, 1st edition, 1999.
4. Preumont, A "Vibration Control of Active Structures", Springer Netherlands, 3rd edition, 2011.

AO4073

NON-DESTRUCTIVE EVALUATION

**L T P C
3 0 0 3**

COURSE OBJECTIVES:

This course will make students

1. To impart knowledge on the fundamentals of nondestructive testing methods and techniques, aircraft inspection methodology using NDT methods
2. To get insights into the basic aspects of electron microscopy.
3. To learn modern NDT techniques like acoustic emission, ultrasonic and thermographic testing methods.
4. To inspect the aircraft structures using NDT techniques.
5. To get basic knowledge on the structural health monitoring of aerospace structures.

UNIT I INTRODUCTION

9

Need for non-destructive evaluation (NDT) – Applications – Structural inspection – Structural deterioration due to corrosion and fatigue – Crack growth – Fabrication defects – Overloading – Detailed visual inspection – Aircraft wing and fuselage inspection using various NDT techniques – Overview and relative comparison of NDT methods – Jet engine inspection – Critical locations –

UNIT II ELECTRON MICROSCOPY

9

Fundamentals of optics – Optical microscope and its instrumental details – Variants in the optical microscopes and image formation – Polarization light effect – Sample preparation and applications of optical microscopes – Introduction to Scanning electron microscopy (SEM) – Instrumental details and image formation of SEM – Introduction to transmission electron microscopy (TEM) – Imaging techniques and spectroscopy – Sample preparation for SEM and TEM

UNIT III ACOUSTIC EMISSION AND ULTRASONICS 9

Sources of acoustic emission – Physical principals involving acoustic emission and ultrasonics – Configuration of ultrasonic sensors – Phased array ultrasonics – Instrument parts and features for acoustic emission and ultrasonics – Defect characterization – Inspection of cracks and other flaws in metals and composites – Interpretation of data – Image processing – Concepts and application

UNIT IV AIRCRAFT INSPECTION 9

Inspection Levels – General Visual Inspection – During pre, or post flight – Detailed Visual Inspection (DET) – Periodic inspection – Special Detailed Inspection (SDET) – Uses of NDT Methods – Jet Engine Inspection – Engine overhaul – Fluorescent penetrate inspection – Airframe Loading – Fuselage Inspection – Critical Locations – Comparison of different methods of NDT – Visual – Radiography – Eddy Current Testing – Liquid Penetrant Testing – Remote Testing - Landing Gear Inspection

UNIT V STRUCTURAL HEALTH MONITORING 9

An Overview of Structural Health Monitoring – Structural Health Monitoring and Role of Smart Materials – Structural Health Monitoring versus Non-Destructive Evaluation – A Broad Overview of Smart Materials Applications – Notable Applications of SHM in Aerospace Engineering – Structural health monitoring of composites – Repair investigation using SHM – Current limits and future trends.

TOTAL: 45 PERIODS**COURSE OUTCOMES:**

At the end of this course, students will be able

CO1: To realize the importance of various NDT techniques.

CO2: To identify suitable NDT technique for a particular application.

CO3: To demonstrate the physical principles involved in acoustic emission and ultrasonics.

CO4: To have knowledge on the physical principles involved in the various other techniques of NDT.

CO5: To realise the state-of-the-art in NDT testing and structural health monitoring.

CO	PO1	PO2	PO3	PO4	PO5	PO6
	1	2	3	4	5	6
CO1	1	1	1	2	1	1
CO2	1	1	1	2	1	1
CO3	2	1	2	2	2	1
CO4	1	1	1	2	1	1
CO5	1	1	1	2	1	1
	1.2	1	1.2	2	1.2	1

REFERENCES:

1. Cullity, BD & Stock, SR, "Elements of X-ray diffraction", Prentice Hall, Inc. USA, 2001.
2. Daniel Balageas, Claus-Peter Fritzen, Alfredo Güemes, "Structural Health Monitoring", Wiley-ISTE, 2006.
3. Douglas E Adams, "Health Monitoring of Structural Materials and Components-Methods with Applications", John Wiley and Sons, 2007.
4. Douglas B. Murphy, "Fundamentals of light microscopy and electronic imaging", Wiley-Liss, Inc. USA, 2001.
5. Richard Brundle. C, Charles A. Evans, Jr., Shaun Wilson, "Encyclopedia of Materials Characterization, Surfaces, Interfaces, Thin Films", Butterworth-Heinemann, Boston, USA, 1992.

6. Williams, DB & Barry Carter,C, "Transmission electron microscopy, vol. 4", Springer, USA, 1996.
7. Non-destructive Testing Handbook – ASNT Series – Volume 1 – 6.

AO4012

COMPONENT DESIGN OF AIRCRAFT ENGINES

L T P C

3 0 0 3

COURSE OBJECTIVES:

1. This course provides the fundamental principles of fluid mechanics and thermodynamics on jet engine design.
2. This course brings out the differences in the design of various types of gas turbine engines.
3. This course imparts knowledge on the effect of inlet design on aerodynamic and propulsive aspects of aircrafts.
4. This course also addresses the problems associated with the design of combustion chambers.
5. This course deals with the practical difficulties in the matching of compressor and turbine.

UNIT I DESIGN FUNDAMENTALS OF GAS TURBINE ENGINE 8

Design Process - Constraint Analysis - Preliminary estimates - Aircraft weight and fuel consumption data- Mission analysis – Performance cycle analysis – Engine installation drag and sizing – Current challenges in gas turbine technology.

UNIT II INLET DESIGN 9

Elements of an Inlet - Engine Integration – Subsonic inlet - Engine Operational Requirements - Supersonic Inlet - Engine Operational Requirements - Engine Impact on Inlet Design - Inlet Impact on Engine Design- Validation of Inlet-Engine System.

UNIT III DESIGN OF ROTATING COMPONENTS 10

Fan and Compressor Aerodynamics - Diffusion factor - Aerofoil geometry - Flow path dimensions - Radial variation - Turbine Aerodynamics - Constant axial velocity – adiabatic - selected Mach number - Mean line stage Design - tage pressure ratio - Airfoil geometry - Radial variation - Turbine cooling - Engine life - Design Examples.

UNIT IV COMBUSTION CHAMBER DESIGN 10

Combustion system components- Chemical reactor theory - Combustor Stability map-Stirring and mixing-Total pressure loss-Fuels-Ignition-Combustion Systems of Main Burner Design: Air partitioning- Main burner component Design: Diffuser-types of burner-inner and outer casing Design-Fuel- nozzle-Dome and liner-Primary zone- swirler-Secondary holes-Dilution holes-Transition duct-Example Design calculation: Design of Afterburners-Design parameters-Components-Diffuser-Fuel injection-Ignition-Flame stabilization-Flame spread and after burner length-Example design calculations.

UNIT V EXHAUST NOZZLE DESIGN 8

Different types of Nozzles – design of nozzles - Jet control methods for reduction of infrared signature on military aircrafts - Simple design problem - One dimensional nozzle flow.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, students will be able

CO1: To successfully design a gas turbine engine for given requirements.

CO2: To have thorough knowledge with the operational behavior of the major components of gas turbine engines.

CO3: To identify the factors those limit the performance of the components of gas turbine engines.

CO4: To find solutions for the compressor and turbine matching in gas turbine engines.

CO5: To overcome the problems associated with inlet on aircrafts.

CO	PO1	PO2	PO3	PO4	PO5	PO6
	1	2	3	4	5	6
CO1	3	1	3	3	3	1
CO2	1	1	1	1	1	1
CO3	2	1	1	1	1	1
CO4	1	1	1	1	1	1
CO5	1			1	1	
	1.6	0.8	1.2	1.4	1.4	0.8

REFERENCES:

1. Cumpsty,N, "Jet Propulsion: A Simple Guide to the Aerodynamics and Thermodynamics Design and Performance of Jet Engines", Cambridge University Press, 2nd edition, 2003.
2. Mattingly.JD,Heiser,WH and Pratt,DT,"Aircraft Engine Design", 2nd Edition, AIAA Education Series, 2002.
3. Oates. GC,"Aircraft Propulsion Systems Technology and Design", AIAA Education Series, 1989.
4. Saravanamuttoo, HIH andRogers,GFC,"Gas Turbine Technology", Pearson Education Canada, 6th edition, 2008.
5. Treager,IE,"Aircraft Gas Turbine Engine Technology", 3rd edition, Glencoe McGraw-Hill, Inc.1995.

AO4013

AIRCRAFT SYSTEMS ENGINEERING

L T P C
3 0 0 3

COURSE OBJECTIVES:

This course will make students

1. To provide exposure to basic concepts of Aircraft product system engineering and design
2. To provide exposure to different fault and failure analysis methods in aircraft systems.
3. To provide exposure on systems engineering process, System Architecture and integration
4. To provide exposure on the importance of Maintainability, reliability and availability of the product.
5. To provide exposure importance of formal planning and documentation in systems engineering.

UNIT I INTRODUCTION TO SYSTEMS ENGINEERING 9

Overview of Systems Engineering- Systems Engineering Concept Map-Systems Definition-The seven steps Systems Engineering-Conceptual System Design- System Engineering Process- Requirements and Management-Trade Studies-Integrated Product And Process Development.

UNITII THE AIRCRAFT SYSTEMS AND DESIGN 9

Introduction- Everyday Examples of Systems- Aircraft Systems –Generic Systems-Product Life Cycle- Different Phases-Whole Life Cycle Tasks- Systems Analysis-Design Drivers in the Project, Product, Operating Environment- Interfaces with the Subsystems-Mission analysis

UNIT III SYSTEM ARCHITECTURE SAND INTEGRATION 9

Introduction- Systems Architectures –Modeling and Trade-Offs Evolution of Avionics Architectures- Systems Integration Definition-Examples of Systems Integration-Integration Skills-Management of Systems Integration.

UNITIV PRACTICAL CONSIDERATIONS AND CONFIGURATION CONTROL 9

Stakeholders- Communications- Criticism- Configuration Control Process-Portrayal of a System-Varying Systems Configurations- Compatibility-Factors Affecting Compatibility–Systems Evolution. Considerations and Integration of Aircraft Systems- Risk Management.

UNITV SYSTEMS RELIABILITYAND MAINTAINABILITY 9

Systems and Components-Analysis- Influence, Economics, Design for Reliability-Fault and Failure Analysis-System Life Cycle cost-Case Study-Maintenance Types-Program-Planning and Design.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of this course, Students will be able to

CO1: Describe the importance of systems engineering process in product development

CO2: Categorize different aircraft systems and will be able to differentiate the avionics architectures

CO3: Outline the different stages of product development and factors influencing in each stage

CO4: Analyze the different alternatives during design process

CO5: Plan, organize and document the task related to product design, development and testing.

CO	PO1	PO2	PO3	PO4	PO5	PO6
	1	2	3	4	5	6
CO1		1	1	1	1	1
CO2				1	1	
CO3				1	1	
CO4	2	2	2	2	2	2
CO5	2	2	2	2	2	2
	0.8	1	1	1.4	1.4	1

REFERENCES:

1. Andrew P.Sage& James E.Armstrong, "Introduction to Systems Engineering", 1st edition, 2000.
2. Erik Aslaksen& Rod Belcher, "Systems Engineering", Prentice Hall, 1992.
3. Ian Moir&Allan Seabridge, "Design and Development of Aircraft Systems", Wiley, 2nd edition, 2012.
4. Ian Moir& Allan Seabridge, "Aircraft Systems Mechanical, electrical, and avionics subsystems integration", John Wiley & Sons Ltd, 2011.
5. Peter. Sydenham, "Systems Approach to Engineering Design",Artechhouse,Inc,London, 2003.

AO4014

AIRCRAFT DESIGN

L T P C
3 0 0 3

COURSE OBJECTIVES:

This course will enable students

1. To get in-depth knowledge about the preliminary concepts of aircraft design.
2. To provide with the basic knowledge on various aircraft loads.
3. To learn the design of aircraft wing.
4. To get exposed to different kinds of landing gear and its design.
5. To provide with the basic knowledge on integration of wing, fuselage, empennage and power plant.

UNIT I PRELIMINARY CONCEPTS

8

Aircraft Design Requirements - Specifications - Role of user - Aerodynamic and Structural considerations - Importance of weight fractions - Airworthiness requirements and standards - Classification of airplanes - Special features of an airplane- Airplane performance aspects - Range and endurance - Take-off and landing - Climbing performance - Engine Performance

UNIT II AIRCRAFT LOADS

10

Ground loads - Flight Loads - Symmetrical loads in flight - Basic flight loading conditions - Load factor calculation during a manouever - Velocity - Load factor diagram - Gust load and its estimation - Structural limits - Airplane weight estimation based on type of airplane - Trends in wing loading - Weight-estimation based on mission requirements - iterative approach - Span wise load distribution - Wing Loading

UNIT III WING DESIGN

10

Selection of airfoil selection - Influencing factors - Planform shapes of an airplane wing - Stalling, takeoff and landing considerations - Wing drag estimation - High lift devices - Supercritical Airfoils - Cockpit and aircraft passenger cabin layout for different aircraft - types of associated structure - structural layout - features of light airplanes using advanced composite materials - Structural design aspects - Bending moment and shear force diagram for wing and fuselage - Design principles of all metal stressed skin construction for civil and military applications

UNIT IV LANDING GEAR

8

Different kinds of landing gears and associated arrangement for civil and military airplanes - Preliminary calculations for locating main and nose landing gears - Integration of Structure and Power Plant - Estimation of Horizontal and Vertical tail volume ratios - Choice of power plant and various options of locations - Considerations of appropriate air-intakes- Power Plant Loading

UNIT V INTEGRATION OF WING, FUSELAGE, EMPENNAGE AND POWER PLANT 9

Estimation of center of gravity - Introduction to advanced concepts - Aircraft Stability - Relaxed static stability - Controlled configured vehicles - V/STOL aircraft & rotary wing vehicles - Design and layout of flying controls and engine controls - Design of a wing-fuselage joint

TOTAL: 45 PERIODS**COURSE OUTCOMES:**

At the end of this course, students will

- CO1:** Have overall knowledge of preliminary aircraft design.
- CO2:** Have basic knowledge of aircraft rules and airworthiness requirements imposed by governing bodies.
- CO3:** Be able to calculate and estimate aircraft loads under different loading conditions.
- CO4:** Be able to configure an aircraft wing based on aerodynamic considerations.
- CO5:** Be exposed to the role of aircraft stability in the aircraft design process.

CO	PO1	PO2	PO3	PO4	PO5	PO6
	1	2	3	4	5	6
CO1	1	1	1	1	1	
CO2		1	1			
CO3	2	1	2	2	1	1
CO4	1	1	1	1	1	
CO5		1	1	1		
	0.8	1	1.2	1	0.6	0.2

REFERENCES:

1. Conway, HG, "Landing Gear Design", Chapman & Hall; 1st edition, 1958.
2. Daniel P Raymer, "Aircraft Design: A conceptual approach", AIAA Educational Series, 5th edition 2012.
3. Darrol Stinton, "The Design of Airplane", Wiley publishers, 2nd edition, 2001.
4. John D Anderson, "Airplane Performance and Design", McGraw Hill, 1st edition, 1999.
5. Nicholai, LM, "Fundamentals of airplane Design", Univ. of Dayton DHIO, 1975.
6. Torenbeek, Egbert, "Synthesis of Subsonic Airplane Design", Springer publishers, 1982.

AO4015 COMPOSITE PRODUCT PROCESSING METHODS L T P C
3 0 0 3

COURSE OBJECTIVES:

This course will make students

1. To impart knowledge on the material selection for fabricating composite products.
2. To impart an idea about the product development and manufacturing of composites.
3. To acquire adequate knowledge about the manufacturing of thermoset composites.
4. To acquire adequate knowledge about the manufacturing of thermoplastic composites.
5. To gain knowledge on joining, machining and cutting of composites.

UNIT I MATERIAL SELECTION 9

Reinforcements - Glass Fiber Manufacturing - Carbon Fiber Manufacturing - Aramid Fiber Manufacturing - Matrix Materials - Thermoset Resins - Thermoplastic Resins - Fabrics - Prepregs - Preforms - Molding Compound - Honeycomb and Other Core Materials - The Need for Material Selection - Reasons for Material Selection - Material Property Information - Steps in the Material Selection Process - Material Selection Methods.

UNIT II PRODUCT DEVELOPMENT AND DESIGN FOR MANUFACTURING 9

Product Development Process - Reasons for Product Development - Importance of Product Development - Concurrent Engineering - Product Life Cycle - Phases of Product Development - Design Review - Failure Modes and Effects Analysis (FMEA) - Design Problems - DFM - DFM Implementation Guidelines - Design Evaluation Method - Design for Assembly (DFA).

UNIT III MANUFACTURING PROCESSES FOR THERMOSET COMPOSITES 9

Prepreg Lay-Up Process - Wet Lay-Up Process - Spray-Up Process - Filament Winding Process - Pultrusion Process - Resin Transfer Molding Process - Structural Reaction Injection Molding (SRIM) Process - Compression Molding Process - Roll Wrapping Process - Injection Molding of Thermoset Composites.

UNIT IV MANUFACTURING PROCESSES FOR THERMOPLASTIC COMPOSITES 9

Thermoplastic Tape Winding - Thermoplastic Pultrusion Process - Compression Molding of GMT - Hot Press Technique - Autoclave Processing - Diaphragm Forming Process - Injection Molding.

UNIT V JOINING, MACHINING AND CUTTING OF COMPOSITES 9

Adhesive Bonding - Failure Modes in Adhesive Bonding - Basic Science of Adhesive Bonding - Types of Adhesives - Advantages of Adhesive Bonding over Mechanical Joints - Disadvantages of Adhesive Bonding - Adhesive Selection Guidelines - Surface Preparation Guidelines - Design Guidelines for Adhesive Bonding- Theoretical Stress Analysis for Bonded Joints - Mechanical Joints - Preparation for the Bolted Joint-Purposes of Machining - Challenges during Machining of Composites - Failure Mode during Machining of Composites - Cutting Tools - Types of Machining Operations - Cutting Operation - Drilling Operation.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of this course, students will be able

CO6: To select the suitable material for making composite products.

CO7: To gain knowledge on product development and manufacturing of composites.

CO8: To select the most appropriate manufacturing process for fabricating thermoset composite components.

CO9: To select the most appropriate manufacturing process for fabricating thermoplastic composite components.

CO10: To gain knowledge about the joining, machining and cutting of composites.

REFERENCES:

1. Allen Baker, "Composite Materials for Aircraft Structures", AIAA Series, 2nd Edition, 2004.
2. Autar K Kaw, "Mechanics of Composite Materials", CRC Press, 2nd edition, 2005.
3. Lubing, "Handbook on Advanced Plastics and Fibre Glass", Von Nostran Reinhold Co., New York, 1989.
4. Sanjay K. Mazumdar, "Composites Manufacturing : Materials, Product, and Process Engineering", CRC Press, Washington, D.C, 2002.

CO	PO1	PO2	PO3	PO4	PO5	PO6
	1	2	3	4	5	6
CO1			2		1	1
CO2			2		1	1
CO3			2		1	1
CO4			2		1	1
CO5			2		1	1
	0	0	2	0	1	1

AO4016

HELICOPTER AERODYNAMICS

L T P C
3 0 0 3

COURSE OBJECTIVES:

1. This course will make students to provide with introductory concepts of types of rotorcraft.
2. This course imparts knowledge on the fundamental aspects of helicopter aerodynamics and performance of helicopters.
3. This course will provide basic knowledge on the performance of helicopters.
4. This course presents stability and control aspects of helicopters.
5. This course will explore the basic aerodynamic design aspects of helicopters.

UNIT I INTRODUCTION 9

Types of rotorcraft – autogyro, gyrodyne, helicopter, Main rotor system – articulated, semi rigid, rigid rotors, Collective pitch control, cyclic pitch control, anti torque pedals.

UNIT II HELICOPTER AERODYNAMICS 10

Momentum / actuator disc theory, Blade element theory, combined blade element and momentum theory, vortex theory, rotor in hover, rotor model with cylindrical wake and constant circulation along blade, free wake model, Constant chord and ideal twist rotors, Lateral flapping, Coriolis forces, reaction torque, compressibility effects, Ground effect.

UNIT III PERFORMANCE 9

Hover and vertical flight, forward level flight, Climb in forward flight, optimum speeds, Maximum level speed, rotor limits envelope – performance curves with effects of altitude

UNIT IV STABILITY AND CONTROL 9

Helicopter Trim, Static stability – Incidence disturbance, forward speed disturbance, angular velocity disturbance, yawing disturbance, Dynamic Stability.

UNIT V AERODYNAMIC DESIGN 9

Blade section design, Blade tip shapes, Drag estimation – Rear fuselage upsweep, vibration problem of Helicopter blades.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of this course, students will be able to

- CO1:** Describe and compare possible helicopter structures and configurations.
CO2: Identify features of aerodynamic components of rotary wing aircraft and its performance.
CO3: Describe the aerodynamic characteristics that affect rotary wing flight.
CO4: Idea about the factors that influence helicopter stability.
CO5: Gain knowledge of helicopter controls and vibration analysis of helicopter blades.

CO	PO1	PO2	PO3	PO4	PO5	PO6
	1	2	3	4	5	6
CO1	2	1	1	1	1	
CO2					2	1
CO3		1		1	1	
CO4	1	1	1	1	1	1
CO5	1	1	1	1	1	1
	0.8	0.8	0.6	0.8	1.2	0.6

REFERENCES:

1. Gessow.A and Meyers,GC,“Aerodynamics of the Helicopter”, Macmillan and Co., New York,1982.
2. John Fay, “The Helicopter”, Himalayan Books, New Delhi, 1995.
3. Lalit Gupta, “Helicopter Engineering”, Himalayan Books, New Delhi, 1996.
4. Lecture Notes on Helicopter Technology, Department of Aerospace Engineering, IIT – Kanpur and Rotary Wing aircraft R&D center, HAL, Bangalore, 1998.
5. Seddon,J,“Basic Helicopter Aerodynamics”, AIAA Education series, Blackwell scientific publications, U.K, 1990.

AO4072

HIGH SPEED JET FLOWS

L T P C
3 0 0 3

COURSE OBJECTIVES:

This course will make students

1. To get insight into the basic aspects of jets and types of jets.
2. To learn the basic properties of jets and its characteristics.
3. To get knowledge on various active and passive jet control methods.
4. To gain knowledge into the basic aspects of jet acoustics
5. To acquire in-depth knowledge on how and what type of control methods can be implemented practically.

UNIT I INTRODUCTION

9

Properties of Turbulent Jets-Fundamental Concepts, Submerged Jets- Velocity Profiles in a Submerged Jet- Spread of a turbulent submerged jet- Lines of Constant Velocity in a Submerged Jet. Velocity Variation along the Axis of a Submerged jet, Velocity, Temperature, and Concentration Profiles in a Turbulent Jet Spreading into an External Stream of Fluid- Spread of a Turbulent Jet into a Co-flowing or Counter-flowing External Stream- Turbulence Characteristics in a Free Jet.

UNIT II JETS

9

Types of Jets-Plane free-jets. Round jets. Plane jets in a co-flowing stream. Round jet in Co flowing stream- Swirling jets-Radial jets- Wall jets- Jet Characteristics & Entrainment, Mathematical treatment of jet profiles- Semi-empirical Theories. Mixing Layers- Computational and Experimental Techniques for Studying the Jets.

UNIT III ACTIVE JETCONTROL METHODS 9

Active control methods- Actuators-Fluidic, Thermal, Acoustic, Piezoelectric, Electromagnetic, MEMS, Synthetic Jets, Controls and Sensors, Applications.

UNIT IV PASSIVE JET CONTROL METHODS 9

Passive control techniques- Tabs, Grooves, Chevrons, non-circular nozzles, Notches & wires, vortex generators. Optical Flow Visualization, Applications.

UNIT V JET ACOUSTICS 9

Introduction to Jet Acoustics – Types of jet noise – Source of generation- Travelling wave solution, standing wave solution – multi-dimensional acoustics-Theoretical Concepts of Jet Noise Generation and Suppression–Jet Noise suppression techniques – applications

TOTAL: 45 PERIODS**COURSE OUTCOMES:**

Upon completion of this course, students will be able

CO1: To acquire knowledge on the unique features of jet flows.

CO2: To analyse the characteristics of jets.

CO3: To have through knowledge on active and passive control methods of jets.

CO4: To acquire knowledge on jet acoustics and methods for suppression of jet noise.

CO5: To demonstrate various experimental techniques to determine jet characteristics.

CO	PO1	PO2	PO3	PO4	PO5	PO6
	1	2	3	4	5	6
CO1			2		3	1
CO2	3		2	2	3	1
CO3			2	1	3	1
CO4			2		3	1
CO5	2		2	3	3	1
	1	0	2	1.2	3	1

REFERENCES:

1. Ethirajan Rathakrishnan, "Applied Gas Dynamics", John Wiley, New York, 2010.
2. Liepmann and Roshko, "Elements of Gas Dynamics", Dover Publishers, 2017.
3. Rathakrishnan E., "Gas Dynamics", Prentice Hall of India, New Delhi, 5th edition, 2014.
4. Shapiro, AH, "Dynamics and Thermodynamics of Compressible Fluid Flow, Vols. I & II", Ronald Press, New York, 1953.

**AO4074 SMART MATERIALS AND STRUCTURAL HEALTH MONITORING L T P C
3 0 0 3**
COURSE OBJECTIVES:

This course will enables students

1. To get basic idea on the fundamentals of structural health monitoring.
2. To impart knowledge in the areas of vibration based techniques in structural health monitoring, fibre optics and piezo electric sensors.
3. To gain knowledge on the fundamentals of fabrication, modelling, analysis, and design of smart materials and structures.
4. To get exposed to the state of the art of smart materials and systems,
5. To impart knowledge on spanning piezoelectrics, shape memory alloys, electro active polymers, mechanochromic materials and fibre optics.

UNIT I STRUCTURAL HEALTH MONITORING 8

An Overview of Structural Health Monitoring, Structural Health Monitoring and Smart Materials, Structural Health Monitoring versus Non Destructive Evaluation A broad Overview of Smart Materials Overview of Application Potential of SHM Notable Applications of SHM – Aerospace Engineering. Structural health monitoring of composites – Repair investigation using SHM.

UNIT II OVERVIEW OF SMART MATERIALS 10

Introduction to Smart Materials, Principles of Piezoelectricity, Perovskite Piezoceramic Materials, Single Crystals vs Polycrystalline Systems, Piezoelectric Polymers, Principles of Magnetostriction, Rare earth Magnetostrictive materials, Giant Magnetostriction and Magneto-resistance Effect, Introduction to Electro-active Materials, Electronic Materials, Electro-active Polymers, Ionic Polymer Matrix Composite (IPMC), Shape Memory Effect, Shape Memory Alloys, Shape Memory Polymers, Electro-rheological Fluids, Magneto Rheological Fluids.

UNIT III SMART COMPOSITES 10

Review of Composite Materials, Micro and Macro-mechanics, Modelling Laminated Composites based on Classical Laminated Plate Theory, Effect of Shear Deformation, Dynamics of Smart Composite Beam, Governing Equation of Motion, Finite Element Modelling of Smart Composite Beams , Vibration Control using SHM –introduction to FE formulation Constitutive Relationship - Element Stiffness Matrix for High Precision Finite Element -Element Mass Matrix for High Precision Finite Element - Developing Actuator and Sensor Influence Matrix .Delamination Sensing using Piezo Sensory Layer.

UNIT IV INTELLIGENT SYSTEMS AND NEURAL NETWORKS 9

Operational evaluation -.Data acquisition- Feature extraction-Statistical model development for feature discrimination -Data Cleansing – Normalization-Data Fusion – Compression – Statistical model building - Supervised pattern recognition - Unsupervised pattern recognition – Signal processing – Fuzzy C means- K means – Kohonen’s Self organization mapping- Fundamentals of Wavelet analysis –Life Prediction.

UNIT V ADVANCES IN SMART STRUCTURES & MATERIALS 8

Self-Sensing Piezoelectric Transducers, Energy Harvesting Materials, Autophagous Materials, Self-Healing Polymers, Intelligent System Design, Emergent System Design of Chemical and Bio-Chemical sensing in structural Assessment – Absorptive chemical sensors – Spectroscopes – Fibre Optic Chemical Sensing Systems and Distributed measurement.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of this course, students will be able

CO1: To familiarize with the fundamentals of history of SHM.

CO2: To provide a systematic approach to SHM process.

CO3: To have knowledge of the various smart materials used for aerospace applications.

CO4: To familiarize with the non-destructive test techniques relevant to SHM.

CO5: To provide hands-on experience with experimental modal analysis.

CO	PO1	PO2	PO3	PO4	PO5	PO6
	1	2	3	4	5	6
CO1	3		3		1	1
CO2			2		1	1
CO3			2		1	1
CO4	3		3		1	1
CO5			2		2	1

REFERENCES:

1. Brian Culshaw, "Smart Structures, and Materials", Artech House, 2000.
2. Daniel Balageas, Claus-Peter Fritzen, Alfredo Güemes, "Structural Health Monitoring", Wiley - ISTE, 2006.
3. Douglas E Adams, "Health Monitoring of Structural Materials and Components-Methods with Applications", John Wiley and Sons, 2007.
4. Gandhi and Thompson, "Smart Materials and Structures", Springer Netherlands, 1992.
5. Laurene Fausett, "Fundamentals Of Neural Networks", Pearson publishers, 1994
6. Victor Giurgliuti, "Structural Health Monitoring with Wafer Active Sensors", Academic Press Inc, 2007.

AO4091

ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

L T P C

3 0 0 3

OBJECTIVES:

1. To gain knowledge on artificial intelligence.
2. To understand the concepts of Machine Learning.
3. To appreciate supervised learning and their applications.
4. To appreciate the concepts and algorithms of unsupervised learning.
5. To understand the theoretical and practical aspects of Probabilistic Graphical Models.

UNIT I ARTIFICIAL INTELLIGENCE

9

Artificial intelligence – Basics – Goals of artificial intelligence– AI techniques–problem representation in AI – Problem reduction and solution techniques - Application of AI and KBES in Robots.

UNIT II INTRODUCTION TO MACHINE LEARNING

9

Machine Learning–Types of Machine Learning –Machine Learning process- preliminaries, testing Machine Learning algorithms, turning data into Probabilities, and Statistics for Machine Learning- Probability theory – Probability Distributions – Decision Theory.

UNIT III SUPERVISED LEARNING

9

Linear Models for Regression – Linear Models for Classification- Discriminant Functions, Probabilistic Generative Models, Probabilistic Discriminative Models – Decision Tree Learning – Bayesian Learning, Naïve Bayes – Ensemble Methods, Bagging, Boosting, Neural Networks, Multi-layer Perceptron, Feed- forward Network, Error Back propagation - Support Vector Machines.

UNIT IV UNSUPERVISED LEARNING

9

Clustering- K-means – EM Algorithm- Mixtures of Gaussians –Dimensionality Reduction, Linear Discriminant Analysis, Factor Analysis, Principal Components Analysis, Independent Components Analysis.

UNIT V PROBABILISTIC GRAPHICAL MODELS

9

Graphical Models – Undirected Graphical Models – Markov Random Fields – Directed Graphical Models –Bayesian Networks – Conditional Independence properties – Markov Random Fields- Hidden Markov Models – Conditional Random Fields (CRFs).

TOTAL: 45 PERIODS

OUTCOMES:

On Completion of the course the student will be able to

- Optimize the robots using Artificial Intelligence.
- Design a learning model appropriate to the application.
- Implement Probabilistic Discriminative and Generative algorithms for an application of your choice and analyze the results.
- Use a tool to implement typical Clustering algorithms for different types of applications.
- Identify applications suitable for different types of Machine Learning with suitable justification.

CO	PO					
	1	2	3	4	5	6
1	2	1	1	2	1	1
2	2	1	1	2	1	1
3	2	1	1	2	1	1
4	2	1	1	2	1	1
5	2	1	1	2	1	1
AVG	2	1	1	2	1	1

1-low, 2-medium, 3-high, ‘-‘- no correlation

REFERENCES:

1. Christopher Bishop, “Pattern Recognition and Machine Learning” Springer, 2007.
2. Stephen Marsland, “Machine Learning – An Algorithmic Perspective”, Chapman and Hall, CRC Press, Second Edition, 2014.
3. Kevin P. Murphy, “Machine Learning: A Probabilistic Perspective”, MIT Press, 2012.
4. Ethem Alpaydin, “Introduction to Machine Learning”, MIT Press, Third Edition, 2014.
5. Tom Mitchell, “Machine Learning”, McGraw-Hill, 1997.

AO4017

AIRCRAFT GUIDANCE AND CONTROL

L T P C
3 0 0 3

COURSE OBJECTIVES:

This course will make students

1. To learn about the aircraft equations of motion and method of linearization.
2. To impart knowledge on the operating principle of guidance law.
3. To gain knowledge on various augmentation systems.
4. To get familiarize with the concepts of longitudinal stability and to design the longitudinal autopilot.
5. To study lateral stability and to design the lateral autopilot.

UNIT I INTRODUCTION

8

Introduction to Guidance and control-Definition, Historical background – Coordinate Frame - Equations of motion – Linearization

UNIT II AUGMENTATION SYSTEMS 8

Need for automatic flight control systems, Stability augmentation systems, control augmentation systems, Design of Limited authority and Full Authority Augmentation systems - Gain scheduling concepts.

UNIT III LONGITUDINAL AUTOPILOT 9

Displacement Autopilot-Pitch Orientation Control system, Acceleration Control System, Glide Slope Coupler and Automatic Flare Control and Flight path stabilization, Longitudinal control law design using back stepping algorithm.

UNIT IV LATERAL AUTOPILOT 10

Damping of the Dutch Roll, Methods of Obtaining Coordination, Yaw Orientation Control system, turn compensation, Automatic lateral Beam Guidance. Introduction to Fly-by-wire flight control systems, Lateral control law design using back stepping algorithm.

UNIT V MISSILE AND LAUNCH VEHICLE GUIDANCE 10

Operating principles and design of guidance laws, homing guidance laws-short range, Medium range and BVR missiles, Launch Vehicle-Introduction, Mission requirements, Implicit guidance schemes, Explicit guidance, Q guidance schemes

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of this course students will be able to

- CO1:** Explain the equations governing the aircraft dynamics and the process of linearizing them.
- CO2:** Define the various guidance schemes & requirements for aircrafts and missiles.
- CO3:** Explain the principle of stability and control augmentation systems.
- CO4:** Explain the oscillatory modes and methods of suppressing them
- CO5:** Design the controller for lateral, longitudinal and directional control of aircrafts.

CO	PO1	PO2	PO3	PO4	PO5	PO6
	1	2	3	4	5	6
CO1	2	2	1	2	2	1
CO2	1	1	1	1	1	1
CO3	2	2	2	2	2	1
CO4	2	2	2	2	2	1
CO5	3	3	3	3	3	3
	2	2	1.8	2	2	1.4

REFERENCES:

1. BlakeLock, JH, "Automatic control of Aircraft and missiles", John Wiley Sons, New York, 1990.
2. Collinson RPG, "Introduction to Avionics", Chapman and Hall, India, 1996.
3. Garnel. P & East DJ, "Guided Weapon control systems", Pergamon Press, Oxford, 1977.
4. Michael V Cook, "Flight Dynamics Principles: A Linear Systems Approach to Aircraft Stability and Control", Elsevier, 2013.
5. Nelson RC, "Flight stability & Automatic Control", McGraw Hill, 1989.
6. Pierre T. Kabamba, Anouck R. Girard, "Fundamentals of Aerospace Navigation and Guidance", Cambridge university press, 2014.
7. Stevens BL and Lewis FL, "Aircraft control & simulation", John Wiley Sons, New York, 1992.
8. Thomas R Yechout, Steven L Morris, David E Bossert, Wayne F Hallgren, James K Hall, "Introduction to Aircraft Flight Mechanics", AIAA Education series, 2014.

AUDIT COURSES

AX4091

ENGLISH FOR RESEARCH PAPER WRITING

L T P C
2 0 0 0

OBJECTIVES

- Teach how to improve writing skills and level of readability
- Tell about what to write in each section
- Summarize the skills needed when writing a Title
- Infer the skills needed when writing the Conclusion
- Ensure the quality of paper at very first-time submission

UNIT I INTRODUCTION TO RESEARCH PAPER WRITING 6

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

UNIT II PRESENTATION SKILLS 6

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction

UNIT III TITLE WRITING SKILLS 6

Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check

UNIT IV RESULT WRITING SKILLS 6

Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions

UNIT V VERIFICATION SKILLS 6

Useful phrases, checking Plagiarism, how to ensure paper is as good as it could possibly be the first- time submission

TOTAL: 30 PERIODS

OUTCOMES

CO1 –Understand that how to improve your writing skills and level of readability

CO2 – Learn about what to write in each section

CO3 – Understand the skills needed when writing a Title

CO4 – Understand the skills needed when writing the Conclusion

CO5 – Ensure the good quality of paper at very first-time submission

REFERENCES

1. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011
2. Day R How to Write and Publish a Scientific Paper, Cambridge University Press 2006
3. Goldbort R Writing for Science, Yale University Press (available on Google Books) 2006
4. Highman N, Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book 1998.

OBJECTIVES

- Summarize basics of disaster
- Explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- Illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- Describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
- Develop the strengths and weaknesses of disaster management approaches

UNIT I INTRODUCTION 6

Disaster: Definition, Factors and Significance; Difference between Hazard And Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

UNIT II REPERCUSSIONS OF DISASTERS AND HAZARDS 6

Economic Damage, Loss of Human and Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

UNIT III DISASTER PRONE AREAS IN INDIA 6

Study of Seismic Zones; Areas Prone To Floods and Droughts, Landslides And Avalanches; Areas Prone To Cyclonic and Coastal Hazards with Special Reference To Tsunami; Post-Disaster Diseases and Epidemics

UNIT IV DISASTER PREPAREDNESS AND MANAGEMENT 6

Preparedness: Monitoring Of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological And Other Agencies, Media Reports: Governmental and Community Preparedness.

UNIT V RISK ASSESSMENT 6

Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival

TOTAL : 30 PERIODS**OUTCOMES**

CO1: Ability to summarize basics of disaster

CO2: Ability to explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.

CO3: Ability to illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.

CO4: Ability to describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.

CO5: Ability to develop the strengths and weaknesses of disaster management approaches

REFERENCES

1. Goel S. L., Disaster Administration And Management Text And Case Studies”, Deep & Deep Publication Pvt. Ltd., New Delhi, 2009.
2. Nishitha Rai, Singh AK, “Disaster Management in India: Perspectives, issues and strategies “New Royal book Company, 2007.
3. Sahni, Pardeep Et. Al. ,” Disaster Mitigation Experiences And Reflections”, Prentice Hall of India, New Delhi, 2001.

AX4093

CONSTITUTION OF INDIA

L T P C
2 0 0 0

OBJECTIVES

Students will be able to:

- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- To address the growth of Indian opinion regarding modern Indian intellectuals’ constitutional Role and entitlement to civil and economic rights as well as the emergence nation hood in the early years of Indian nationalism.
- To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.

UNIT I HISTORY OF MAKING OF THE INDIAN CONSTITUTION

History, Drafting Committee, (Composition & Working)

UNIT II PHILOSOPHY OF THE INDIAN CONSTITUTION

Preamble, Salient Features

UNIT III CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES

Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

UNIT IV ORGANS OF GOVERNANCE

Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.

UNIT V LOCAL ADMINISTRATION

District’s Administration head: Role and Importance, □ Municipalities: Introduction, Mayor and role of Elected Representative, CEO, Municipal Corporation. Pachayati raj: Introduction, PRI: Zila Pachayat. Elected officials and their roles, CEO Zila Pachayat: Position and role. Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy.

UNIT VI ELECTION COMMISSION

Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners - Institute and Bodies for the welfare of SC/ST/OBC and women.

TOTAL: 30 PERIODS

OUTCOMES

Students will be able to:

- Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
- Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
- Discuss the circumstances surrounding the foundation of the Congress Socialist Party[CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
- Discuss the passage of the Hindu Code Bill of 1956.

SUGGESTED READING

- The Constitution of India,1950(Bare Act),Government Publication.
- Dr.S.N.Busi, Dr.B. R.Ambedkar framing of Indian Constitution,1st Edition, 2015.
- M.P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis,2014.
- D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

AX4094

நற்றமிழ் இலக்கியம்

L T P C
2 0 0 0

UNIT I

சங்க இலக்கியம்

6

1. தமிழின் துவக்க நூல் தொல்காப்பியம்
– எழுத்து, சொல், பொருள்
2. அகநானூறு (82)
- இயற்கை இன்னிசை அரங்கம்
3. குறிஞ்சிப் பாட்டின் மலர்க்காட்சி
4. புறநானூறு (95,195)
- போரை நிறுத்திய ஔவையார்

UNIT II

அறநெறித் தமிழ்

6

1. அறநெறி வகுத்த திருவள்ளுவர்
- அறம் வலியுறுத்தல், அன்புடைமை, ஒப்புரவறிதல், ஈகை, புகழ்
2. பிற அறநூல்கள் - இலக்கிய மருந்து
– ஏலாதி, சிறுபஞ்சமூலம், திரிகடுகம், ஆசாரக்கோவை (தூய்மையை வலியுறுத்தும் நூல்)

UNIT III**இரட்டைக் காப்பியங்கள்**

6

1. கண்ணகியின் புரட்சி
- சிலப்பதிகார வழக்குரை காதை
2. சமூகசேவை இலக்கியம் மணிமேகலை
- சிறைக்கோட்டம் அறக்கோட்டமாகிய காதை

UNIT IV**அருள்நெறித் தமிழ்**

6

1. சிறுபாணாற்றுப்படை
- பாரி முல்லைக்குத் தேர் கொடுத்தது,
பேகன் மயிலுக்குப் போர்வை கொடுத்தது, அதியமான் ஓளவைக்கு
நெல்லிக்கனி கொடுத்தது, அரசர் பண்புகள்
2. நற்றிணை
- அன்னைக்குரிய புன்னை சிறப்பு
3. திருமந்திரம் (617, 618)
- இயமம் நியமம் விதிகள்
4. தர்மச்சாலையை நிறுவிய வள்ளலார்
5. புறநானூறு
- சிறுவனே வள்ளலானான்
6. அகநானூறு (4) - வண்டு
நற்றிணை (11) - நண்டு
கலித்தொகை (11) - யானை, புறா
ஐந்திணை 50 (27) - மான்
ஆகியவை பற்றிய செய்திகள்

UNIT V**நவீன தமிழ் இலக்கியம்**

6

1. உரைநடைத் தமிழ்,
- தமிழின் முதல் புதினம்,
- தமிழின் முதல் சிறுகதை,
- கட்டுரை இலக்கியம்,
- பயண இலக்கியம்,
- நாடகம்,
2. நாட்டு விடுதலை போராட்டமும் தமிழ் இலக்கியமும்,
3. சமுதாய விடுதலையும் தமிழ் இலக்கியமும்,
4. பெண் விடுதலையும் விளிம்பு நிலையினரின் மேம்பாட்டில் தமிழ்
இலக்கியமும்,
5. அறிவியல் தமிழ்,
6. இணையத்தில் தமிழ்,
7. சுற்றுச்சூழல் மேம்பாட்டில் தமிழ் இலக்கியம்.

TOTAL: 30 PERIODS

தமிழ் இலக்கிய வெளியீடுகள் / புத்தகங்கள்

1. தமிழ் இணைய கல்விக்கழகம் (Tamil Virtual University)
 - www.tamilvu.org
2. தமிழ் விக்கிப்பீடியா (Tamil Wikipedia)
 - <https://ta.wikipedia.org>
3. தர்மபுர ஆதீன வெளியீடு
4. வாழ்வியல் களஞ்சியம்
 - தமிழ்ப் பல்கலைக்கழகம், தஞ்சாவூர்
5. தமிழ்கலைக் களஞ்சியம்
 - தமிழ் வளர்ச்சித் துறை (thamilvalarchithurai.com)
6. அறிவியல் களஞ்சியம்
 - தமிழ்ப் பல்கலைக்கழகம், தஞ்சாவூர்



REFERENCES:

1. Cech Thomas V., Principles of water resources: history, development, management and policy. John Wiley and Sons Inc., New York. 2003.
2. Mollinga .P. etal “ Integrated Water Resources Management”, Water in South Asia Volume I, Sage Publications, 2006.
3. Technical Advisory Committee, Integrated Water Resources management, Technical Advisory Committee Background Paper No: 4. Global water partnership, Stockholm, Sweden. 2002.
4. Technical Advisory Committee, Dublin principles for water as reflected in comparative assessment of institutional and legal arrangements for Integrated Water Resources Management, Technical Advisory Committee Background paper No: 3. Global water partnership, Stockholm, Sweden. 1999.
5. Technical Advisory Committee, Effective Water Governance”. Technical Advisory Committee Background paper No: 7. Global water partnership, Stockholm, Sweden, 2003.

CO – PO Mapping - INTEGRATED WATER RESOURCES MANAGEMENT

POs/PSOs		Course Outcome					Overall Correlation of COs to POs
		CO1	CO2	CO3	CO4	CO5	
PO1	Knowledge of Engineering Sciences	3	2	2	2	2	2
PO2	Problem analysis	1	3	2	2	2	2
PO3	Design / development of solutions		2	2	2	2	2
PO4	Investigation	1	2			1	1
PO5	Modern Tool Usage	1	1	2	1	1	1
PO6	Individual and Team work		2	2			2
PO7	Communication		2	2			2
PO8	Engineer and Society	2	2	3	2	3	3
PO9	Ethics		2	3	2	2	2
PO10	Environment and Sustainability	3	3	3	3	3	3
PO11	Project Management and Finance	1	1	1		1	1
PO12	Life Long Learning		2	2	2	2	2
PSO1	Knowledge of field research methodology, gender, legal and environmental aspects in the context of integrated water resources management	3	2	2	2	2	2
PSO2	Formulate, analyze and comprehend the differences in social and environmental variability in South Indian context with their peers and strive to work towards sustainability	2	2	2	2	2	2
PSO3	Produce and publish professional reports, peer-reviewed journal, on contemporary and state of the art research in integrated water resources management	2	2	2	2	2	2

OBJECTIVES:

- Understand the accelerating health impacts due to the present managerial aspects and initiatives in water and sanitation and health sectors in the developing scenario

UNIT I FUNDAMENTALS WASH 9

Meanings and Definition: Safe Water- Health, Nexus: Water- Sanitation - Health and Hygiene – Equity issues-Water security - Food Security. Sanitation And Hygiene (WASH) and Integrated Water Resources Management (IWRM) - Need and Importance of WASH

UNIT II MANAGERIAL IMPLICATIONS AND IMPACT 9

Third World Scenario – Poor and Multidimensional Deprivation--Health Burden in Developing Scenario -Factors contribute to water, sanitation and hygiene related diseases-Social: Social Stratification and Literacy Demography: Population and Migration- Fertility - Mortality- Environment: Water Borne-Water Washed and Water Based Diseases - Economic: Wage - Water and Health Budgeting -Psychological: Non-compliance - Disease Relapse - Political: Political Will.

UNIT III CHALLENGES IN MANAGEMENT AND DEVELOPMENT 9

Common Challenges in WASH - Bureaucracy and Users- Water Utilities -Sectoral Allocation:- Infrastructure- Service Delivery: Health services: Macro and Micro- level: Community and Gender Issues- Equity Issues - Paradigm Shift: Democratization of Reforms and Initiatives.

UNIT IV GOVERNANCE 9

Public health -Community Health Assessment and Improvement Planning (CHA/CHIP)- Infrastructure and Investments on Water, (WASH) - Cost Benefit Analysis – Institutional Intervention-Public Private Partnership - Policy Directives - Social Insurance -Political Will vs Participatory Governance -

UNIT V INITIATIVES 9

Management vs Development -Accelerating Development- Development Indicators -Inclusive Development-Global and Local- Millennium Development Goal (MDG) and Targets - Five Year Plans - Implementation - Capacity Building - Case studies on WASH.

TOTAL: 45 PERIODS**OUTCOMES:**

CO1	Capture to fundamental concepts and terms which are to be applied and understood all through the study.
CO2	Comprehend the various factors affecting water sanitation and health through the lens of third world scenario.
CO3	Critically analyse and articulate the underlying common challenges in water, sanitation and health.
CO4	Acquire knowledge on the attributes of governance and its say on water sanitation and health.
CO5	Gain an overarching insight in to the aspects of sustainable resource management in the absence of a clear level playing field in the developmental aspects.

REFERENCES

1. Bonitha R., Beaglehole R., Kjellstorm, 2006, "Basic Epidemiology", 2nd Edition, World Health Organization.
2. Van Note Chism, N. and Bickford, D. J. (2002), Improving the environment for learning: An expanded agenda. *New Directions for Teaching and Learning*, 2002: 91–98. doi: 10.1002/tl.83 Improving the Environment for learning: An Expanded Agenda
3. National Research Council. *Global Issues in Water, Sanitation, and Health: Workshop Summary*. Washington, DC: The National Academies Press, 2009.
4. Sen, Amartya 1997. *On Economic Inequality*. Enlarged edition, with annex by James Foster and Amartya Sen, Oxford: Clarendon Press, 1997.
5. *Intersectoral Water Allocation Planning and Management*, 2000, World Bank Publishers www. Amazon.com
6. Third World Network.org (www.twn.org).

CO PO MAPPING : WATER, SANITATION AND HEALTH

PO/PSO		Course Outcome					Overall Correlation of COs to POs
		CO1	CO2	CO3	CO4	CO5	
PO1	Knowledge of Engineering Sciences		1	1	M	1	1
PO2	Problem analysis		2	2	2	2	2
PO3	Design / development of solutions			2	1	2	2
PO4	Investigation		2	3	3	3	3
PO5	Modern Tool Usage				1		1
PO6	Individual and Team work		2	2	1	2	2
PO7	Communication				2	2	2
PO8	Engineer and Society		3	3	3	3	3
PO9	Ethics			1	2	2	2
PO10	Environment and Sustainability		3			3	3
PO11	Project Management and Finance					1	1
PO12	Life Long Learning	2	3	2	3	3	3
PSO1	Explain the concepts of water management, field research methodology, gender, legal and environmental aspects in the context of integrated water resources management		3	3	3	3	3
PSO2	Formulate, analyse and comprehend the differences in social and economic variability in South Asian context with their peers and strive to work towards sustainability.		3	2	3	3	3
PSO3	Produce and publish professional reports, peer reviewed journal on contemporary and state of art research in water resources Engineering.		3	3	3	2	3

OBJECTIVES:

- To impart knowledge on environmental, social and economic dimensions of sustainability and the principles evolved through landmark events so as to develop an action mindset for sustainable development.

UNIT I SUSTAINABILITY AND DEVELOPMENT CHALLENGES 9

Definition of sustainability – environmental, economical and social dimensions of sustainability - sustainable development models – strong and weak sustainability – defining development-millennium development goals – mindsets for sustainability: earthly, analytical, precautionary, action and collaborative– syndromes of global change: utilisation syndromes, development syndromes, and sink syndromes – core problems and cross cutting Issues of the 21 century - global, regional and local environmental issues – social insecurity - resource degradation – climate change – desertification.

UNIT II PRINCIPLES AND FRAME WORK 9

History and emergence of the concept of sustainable development - our common future - Stockholm to Rio plus 20– Rio Principles of sustainable development – Agenda 21 natural step-peoples earth charter – business charter for sustainable development –UN Global Compact - Role of civil society, business and government – United Nations' 2030 Agenda for sustainable development – 17 sustainable development goals and targets, indicators and intervention areas

UNIT III SUSTAINABLE DEVELOPMENT AND WELLBEING 9

The Unjust World and inequities - Quality of Life - Poverty, Population and Pollution - Combating Poverty - - Demographic dynamics of sustainability - Strategies to end Rural and Urban Poverty and Hunger – Sustainable Livelihood Framework- Health, Education and Empowerment of Women, Children, Youth, Indigenous People, Non-Governmental Organizations, Local Authorities and Industry for Prevention, Precaution, Preservation and Public participation.

UNIT IV SUSTAINABLE SOCIO-ECONOMIC SYSTEMS 10

Sustainable Development Goals and Linkage to Sustainable Consumption and Production – Investing in Natural Capital- Agriculture, Forests, Fisheries - Food security and nutrition and sustainable agriculture- Water and sanitation - Biodiversity conservation and Ecosystem integrity –Ecotourism - Sustainable Cities – Sustainable Habitats- Green Buildings - Sustainable Transportation — Sustainable Mining - Sustainable Energy– Climate Change –Mitigation and Adaptation - Safeguarding Marine Resources - Financial Resources and Mechanisms

UNIT V ASSESSING PROGRESS AND WAY FORWARD 8

Nature of sustainable development strategies and current practice- Sustainability in global, regional and national context –Approaches to measuring and analysing sustainability– limitations of GDP- Ecological Footprint- Human Development Index- Human Development Report – National initiatives for Sustainable Development - Hurdles to Sustainability - Science and

Technology for sustainable development –Performance indicators of sustainability and Assessment mechanism – Inclusive Green Growth and Green Economy – National Sustainable Development Strategy Planning and National Status of Sustainable Development Goals

TOTAL: 45 PERIODS

OUTCOMES:

- On completion of the course, the student is expected to be able to

CO1	Explain and evaluate current challenges to sustainability, including modern world social, environmental, and economic structures and crises.
CO2	Identify and critically analyze the social environmental, and economic dimensions of sustainability in terms of UN Sustainable development goals
CO3	Develop a fair understanding of the social, economic and ecological linkage of Human well being, production and consumption
CO4	Evaluate sustainability issues and solutions using a holistic approach that focuses on connections between complex human and natural systems.
CO5	Integrate knowledge from multiple sources and perspectives to understand environmental limits governing human societies and economies and social justice dimensions of sustainability.

REFERENCES:

1. Tom Theis and Jonathan Tomkin, Sustainability: A Comprehensive Foundation, Rice University, Houston, Texas, 2012
2. A guide to SDG interactions:from science to implementation, International Council for Science, Paris,2017
3. Karel Mulder, Sustainable Development for Engineers - A Handbook and Resource Guide, Rouledge Taylor and Francis, 2017.
4. The New Global Frontier - Urbanization, Poverty and Environmentin the 21st Century - *George Martine,Gordon McGranahan,Mark Montgomery and Rogelio Fernández-Castilla*, IIED and UNFPA, Earthscan, UK, 2008
5. Nolberto Munier, Introduction to Sustainability: Road to a Better Future, Springer, 2006
6. Barry Dalal Clayton and Stephen Bass, Sustainable Development Strategies- a resource book”, Earthscan Publications Ltd, London, 2002.

CO – PO Mapping –Principles of Sustainable Development

PO/PSO		Course Outcome					Overall Correlation of COs to POs
		CO1	CO2	CO3	CO4	CO5	
PO1	Knowledge of Engineering Sciences						
PO2	Problem analysis	3	3				3
PO3	Design / development of solutions				3	3	3
PO4	Investigation		2	2	2	2	2
PO5	Modern Tool Usage						
PO6	Individual and Team work		2	2			2
PO7	Communication					1	1
PO8	Engineer and Society	3			3		3
PO9	Ethics				2	2	2
PO10	Environment and Sustainability	3	3	3	3	3	3
PO11	Project Management and Finance						
PO12	Life Long Learning					1	1

PSO1	Knowledge of Environmental Management discipline	3	3	3	3		3
PSO2	Environmental Performance Evaluation and coordination						
PSO3	Conceptualization of Environmental Management Systems						

OCE434

ENVIRONMENTAL IMPACT ASSESSMENT

L T P C

3 0 0 3

OBJECTIVES:

- To make the students to understand environmental clearance, its legal requirements and to provide knowledge on overall methodology of EIA, prediction tools and models, environmental management plan and case studies.

UNIT I INTRODUCTION

9

Historical development of Environmental Impact Assessment (EIA). Environmental Clearance- EIA in project cycle. legal and regulatory aspects in India – types and limitations of EIA –EIA process- screening – scoping - terms of reference in EIA- setting – analysis – mitigation. Cross sectoral issues –public hearing in EIA- EIA consultant accreditation.

UNIT II IMPACT IDENTIFICATION AND PREDICTION

10

Matrices – networks – checklists – cost benefit analysis – analysis of alternatives – expert systems in EIA. prediction tools for EIA – mathematical modeling for impact prediction – assessment of impacts – air – water – soil – noise – biological — cumulative impact assessment

UNIT III SOCIO-ECONOMIC IMPACT ASSESSMENT

8

Socio-economic impact assessment - relationship between social impacts and change in community and institutional arrangements. factors and methodologies- individual and family level impacts. communities in transition-rehabilitation

UNIT IV EIA DOCUMENTATION AND ENVIRONMENTAL MANAGEMENT PLAN

9

Environmental management plan - preparation, implementation and review – mitigation and rehabilitation plans – policy and guidelines for planning and monitoring programmes – post project audit – documentation of EIA findings – ethical and quality aspects of environmental impact assessment

UNIT V CASE STUDIES

9

Mining, power plants, cement plants, highways, petroleum refining industry, storage & handling of hazardous chemicals, common hazardous waste facilities, CETPs, CMSWMF, building and construction projects

TOTAL: 45 PERIODS

OUTCOMES:

- On completion of the course, the student is expected to be able to

CO1	Understand need for environmental clearance, its legal procedure, need of EIA, its types, stakeholders and their roles
------------	--

CO2	Understand various impact identification methodologies, prediction techniques and model of impacts on various environments
CO3	Understand relationship between social impacts and change in community due to development activities and rehabilitation methods
CO4	Document the EIA findings and prepare environmental management and monitoring plan
CO5	Identify, predict and assess impacts of similar projects based on case studies

REFERENCES:

1. EIA Notification 2006 including recent amendments, by Ministry of Environment, Forest and Climate Change, Government of India
2. Sectoral Guidelines under EIA Notification by Ministry of Environment, Forest and Climate Change, Government of India
3. Canter, L.W., Environmental Impact Assessment, McGraw Hill, New York. 1996
4. Lawrence, D.P., Environmental Impact Assessment – Practical solutions to recurrent problems, Wiley-Interscience, New Jersey. 2003
5. Lee N. and George C. 2000. Environmental Assessment in Developing and Transitional Countries. Chichester: Willey
6. World Bank –Source book on EIA ,1999
7. Sam Mannan, Lees' Loss Prevention in the Process Industries, Hazard Identification Assessment and Control, 4th Edition, Butterworth Heineman, 2012.

CO – PO Mapping- ENVIRONMENTAL IMPACT ASSESSMENT

PO/PSO		Course Outcome					Overall Correlation of COs to Pos
		CO1	CO2	CO3	CO4	CO5	
PO1	Knowledge of Engineering Sciences		3			3	3
PO2	Problem analysis		2	2			2
PO3	Design / development of solutions		3	3	3		3
PO4	Investigation		2	2		2	2
PO5	Modern Tool Usage		2	2	3		2
PO6	Individual and Team work		2	2	2		2
PO7	Communication				1		1
PO8	Engineer and Society	2			2		2
PO9	Ethics	3	3	3	2	2	3
PO10	Environment and Sustainability	3			2		2
PO11	Project Management and Finance				1		L
PO12	Life Long Learning		1	1			L
PSO1	Knowledge of Environmental Engineering discipline	2					2
PSO2	Environmental Performance Evaluation and coordination		2	2	2		2
PSO3	Conceptualization of Environmental Engineering Systems		2		2		2

COURSE OBJECTIVES:

- This course is intended to study the basics of Blockchain technology.
- During this course the learner will explore various aspects of Blockchain technology like application in various domains.
- By implementing, learners will have idea about private and public Blockchain, and smart contract.

UNIT I INTRODUCTION OF CRYPTOGRAPHY AND BLOCKCHAIN 9

Introduction to Blockchain, Blockchain Technology Mechanisms & Networks, Blockchain Origins, Objective of Blockchain, Blockchain Challenges, Transactions and Blocks, P2P Systems, Keys as Identity, Digital Signatures, Hashing, and public key cryptosystems, private vs. public Blockchain.

UNIT II BITCOIN AND CRYPTOCURRENCY 9

Introduction to Bitcoin, The Bitcoin Network, The Bitcoin Mining Process, Mining Developments, Bitcoin Wallets, Decentralization and Hard Forks, Ethereum Virtual Machine (EVM), Merkle Tree, Double-Spend Problem, Blockchain and Digital Currency, Transactional Blocks, Impact of Blockchain Technology on Cryptocurrency.

UNIT III INTRODUCTION TO ETHEREUM 9

Introduction to Ethereum, Consensus Mechanisms, Metamask Setup, Ethereum Accounts, Transactions, Receiving Ethers, Smart Contracts.

UNIT-IV INTRODUCTION TO HYPERLEDGER AND SOLIDITY PROGRAMMING 10

Introduction to Hyperledger, Distributed Ledger Technology & its Challenges, Hyperledger & Distributed Ledger Technology, Hyperledger Fabric, Hyperledger Composer. Solidity - Language of Smart Contracts, Installing Solidity & Ethereum Wallet, Basics of Solidity, Layout of a Solidity Source File & Structure of Smart Contracts, General Value Types.

UNIT V BLOCKCHAIN APPLICATIONS 8

Internet of Things, Medical Record Management System, Domain Name Service and Future of Blockchain, Alt Coins.

TOTAL: 45 PERIODS**COURSE OUTCOMES:**

After the completion of this course, student will be able to

CO1: Understand and explore the working of Blockchain technology

CO2: Analyze the working of Smart Contracts

CO3: Understand and analyze the working of Hyperledger

CO4: Apply the learning of solidity to build de-centralized apps on Ethereum

CO5: Develop applications on Blockchain

REFERENCES:

1. Imran Bashir, "Mastering Blockchain: Distributed Ledger Technology, Decentralization, and Smart Contracts Explained", Second Edition, Packt Publishing, 2018.
2. Narayanan, J. Bonneau, E. Felten, A. Miller, S. Goldfeder, "Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction" Princeton University Press, 2016
3. Antonopoulos, Mastering Bitcoin, O'Reilly Publishing, 2014. .
4. Antonopoulos and G. Wood, "Mastering Ethereum: Building Smart Contracts and Dapps", O'Reilly Publishing, 2018.
5. D. Drescher, Blockchain Basics. Apress, 2017.

COURSE OBJECTIVES:

- Develop and Train Deep Neural Networks.
- Develop a CNN, R-CNN, Fast R-CNN, Faster-R-CNN, Mask-RCNN for detection and recognition
- Build and train RNNs, work with NLP and Word Embeddings
- The internal structure of LSTM and GRU and the differences between them
- The Auto Encoders for Image Processing

UNIT I DEEP LEARNING CONCEPTS**6**

Fundamentals about Deep Learning. Perception Learning Algorithms. Probabilistic modelling. Early Neural Networks. How Deep Learning different from Machine Learning. Scalars. Vectors. Matrixes, Higher Dimensional Tensors. Manipulating Tensors. Vector Data. Time Series Data. Image Data. Video Data.

UNIT II NEURAL NETWORKS**9**

About Neural Network. Building Blocks of Neural Network. Optimizers. Activation Functions. Loss Functions. Data Pre-processing for neural networks, Feature Engineering. Overfitting and Underfitting. Hyperparameters.

UNIT III CONVOLUTIONAL NEURAL NETWORK**10**

About CNN. Linear Time Invariant. Image Processing Filtering. Building a convolutional neural network. Input Layers, Convolution Layers. Pooling Layers. Dense Layers. Backpropagation Through the Convolutional Layer. Filters and Feature Maps. Backpropagation Through the Pooling Layers. Dropout Layers and Regularization. Batch Normalization. Various Activation Functions. Various Optimizers. LeNet, AlexNet, VGG16, ResNet. Transfer Learning with Image Data. Transfer Learning using Inception Oxford VGG Model, Google Inception Model, Microsoft ResNet Model. R-CNN, Fast R-CNN, Faster R-CNN, Mask-RCNN, YOLO

UNIT VI NATURAL LANGUAGE PROCESSING USING RNN**10**

About NLP & its Toolkits. Language Modeling . Vector Space Model (VSM). Continuous Bag of Words (CBOW). Skip-Gram Model for Word Embedding. Part of Speech (PoS) Global Co-occurrence Statistics-based Word Vectors. Transfer Learning. Word2Vec. Global Vectors for Word Representation GloVe. Backpropagation Through Time. Bidirectional RNNs (BRNN) . Long Short Term Memory (LSTM). Bi-directional LSTM. Sequence-to-Sequence Models (Seq2Seq). Gated recurrent unit GRU.

UNIT V DEEP REINFORCEMENT & UNSUPERVISED LEARNING**10**

About Deep Reinforcement Learning. Q-Learning. Deep Q-Network (DQN). Policy Gradient Methods. Actor-Critic Algorithm. About Autoencoding. Convolutional Auto Encoding. Variational Auto Encoding. Generative Adversarial Networks. Autoencoders for Feature Extraction. Auto Encoders for Classification. Denoising Autoencoders. Sparse Autoencoders

COURSE OUTCOMES:

CO1: Feature Extraction from Image and Video Data

CO2: Implement Image Segmentation and Instance Segmentation in Images

CO3: Implement image recognition and image classification using a pretrained network (Transfer Learning)

CO4: Traffic Information analysis using Twitter Data
CO5: Autoencoder for Classification & Feature Extraction

TOTAL : 45 PERIODS

REFERENCES

1. Deep Learning A Practitioner's Approach Josh Patterson and Adam Gibson O'Reilly Media, Inc.2017
2. Learn Keras for Deep Neural Networks, Jojo Moolayil, Apress,2018
3. Deep Learning Projects Using TensorFlow 2, Vinita Silaparasetty, Apress, 2020
4. Deep Learning with Python, FRANÇOIS CHOLLET, MANNING SHELTER ISLAND,2017
5. Pro Deep Learning with TensorFlow, Santanu Pattanayak, Apress,2017

OBA431

SUSTAINABLE MANAGEMENT

LT P C
3 0 0 3

COURSE OBJECTIVES:

- To provide students with fundamental knowledge of the notion of corporate sustainability.
- To determine how organizations impacts on the environment and socio-technical systems, the relationship between social and environmental performance and competitiveness, the approaches and methods.

UNIT I MANAGEMENT OF SUSTAINABILITY

9

Management of sustainability -rationale and political trends: An introduction to sustainability management, International and European policies on sustainable development, theoretical pillars in sustainability management studies.

UNIT II CORPORATE SUSTAINABILITY AND RESPONSIBILITY

9

Corporate sustainability parameter, corporate sustainability institutional framework, integration of sustainability into strategic planning and regular business practices, fundamentals of stakeholder engagement.

UNIT III SUSTAINABILITY MANAGEMENT: STRATEGIES AND APPROACHES

9

Corporate sustainability management and competitiveness: Sustainability-oriented corporate strategies, markets and competitiveness, Green Management between theory and practice, Sustainable Consumption and Green Marketing strategies, Environmental regulation and strategic postures; Green Management approaches and tools; Green engineering: clean technologies and innovation processes; Sustainable Supply Chain Management and Procurement.

UNIT IV SUSTAINABILITY AND INNOVATION

9

Socio-technical transitions and sustainability, Sustainable entrepreneurship, Sustainable pioneers in green market niches, Smart communities and smart specializations.

UNIT V SUSTAINABLE MANAGEMENT OF RESOURCES, COMMODITIES AND COMMONS

9

Energy management, Water management, Waste management, Wild Life Conservation, Emerging trends in sustainable management, Case Studies.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- CO1: An understanding of sustainability management as an approach to aid in evaluating and minimizing environmental impacts while achieving the expected social impact.
- CO2: An understanding of corporate sustainability and responsible Business Practices
- CO3: Knowledge and skills to understand, to measure and interpret sustainability performances.
- CO4: Knowledge of innovative practices in sustainable business and community management
- CO5: Deep understanding of sustainable management of resources and commodities

REFERENCES:

1. Daddi, T., Iraldo, F., Testa, Environmental Certification for Organizations and Products: Management, 2015
2. Christian N. Madu, Handbook of Sustainability Management 2012
3. Petra Molthan-Hill, The Business Student's Guide to Sustainable Management: Principles and Practice, 2014
4. Margaret Robertson, Sustainability Principles and Practice, 2014
5. Peter Rogers, An Introduction to Sustainable Development, 2006

OBA432

MICRO AND SMALL BUSINESS MANAGEMENT

L T P C
3 0 0 3

COURSE OBJECTIVES

- To familiarize students with the theory and practice of small business management.
- To learn the legal issues faced by small business and how they impact operations.

UNIT I INTRODUCTION TO SMALL BUSINESS 9

Creation, Innovation, entrepreneurship and small business - Defining Small Business –Role of Owner – Manager – government policy towards small business sector –elements of entrepreneurship –evolution of entrepreneurship –Types of Entrepreneurship – social, civic, corporate - Business life cycle - barriers and triggers to new venture creation – process to assist start ups – small business and family business.

UNIT II SCREENING THE BUSINESS OPPORTUNITY AND FORMULATING THE BUSINESS PLAN 9

Concepts of opportunity recognition; Key factors leading to new venture failure; New venture screening process; Applying new venture screening process to the early stage small firm Role planning in small business – importance of strategy formulation – management skills for small business creation and development.

UNIT III BUILDING THE RIGHT TEAM AND MARKETING STRATEGY 9

Management and Leadership – employee assessments – Tuckman's stages of group development - The entrepreneurial process model - Delegation and team building - Comparison of HR management in small and large firms - Importance of coaching and how to apply a coaching model.

Marketing within the small business - success strategies for small business marketing - customer delight and business generating systems, - market research, - assessing market performance-sales management and strategy - the marketing mix and marketing strategy.

UNIT IV FINANCING SMALL BUSINESS 9

Main sources of entrepreneurial capital; Nature of 'bootstrap' financing - Difference between cash and profit - Nature of bank financing and equity financing - Funding-equity gap for small firms. Importance of working capital cycle - Calculation of break-even point - Power of gross profit margin- Pricing for profit - Credit policy issues and relating these to cash flow management and profitability.

UNIT V VALUING SMALL BUSINESS AND CRISIS MANAGEMENT 9

Causes of small business failure - Danger signals of impending trouble - Characteristics of poorly performing firms - Turnaround strategies - Concept of business valuation - Different valuation measurements - Nature of goodwill and how to measure it - Advantages and disadvantages of buying an established small firm - Process of preparing a business for sale.

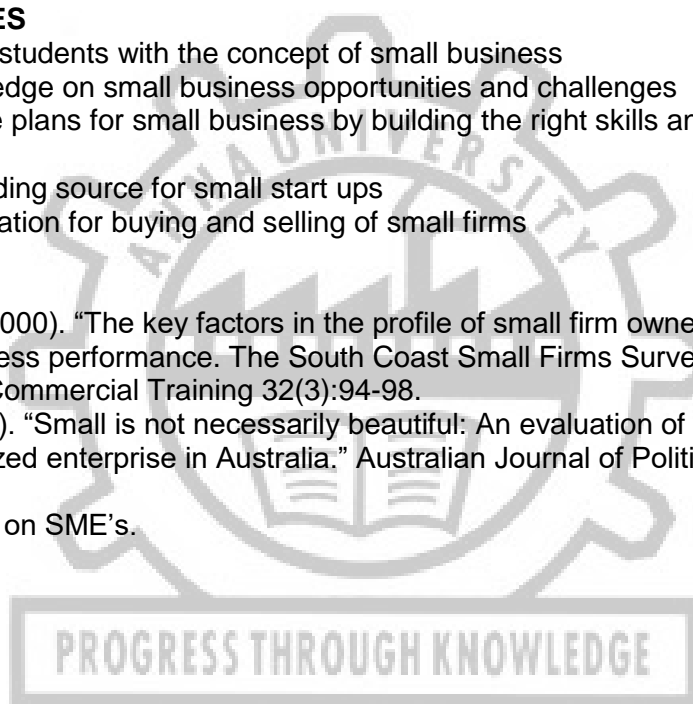
TOTAL: 45 PERIODS

COURSE OUTCOMES

- CO1. Familiarise the students with the concept of small business
- CO2. In depth knowledge on small business opportunities and challenges
- CO3. Ability to devise plans for small business by building the right skills and marketing strategies
- CO4. Identify the funding source for small start ups
- CO5. Business evaluation for buying and selling of small firms

REFERENCES

1. Hankinson,A.(2000). "The key factors in the profile of small firm owner-managers that influence business performance. The South Coast Small Firms Survey, 1997-2000." Industrial and Commercial Training 32(3):94-98.
2. Parker,R.(2000). "Small is not necessarily beautiful: An evaluation of policy support for small and medium-sized enterprise in Australia." Australian Journal of Political Science 35(2):239-253.
3. Journal articles on SME's.



**OBA433 INTELLECTUAL PROPERTY RIGHTS L T P C
3 0 0 3**

COURSE OBJECTIVE

- To understand intellectual property rights and its valuation.

UNIT I INTRODUCTION 9

Intellectual property rights - Introduction, Basic concepts, Patents, Copyrights, Trademarks, Trade Secrets, Geographic Indicators; Nature of Intellectual Property, Technological Research, Inventions and Innovations, History - the way from WTO to WIPO, TRIPS.

UNIT II PROCESS 9

New Developments in IPR, Procedure for grant of Patents, TM, GIs, Patenting under Patent Cooperation Treaty, Administration of Patent system in India, Patenting in foreign countries.

UNIT III STATUTES**9**

International Treaties and conventions on IPRs, The TRIPs Agreement, PCT Agreement, The Patent Act of India, Patent Amendment Act (2005), Design Act, Trademark Act, Geographical Indication Act, Bayh- Dole Act and Issues of Academic Entrepreneurship.

UNIT IV STRATEGIES IN INTELLECTUAL PROPERTY**9**

Strategies for investing in R&D, Patent Information and databases, IPR strength in India, Traditional Knowledge, Case studies.

UNIT V MODELS**9**

The technologies Know-how, concept of ownership, Significance of IP in Value Creation, IP Valuation and IP Valuation Models, Application of Real Option Model in Strategic Decision Making, Transfer and Licensing.

TOTAL: 45 PERIODS**COURSE OUTCOMES**

CO1: Understanding of intellectual property and appreciation of the need to protect it

CO2: Awareness about the process of patenting

CO3: Understanding of the statutes related to IPR

CO4: Ability to apply strategies to protect intellectual property

CO5: Ability to apply models for making strategic decisions related to IPR

REFERENCES

1. V. Sople Vinod, Managing Intellectual Property by (Prentice hall of India Pvt.Ltd), 2006.
2. Intellectual Property rights and copyrights, EssEss Publications.
3. Primer, R. Anita Rao and Bhanoji Rao, Intellectual Property Rights, Lastain Book company.
4. Edited by Derek Bosworth and Elizabeth Webster, The Management of Intellectual Property, Edward Elgar Publishing Ltd., 2006.
5. WIPO Intellectual Property Hand book.

OBA434**ETHICAL MANAGEMENT****L T P C
3 0 0 3****COURSE OBJECTIVE**

- To help students develop knowledge and competence in ethical management and decision making in organizational contexts.

UNIT I ETHICS AND SOCIETY**9**

Ethical Management- Definition, Motivation, Advantages-Practical implications of ethical management. Managerial ethics, professional ethics, and social Responsibility-Role of culture and society's expectations- Individual and organizational responsibility to society and the community.

UNIT II ETHICAL DECISION MAKING AND MANAGEMENT IN A CRISIS**9**

Managing in an ethical crisis, the nature of a crisis, ethics in crisis management, discuss case studies, analyze real-world scenarios, develop ethical management skills, knowledge, and competencies. Proactive crisis management.

UNIT III STAKEHOLDERS IN ETHICAL MANAGEMENT**9**

Stakeholders in ethical management, identifying internal and external stakeholders, nature of stakeholders, ethical management of various kinds of stakeholders: customers (product and service issues), employees (leadership, fairness, justice, diversity) suppliers, collaborators,

business, community, the natural environment (the sustainability imperative, green management, Contemporary issues).

UNIT IV INDIVIDUAL VARIABLES IN ETHICAL MANAGEMENT 9

Understanding individual variables in ethics, managerial ethics, concepts in ethical psychology-ethical awareness, ethical courage, ethical judgment, ethical foundations, ethical emotions/intuitions/intensity. Utilization of these concepts and competencies for ethical decision-making and management.

UNIT V PRACTICAL FIELD-GUIDE, TECHNIQUES AND SKILLS 9

Ethical management in practice, development of techniques and skills, navigating challenges and dilemmas, resolving issues and preventing unethical management proactively. Role modelling and creating a culture of ethical management and human flourishing.

TOTAL: 45 PERIODS

COURSE OUTCOMES

- CO1: Role modelling and influencing the ethical and cultural context.
- CO2: Respond to ethical crises and proactively address potential crises situations.
- CO3: Understand and implement stakeholder management decisions.
- CO4: Develop the ability, knowledge, and skills for ethical management.
- CO5: Develop practical skills to navigate, resolve and thrive in management situations

REFERENCES

1. Brad Agle, Aaron Miller, Bill O' Rourke, The Business Ethics Field Guide: the essential companion to leading your career and your company, 2016.
2. Steiner & Steiner, Business, Government & Society: A managerial Perspective, 2011.
3. Lawrence & Weber, Business and Society: Stakeholders, Ethics, Public Policy, 2020.

ET4251

IoT FOR SMART SYSTEMS

**LT P C
3 0 0 3**

COURSE OBJECTIVES:

1. To study about **Internet of Things** technologies and its role in real time applications.
2. To introduce the infrastructure required for IoT
3. To familiarize the accessories and communication techniques for IoT.
4. To provide insight about the embedded processor and sensors required for IoT
5. To familiarize the different platforms and Attributes for IoT

UNIT I INTRODUCTION TO INTERNET OF THINGS 9

Overview, Hardware and software requirements for IOT, Sensor and actuators, Technology drivers, Business drivers, Typical IoT applications, Trends and implications.

UNIT II IOT ARCHITECTURE 9

IoT reference model and architecture -Node Structure - Sensing, Processing, Communication, Powering, Networking - Topologies, Layer/Stack architecture, IoT standards, Cloud computing for IoT, Bluetooth, Bluetooth Low Energy beacons.

UNIT III PROTOCOLS AND WIRELESS TECHNOLOGIES FOR IOT 9

PROTOCOLS:

NFC, SCADA and RFID, Zigbee MIPI, M-PHY, UniPro, SPMI, SPI, M-PCIe GSM, CDMA, LTE, GPRS, small cell.

Wireless technologies for IoT: WiFi (IEEE 802.11), Bluetooth/Bluetooth Smart, ZigBee/ZigBee Smart, UWB (IEEE 802.15.4), 6LoWPAN, Proprietary systems-Recent trends.

UNIT IV IOT PROCESSORS 9

Services/Attributes: Big-Data Analytics for IOT, Dependability, Interoperability, Security, Maintainability.

Embedded processors for IOT : Introduction to Python programming -Building IOT with RASPBERRY PI and Arduino.

UNIT V CASE STUDIES 9

Industrial IoT, Home Automation, smart cities, Smart Grid, connected vehicles, electric vehicle charging, Environment, Agriculture, Productivity Applications, IOT Defense

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students will have the ability to

CO1: Analyze the concepts of IoT and its present developments.

CO2: Compare and contrast different platforms and infrastructures available for IoT

CO3: Explain different protocols and communication technologies used in IoT

CO4: Analyze the big data analytic and programming of IoT

CO5: Implement IoT solutions for smart applications

REFERENCES:

1. ArshdeepBahga and VijaiMadiseti : A Hands-on Approach “Internet of Things”,Universities Press 2015.
2. Oliver Hersent , David Boswarthick and Omar Elloumi “ The Internet of Things”, Wiley,2016.
3. Samuel Greengard, “ The Internet of Things”, The MIT press, 2015.
4. Adrian McEwen and Hakim Cassimally“Designing the Internet of Things “Wiley,2014.
5. Jean- Philippe Vasseur, Adam Dunkels, “Interconnecting Smart Objects with IP: The Next Internet” Morgan Kuffmann Publishers, 2010.
6. Adrian McEwen and Hakim Cassimally, “Designing the Internet of Things”, John Wiley and sons, 2014.
7. Lingyang Song/DusitNiyato/ Zhu Han/ Ekram Hossain,” Wireless Device-to-Device Communications and Networks, CAMBRIDGE UNIVERSITY PRESS,2015.
8. OvidiuVermesan and Peter Friess (Editors), “Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems”, River Publishers Series in Communication, 2013.
9. Vijay Madiseti , ArshdeepBahga, “Internet of Things (A Hands on-Approach)”, 2014.

10. Zach Shelby, Carsten Bormann, "6LoWPAN: The Wireless Embedded Internet", John Wiley and sons, 2009.
11. Lars T.Berger and Krzysztof Iniewski, "Smart Grid applications, communications and security", Wiley, 2015.
12. JanakaEkanayake, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama and Nick Jenkins, "Smart Grid Technology and Applications", Wiley, 2015.
13. UpenaDalal,"Wireless Communications & Networks,Oxford,2015.

ET4072

MACHINE LEARNING AND DEEP LEARNING

**L T P C
3 0 0 3**

COURSE OBJECTIVES:

The course is aimed at

1. Understanding about the learning problem and algorithms
2. Providing insight about neural networks
3. Introducing the machine learning fundamentals and significance
4. Enabling the students to acquire knowledge about pattern recognition.
5. Motivating the students to apply deep learning algorithms for solving real life problems.

UNIT I LEARNING PROBLEMS AND ALGORITHMS 9

Various paradigms of learning problems, Supervised, Semi-supervised and Unsupervised algorithms

UNIT II NEURAL NETWORKS 9

Differences between Biological and Artificial Neural Networks - Typical Architecture, Common Activation Functions, Multi-layer neural network, Linear Separability, Hebb Net, Perceptron, Adaline, Standard Back propagation Training Algorithms for Pattern Association - Hebb rule and Delta rule, Hetero associative, Auto associative, Kohonen Self Organising Maps, Examples of Feature Maps, Learning Vector Quantization, Gradient descent, Boltzmann Machine Learning.

UNIT III MACHINE LEARNING – FUNDAMENTALS & FEATURE SELECTIONS & CLASSIFICATIONS 9

Classifying Samples: The confusion matrix, Accuracy, Precision, Recall, F1- Score, the curse of dimensionality, training, testing, validation, cross validation, overfitting, under-fitting the data, early stopping, regularization, bias and variance. Feature Selection, normalization, dimensionality reduction, Classifiers: KNN, SVM, Decision trees, Naïve Bayes, Binary classification, multi class classification, clustering.

UNIT IV DEEP LEARNING: CONVOLUTIONAL NEURAL NETWORKS 9

Feed forward networks, Activation functions, back propagation in CNN, optimizers, batch normalization, convolution layers, pooling layers, fully connected layers, dropout, Examples of CNNs.

UNIT V DEEP LEARNING: RNNs, AUTOENCODERS AND GANS**9**

State, Structure of RNN Cell, LSTM and GRU, Time distributed layers, Generating Text, Autoencoders: Convolutional Autoencoders, Denoising autoencoders, Variational autoencoders, GANs: The discriminator, generator, DCGANs

TOTAL : 45 PERIODS**COURSE OUTCOMES (CO):**

At the end of the course the student will be able to

CO1 : Illustrate the categorization of machine learning algorithms.

CO2: Compare and contrast the types of neural network architectures, activation functions

CO3: Acquaint with the pattern association using neural networks

CO4: Elaborate various terminologies related with pattern recognition and architectures of convolutional neural networks

CO5: Construct different feature selection and classification techniques and advanced neural network architectures such as RNN, Autoencoders, and GANs.

REFERENCES:

1. J. S. R. Jang, C. T. Sun, E. Mizutani, Neuro Fuzzy and Soft Computing - A Computational Approach to Learning and Machine Intelligence, 2012, PHI learning
2. Deep Learning, Ian Good fellow, YoshuaBengio and Aaron Courville, MIT Press, ISBN: 9780262035613, 2016.
3. The Elements of Statistical Learning. Trevor Hastie, Robert Tibshirani and Jerome Friedman. Second Edition. 2009.
4. Pattern Recognition and Machine Learning. Christopher Bishop. Springer. 2006.
5. Understanding Machine Learning. Shai Shalev-Shwartz and Shai Ben-David. Cambridge University Press. 2017.

PX4012**RENEWABLE ENERGY TECHNOLOGY****L T P C
3 0 0 3****OBJECTIVES:**

To impart knowledge on

- Different types of renewable energy technologies
- Standalone operation, grid connected operation of renewable energy systems

UNIT I INTRODUCTION**9**

Classification of energy sources – Co2 Emission - Features of Renewable energy - Renewable energy scenario in India -Environmental aspects of electric energy conversion: impacts of renewable energy generation on environment Per Capital Consumption - CO₂ Emission - importance of renewable energy sources, Potentials – Achievements– Applications.

UNIT II SOLAR PHOTOVOLTAICS**9**

Solar Energy: Sun and Earth-Basic Characteristics of solar radiation- angle of sunrays on solar collector-Estimating Solar Radiation Empirically - Equivalent circuit of PV Cell- Photovoltaic cell-characteristics: P-V and I-V curve of cell-Impact of Temperature and Insolation on I-V characteristics-Shading Impacts on I-V characteristics-Bypass diode -Blocking diode.

UNIT III PHOTVOLTAIC SYSTEM DESIGN

9

Block diagram of solar photo voltaic system : Line commutated converters (inversion mode) - Boost and buck-boost converters - selection of inverter, battery sizing, array sizing - PV systems classification- standalone PV systems - Grid tied and grid interactive inverters- grid connection issues.

UNIT IV WIND ENERGY CONVERSION SYSTEMS

9

Origin of Winds: Global and Local Winds- Aerodynamics of Wind turbine-Derivation of Betz's limit-Power available in wind-Classification of wind turbine: Horizontal Axis wind turbine and Vertical axis wind turbine- Aerodynamic Efficiency-Tip Speed-Tip Speed Ratio-Solidity-Blade Count-Power curve of wind turbine - Configurations of wind energy conversion systems: Type A, Type B, Type C and Type D Configurations- Grid connection Issues - Grid integrated SCIG and PMSG based WECS.

UNIT V OTHER RENEWABLE ENERGY SOURCES

9

Qualitative study of different renewable energy resources: ocean, Biomass, Hydrogen energy systems, Fuel cells, Ocean Thermal Energy Conversion (OTEC), Tidal and wave energy, Geothermal Energy Resources.

TOTAL : 45 PERIODS

OUTCOMES:

After completion of this course, the student will be able to:

- CO1: Demonstrate the need for renewable energy sources.
- CO2: Develop a stand-alone photo voltaic system and implement a maximum power point tracking in the PV system.
- CO3: Design a stand-alone and Grid connected PV system.
- CO4: Analyze the different configurations of the wind energy conversion systems.
- CO5: Realize the basic of various available renewable energy sources

REFERENCES:

1. S.N.Bhadra, D. Kasta, & S. Banerjee "Wind Electrical Systems", Oxford University Press, 2009.
2. Rai. G.D, "Non conventional energy sources", Khanna publishes, 1993.
3. Rai. G.D," Solar energy utilization", Khanna publishes, 1993.
4. Chetan Singh Solanki, "Solar Photovoltaics: Fundamentals, Technologies and Applications", PHI Learning Private Limited, 2012.
5. John Twideu and Tony Weir, "Renewal Energy Resources" BSP Publications, 2006
6. Gray, L. Johnson, "Wind energy system", prentice hall of India, 1995.
7. B.H.Khan, " Non-conventional Energy sources", , McGraw-hill, 2nd Edition, 2009.
8. Fang Lin Luo Hong Ye, " Renewable Energy systems", Taylor & Francis Group,2013.

COURSE OBJECTIVES

- To Study about Smart Grid technologies, different smart meters and advanced metering infrastructure.
- To know about the function of smart grid.
- To familiarize the power quality management issues in Smart Grid.
- To familiarize the high performance computing for Smart Grid applications
- To get familiarized with the communication networks for Smart Grid applications

UNIT I INTRODUCTION TO SMART GRID 9

Evolution of Electric Grid, Concept, Definitions and Need for Smart Grid, Smart grid drivers, functions, opportunities, challenges and benefits, Difference between conventional & Smart Grid, Comparison of Micro grid and Smart grid, Present development & International policies in Smart Grid, Smart Grid Initiative for Power Distribution Utility in India – Case Study.

UNIT II SMART GRID TECHNOLOGIES 9

Technology Drivers, Smart Integration of energy resources, Smart substations, Substation Automation, Feeder Automation, Transmission systems: EMS, FACTS and HVDC, Wide area monitoring, Protection and control, Distribution systems: DMS, Volt/Var control, Fault Detection, Isolation and service restoration, Outage management, High-Efficiency Distribution Transformers, Phase Shifting Transformers, Plug in Hybrid Electric Vehicles (PHEV) – Grid to Vehicle and Vehicle to Grid charging concepts.

UNIT III SMART METERS AND ADVANCED METERING INFRASTRUCTURE 9

Introduction to Smart Meters, Advanced Metering infrastructure (AMI) drivers and benefits, AMI protocols, standards and initiatives, AMI needs in the smart grid, Phasor Measurement Unit(PMU) & their application for monitoring & protection. Demand side management and demand response programs, Demand pricing and Time of Use, Real Time Pricing, Peak Time Pricing.

UNIT IV POWER QUALITY MANAGEMENT IN SMART GRID 9

Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring, Power Quality Audit.

Unit V HIGH PERFORMANCE COMPUTING FOR SMART GRID APPLICATIONS 9

Architecture and Standards -Local Area Network (LAN), House Area Network (HAN), Wide Area Network (WAN), Broadband over Power line (BPL), PLC, Zigbee, GSM, IP based Protocols, Basics of Web Service and CLOUD Computing, Cyber Security for Smart Grid.

TOTAL : 45 PERIODS**COURSE OUTCOME:**

Students able to

CO1: Relate with the smart resources, smart meters and other smart devices.

CO2: Explain the function of Smart Grid.

CO3: Experiment the issues of Power Quality in Smart Grid.

CO4: Analyze the performance of Smart Grid.

CO5: Recommend suitable communication networks for smart grid applications

REFERENCES

1. Stuart Borlase 'Smart Grid: Infrastructure, Technology and Solutions', CRC Press 2012.
2. JanakaEkanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama, 'Smart Grid: Technology and Applications', Wiley, 2012.
3. Mini S. Thomas, John D McDonald, 'Power System SCADA and Smart Grids', CRC Press, 2015
4. Kenneth C.Budka, Jayant G. Deshpande, Marina Thottan, 'Communication Networks for Smart Grids', Springer, 2014
5. SMART GRID Fundamentals of Design and Analysis, James Momoh, IEEE press, A John Wiley & Sons, Inc., Publication.

CP4391

SECURITY PRACTICES

L T P C
3 0 0 3

COURSE OBJECTIVES:

- To learn the core fundamentals of system and web security concepts
- To have through understanding in the security concepts related to networks
- To deploy the security essentials in IT Sector
- To be exposed to the concepts of Cyber Security and cloud security
- To perform a detailed study of Privacy and Storage security and related Issues

UNIT I SYSTEM SECURITY 9

Model of network security – Security attacks, services and mechanisms – OSI security architecture -A Cryptography primer- Intrusion detection system- Intrusion Prevention system - Security web applications- Case study: OWASP - Top 10 Web Application Security Risks.

UNIT II NETWORK SECURITY 9

Internet Security - Intranet security- Local Area Network Security - Wireless Network Security - Wireless Sensor Network Security- Cellular Network Security - Mobile security - IOT security - Case Study - Kali Linux.

UNIT III SECURITY MANAGEMENT 9

Information security essentials for IT Managers- Security Management System - Policy Driven System Management- IT Security - Online Identity and User Management System. Case study: Metasploit

UNIT IV CYBER SECURITY AND CLOUD SECURITY 9

Cyber Forensics- Disk Forensics – Network Forensics – Wireless Forensics – Database Forensics – Malware Forensics – Mobile Forensics – Email Forensics- Best security practices for automate Cloud infrastructure management – Establishing trust in IaaS, PaaS, and SaaS Cloud types. Case study: DVWA

UNIT V PRIVACY AND STORAGE SECURITY 9

Privacy on the Internet - Privacy Enhancing Technologies - Personal privacy Policies - Detection of Conflicts in security policies- privacy and security in environment monitoring systems. Storage Area Network Security - Storage Area Network Security Devices - Risk management - Physical Security Essentials.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- CO1:** Understand the core fundamentals of system security
- CO2:** Apply the security concepts to wired and wireless networks
- CO3:** Implement and Manage the security essentials in IT Sector
- CO4:** Explain the concepts of Cyber Security and Cyber forensics
- CO5:** Be aware of Privacy and Storage security Issues.

REFERENCES

1. John R. Vacca, Computer and Information Security Handbook, Third Edition, Elsevier 2017
2. Michael E. Whitman, Herbert J. Mattord, Principles of Information Security, Seventh Edition, Cengage Learning, 2022
3. Richard E. Smith, Elementary Information Security, Third Edition, Jones and Bartlett Learning, 2019
4. Mayor, K.K.Mookhey, Jacopo Cervini, Fairuzan Roslan, Kevin Beaver, Metasploit Toolkit for Penetration Testing, Exploit Development and Vulnerability Research, Syngress publications, Elsevier, 2007. ISBN : 978-1-59749-074-0
5. John Sammons, "The Basics of Digital Forensics- The Primer for Getting Started in Digital Forensics", Syngress, 2012
6. Cory Altheide and Harlan Carvey, "Digital Forensics with Open Source Tools", 2011 Syngress, ISBN: 9781597495875.
7. Siani Pearson, George Yee "Privacy and Security for Cloud Computing" Computer Communications and Networks, Springer, 2013.

MP4251

CLOUD COMPUTING TECHNOLOGIES

**L T P C
3 0 0 3**

COURSE OBJECTIVES:

- To gain expertise in Virtualization, Virtual Machines and deploy practical virtualization solution
- To understand the architecture, infrastructure and delivery models of cloud computing.
- To explore the roster of AWS services and illustrate the way to make applications in AWS
- To gain knowledge in the working of Windows Azure and Storage services offered by Windows Azure
- To develop the cloud application using various programming model of Hadoop and Aneka

UNIT I VIRTUALIZATION AND VIRTUALIZATION INFRASTRUCTURE 6

Basics of Virtual Machines - Process Virtual Machines – System Virtual Machines –Emulation – Interpretation – Binary Translation - Taxonomy of Virtual Machines. Virtualization –Management Virtualization — Hardware Maximization – Architectures – Virtualization Management – Storage Virtualization – Network Virtualization- Implementation levels of virtualization – virtualization structure – virtualization of CPU, Memory and I/O devices – virtual clusters and Resource Management – Virtualization for data center automation

UNIT II CLOUD PLATFORM ARCHITECTURE 12

Cloud Computing: Definition, Characteristics - Cloud deployment models: public, private, hybrid, community – Categories of cloud computing: Everything as a service: Infrastructure, platform, software- A Generic Cloud Architecture Design – Layered cloud Architectural Development – Architectural Design Challenges

COURSE OBJECTIVES:

- To provide a sound knowledge in UI & UX
- To understand the need for UI and UX
- Research Methods used in Design
- Tools used in UI & UX
- Creating a wireframe and prototype

UNIT I UX LIFECYCLE TEMPLATE 8

Introduction. A UX process lifecycle template. Choosing a process instance for your project. The system complexity space. Meet the user interface team. Scope of UX presence within the team. More about UX lifecycles. Business Strategy. Value Innovation. Validated User Research. Killer UX Design. The Blockbuster Value Proposition. What Is a Value Proposition?.

UNIT II CONTEXTUAL INQUIRY 10

The system concept statement. User work activity data gathering. Look for emotional aspects of work practice. Abridged contextual inquiry process. Data-driven vs. model-driven inquiry. Organizing concepts: work roles and flow model. Creating and managing work activity notes. Constructing your work activity affinity diagram (WAAD). Abridged contextual analysis process. History of affinity diagrams.

UNIT III DESIGN THINKING, IDEATION, AND SKETCHING 9

Design-informing models: second span of the bridge . Some general “how to” suggestions. A New example domain: slideshow presentations. User models. Usage models. Work environment models. Barrier summaries. Model consolidation. Protecting your sources. Abridged methods for design-informing models extraction. Design paradigms. Design thinking. Design perspectives. User personas. Ideation. Sketching

UNIT IV UX GOALS, METRICS, AND TARGETS 8

Introduction. UX goals. UX target tables. Work roles, user classes, and UX goals. UX measures. Measuring instruments. UX metrics. Baseline level. Target level. Setting levels. Observed results. Practical tips and cautions for creating UX targets. How UX targets help manage the user experience engineering process.

UNIT V ANALYSING USER EXPERIENCE 10

Sharpening Your Thinking Tools. UX Research and Strength of Evidence. Agile Personas. How to Prioritize Usability Problems. Creating Insights, Hypotheses and Testable Design Ideas. How to Manage Design Projects with User Experience Metrics. Two Measures that Will Justify Any Design Change. Evangelizing UX Research. How to Create a User Journey Map. Generating Solutions to Usability Problems. Building UX Research Into the Design Studio Methodology. Dealing with Common objections to UX Research. The User Experience Debrief Meeting. Creating a User Experience Dashboard.

SUGGESTED ACTIVITIES:

- 1: Hands on Design Thinking process for a product
- 2: Defining the Look and Feel of any new Project
- 3: Create a Sample Pattern Library for that product (Mood board, Fonts, Colors based on UI principles)

- 4: Identify a customer problem to solve.
- 5: Conduct end-to-end user research - User research, creating personas, Ideation process (User stories, Scenarios), Flow diagrams, Flow Mapping

TOTAL : 45 PERIODS

COURSE OUTCOMES:

- CO1:** Build UI for user Applications
- CO2:** Use the UI Interaction behaviors and principles
- CO3:** Evaluate UX design of any product or application
- CO4:** Demonstrate UX Skills in product development
- CO5:** Implement Sketching principles

REFERENCES

1. UX for Developers: How to Integrate User-Centered Design Principles Into Your Day-to-Day Development Work, Westley Knight. Apress, 2018
2. The UX Book: Process and Guidelines for Ensuring a Quality User Experience, Rex Hartson, Pardha Pyla. Morgan Kaufmann, 2012
3. UX Fundamentals for Non-UX Professionals: User Experience Principles for Managers, Writers, Designers, and Developers, Edward Stull. Apress, 2018
4. Lean UX: Designing Great Products with Agile Teams, Gothelf, Jeff, Seiden, and Josh. O'Reilly Media, 2016
5. Designing UX: Prototyping: Because Modern Design is Never Static, Ben Coleman, and Dan Goodwin. SitePoint, 2017

MU4153

PRINCIPLES OF MULTIMEDIA

L T P C
3 0 0 3

COURSE OBJECTIVES:

- To get familiarity with gamut of multimedia and its significance
- To acquire knowledge in multimedia components.
- To acquire knowledge about multimedia tools and authoring.
- To acquire knowledge in the development of multimedia applications.
- To explore the latest trends and technologies in multimedia

UNIT I INTRODUCTION

9

Introduction to Multimedia – Characteristics of Multimedia Presentation – Multimedia Components – Promotion of Multimedia Based Components – Digital Representation – Media and Data Streams – Multimedia Architecture – Multimedia Documents, Multimedia Tasks and Concerns, Production, sharing and distribution, Hypermedia, WWW and Internet, Authoring, Multimedia over wireless and mobile networks.

Suggested Activities:

1. Flipped classroom on media Components.
2. External learning – Interactive presentation.

Suggested Evaluation Methods:

1. Tutorial – Handling media components
2. Quizzes on different types of data presentation.

UNIT II ELEMENTS OF MULTIMEDIA

9

Text-Types, Font, Unicode Standard, File Formats, Graphics and Image data representations – data types, file formats, color models; video – color models in video, analog video, digital video, file formats, video display interfaces, 3D video and TV: Audio – Digitization, SNR, SQNR, quantization, audio quality, file formats, MIDI; Animation- Key Frames and Tweening, other Techniques, 2D and 3D Animation.

Suggested Activities:

1. Flipped classroom on different file formats of various media elements.
2. External learning – Adobe after effects, Adobe Media Encoder, Adobe Audition.

Suggested Evaluation Methods:

1. Demonstration on after effects animations.
2. Quizzes on file formats and color models.

UNIT III MULTIMEDIA TOOLS

9

Authoring Tools – Features and Types – Card and Page Based Tools – Icon and Object Based Tools – Time Based Tools – Cross Platform Authoring Tools – Editing Tools – Painting and Drawing Tools – 3D Modeling and Animation Tools – Image Editing Tools – Sound Editing Tools – Digital Movie Tools.

Suggested Activities:

1. Flipped classroom on multimedia tools.
2. External learning – Comparison of various authoring tools.

Suggested Evaluation Methods:

1. Tutorial – Audio editing tool.
2. Quizzes on animation tools.

UNIT IV MULTIMEDIA SYSTEMS

9

Compression Types and Techniques: CODEC, Text Compression: GIF Coding Standards, JPEG standard – JPEG 2000, basic audio compression – ADPCM, MPEG Psychoacoustics, basic Video compression techniques – MPEG, H.26X – Multimedia Database System – User Interfaces – OS Multimedia Support – Hardware Support – Real Time Protocols – Play Back Architectures – Synchronization – Document Architecture – Hypermedia Concepts: Hypermedia Design – Digital Copyrights, Content analysis.

Suggested Activities:

1. Flipped classroom on concepts of multimedia hardware architectures.
2. External learning – Digital repositories and hypermedia design.

Suggested Evaluation Methods:

1. Quizzes on multimedia hardware and compression techniques.
2. Tutorial – Hypermedia design.

UNIT V MULTIMEDIA APPLICATIONS FOR THE WEB AND MOBILE PLATFORMS

9

ADDIE Model – Conceptualization – Content Collection – Storyboard–Script Authoring Metaphors – Testing – Report Writing – Documentation. Multimedia for the web and mobile platforms. Virtual Reality, Internet multimedia content distribution, Multimedia Information sharing – social media sharing, cloud computing for multimedia services, interactive cloud gaming. Multimedia information retrieval.

Suggested Activities:

1. External learning – Game consoles.
2. External learning – VRML scripting languages.

Suggested Evaluation Methods:

1. Demonstration of simple interactive games.
2. Tutorial – Simple VRML program.

TOTAL : 45 PERIODS**COURSE OUTCOMES:****CO1:** Handle the multimedia elements effectively.**CO2:** Articulate the concepts and techniques used in multimedia applications.**CO3:** Develop effective strategies to deliver Quality of Experience in multimedia applications.**CO4:** Design and implement algorithms and techniques applied to multimedia objects.**CO5:** Design and develop multimedia applications following software engineering models.**REFERENCES:**

1. Li, Ze-Nian, Drew, Mark, Liu, Jiangchuan, “Fundamentals of Multimedia”, Springer, Third Edition, 2021.
2. Prabhat K. Andleigh, Kiran Thakrar, “MULTIMEDIA SYSTEMS DESIGN”, Pearson Education, 2015.
3. Gerald Friedland, Ramesh Jain, “Multimedia Computing”, Cambridge University Press, 2018. (digital book)
4. Ranjan Parekh, “Principles of Multimedia”, Second Edition, McGraw-Hill Education, 2017

DS4015**BIG DATA ANALYTICS****L T P C
3 0 0 3****COURSE OBJECTIVES:**

- To understand the basics of big data analytics
- To understand the search methods and visualization
- To learn mining data streams
- To learn frameworks
- To gain knowledge on R language

UNIT I INTRODUCTION TO BIG DATA**9**

Introduction to Big Data Platform – Challenges of Conventional Systems - Intelligent data analysis –Nature of Data - Analytic Processes and Tools - Analysis Vs Reporting - Modern Data Analytic Tools- Statistical Concepts: Sampling Distributions - Re-Sampling - Statistical Inference - Prediction Error.

UNIT II SEARCH METHODS AND VISUALIZATION**9**

Search by simulated Annealing – Stochastic, Adaptive search by Evaluation – Evaluation Strategies –Genetic Algorithm – Genetic Programming – Visualization – Classification of Visual Data Analysis Techniques – Data Types – Visualization Techniques – Interaction techniques – Specific Visual data analysis Techniques

UNIT III MINING DATA STREAMS**9**

Introduction To Streams Concepts – Stream Data Model and Architecture - Stream Computing - Sampling Data in a Stream – Filtering Streams – Counting Distinct Elements in a Stream – Estimating Moments – Counting Oneness in a Window – Decaying Window - Real time Analytics Platform(RTAP) Applications - Case Studies - Real Time Sentiment Analysis, Stock Market Predictions

UNIT IV FRAMEWORKS**9**

MapReduce – Hadoop, Hive, MapR – Sharding – NoSQL Databases - S3 - Hadoop Distributed File Systems – Case Study- Preventing Private Information Inference Attacks on Social Networks- Grand Challenge: Applying Regulatory Science and Big Data to Improve Medical Device Innovation

UNIT V R LANGUAGE**9**

Overview, Programming structures: Control statements -Operators -Functions -Environment and scope issues -Recursion -Replacement functions, R data structures: Vectors -Matrices and arrays -Lists -Data frames -Classes, Input/output, String manipulations

COURSE OUTCOMES:

CO1:understand the basics of big data analytics

CO2: Ability to use Hadoop, Map Reduce Framework.

CO3: Ability to identify the areas for applying big data analytics for increasing the business outcome.

CO4:gain knowledge on R language

CO5: Contextually integrate and correlate large amounts of information to gain faster insights.

TOTAL:45 PERIODS**REFERENCE:**

1. Michael Berthold, David J. Hand, Intelligent Data Analysis, Springer, 2007.
2. Anand Rajaraman and Jeffrey David Ullman, Mining of Massive Datasets, Cambridge University Press, 3rd edition 2020.
3. Norman Matloff, The Art of R Programming: A Tour of Statistical Software Design, No Starch Press, USA, 2011.
4. Bill Franks, Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics, John Wiley & sons, 2012.
5. Glenn J. Myatt, Making Sense of Data, John Wiley & Sons, 2007.

COURSE OBJECTIVES:

- To understand Smart Objects and IoT Architectures
- To learn about various IOT-related protocols
- To build simple IoT Systems using Arduino and Raspberry Pi.
- To understand data analytics and cloud in the context of IoT
- To develop IoT infrastructure for popular applications

UNIT I FUNDAMENTALS OF IoT**9**

Introduction to IoT – IoT definition – Characteristics – IoT Complete Architectural Stack – IoT enabling Technologies – IoT Challenges. Sensors and Hardware for IoT – Hardware Platforms – Arduino, Raspberry Pi, Node MCU. A Case study with any one of the boards and data acquisition from sensors.

UNIT II PROTOCOLS FOR IoT**9**

Infrastructure protocol (IPV4/V6/RPL), Identification (URIs), Transport (Wifi, Lifi, BLE), Discovery, Data Protocols, Device Management Protocols. – A Case Study with MQTT/CoAP usage-IoT privacy, security and vulnerability solutions.

UNIT III CASE STUDIES/INDUSTRIAL APPLICATIONS**9**

Case studies with architectural analysis: IoT applications – Smart City – Smart Water – Smart Agriculture – Smart Energy – Smart Healthcare – Smart Transportation – Smart Retail – Smart waste management.

UNIT IV CLOUD COMPUTING INTRODUCTION**9**

Introduction to Cloud Computing - Service Model – Deployment Model- Virtualization Concepts – Cloud Platforms – Amazon AWS – Microsoft Azure – Google APIs.

UNIT V IoT AND CLOUD**9**

IoT and the Cloud - Role of Cloud Computing in IoT - AWS Components - S3 – Lambda - AWS IoT Core -Connecting a web application to AWS IoT using MQTT- AWS IoT Examples. Security Concerns, Risk Issues, and Legal Aspects of Cloud Computing- Cloud Data Security

TOTAL:45 PERIODS**COURSE OUTCOMES:**

At the end of the course, the student will be able to:

CO1: Understand the various concept of the IoT and their technologies..

CO2: Develop IoT application using different hardware platforms

CO3: Implement the various IoT Protocols

CO4: Understand the basic principles of cloud computing.

CO5: Develop and deploy the IoT application into cloud environment

REFERENCES

1. "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", by Pethuru Raj and Anupama C. Raman ,CRC Press, 2017
2. Adrian McEwen, Designing the Internet of Things, Wiley,2013.
3. EMC Education Services, "Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data", Wiley publishers, 2015.
4. Simon Walkowiak, "Big Data Analytics with R" PackT Publishers, 2016
5. Bart Baesens, "Analytics in a Big Data World: The Essential Guide to Data Science and its Applications", Wiley Publishers, 2015.

COURSE OBJECTIVES:

- To explain the basic concepts of robots and types of robots
- To discuss the designing procedure of manipulators, actuators and grippers
- To impart knowledge on various types of sensors and power sources
- To explore various applications of Robots in Medicine
- To impart knowledge on wearable robots

UNIT I INTRODUCTION TO ROBOTICS 9

Introduction to Robotics, Overview of robot subsystems, Degrees of freedom, configurations and concept of workspace, Dynamic Stabilization

Sensors and Actuators

Sensors and controllers, Internal and external sensors, position, velocity and acceleration sensors, Proximity sensors, force sensors Pneumatic and hydraulic actuators, Stepper motor control circuits, End effectors, Various types of Grippers, PD and PID feedback actuator models

UNIT II MANIPULATORS & BASIC KINEMATICS 9

Construction of Manipulators, Manipulator Dynamic and Force Control, Electronic and pneumatic manipulator, Forward Kinematic Problems, Inverse Kinematic Problems, Solutions of Inverse Kinematic problems

Navigation and Treatment Planning

Variable speed arrangements, Path determination – Machinery vision, Ranging – Laser – Acoustic, Magnetic, fiber optic and Tactile sensor

UNIT III SURGICAL ROBOTS 9

Da Vinci Surgical System, Image guided robotic systems for focal ultrasound based surgical applications, System concept for robotic Tele-surgical system for off-pump, CABG surgery, Urologic applications, Cardiac surgery, Neuro-surgery, Pediatric and General Surgery, Gynecologic Surgery, General Surgery and Nanorobotics. Case Study

UNIT IV REHABILITATION AND ASSISTIVE ROBOTS 9

Pediatric Rehabilitation, Robotic Therapy for the Upper Extremity and Walking, Clinical-Based Gait Rehabilitation Robots, Motion Correlation and Tracking, Motion Prediction, Motion Replication. Portable Robot for Tele rehabilitation, Robotic Exoskeletons – Design considerations, Hybrid assistive limb. Case Study

UNIT V WEARABLE ROBOTS 9

Augmented Reality, Kinematics and Dynamics for Wearable Robots, Wearable Robot technology, Sensors, Actuators, Portable Energy Storage, Human–robot cognitive interaction (cHRI), Human–robot physical interaction (pHRI), Wearable Robotic Communication - case study

TOTAL:45 PERIODS**COURSE OUTCOMES:**

CO1: Describe the configuration, applications of robots and the concept of grippers and actuators

CO2: Explain the functions of manipulators and basic kinematics

CO3: Describe the application of robots in various surgeries

CO4: Design and analyze the robotic systems for rehabilitation

CO5: Design the wearable robots

REFERENCES

1. Nagrath and Mittal, "Robotics and Control", Tata McGraw Hill, First edition, 2003
2. Spong and Vidhyasagar, "Robot Dynamics and Control", John Wiley and Sons, First edition, 2008
3. Fu.K.S, Gonzalez. R.C., Lee, C.S.G, "Robotics, control", sensing, Vision and Intelligence, Tata McGraw Hill International, First edition, 2008
4. Bruno Siciliano, Oussama Khatib, Springer Handbook of Robotics, 1st Edition, Springer, 2008
5. Shane (S.Q.) Xie, Advanced Robotics for Medical Rehabilitation - Current State of the Art and Recent Advances, Springer, 2016
6. Sashi S Kommu, Rehabilitation Robotics, I-Tech Education and Publishing, 2007
7. Jose L. Pons, Wearable Robots: Biomechatronic Exoskeletons, John Wiley & Sons Ltd, England, 2008
8. Howie Choset, Kevin Lynch, Seth Hutchinson, "Principles of Robot Motion: Theory, Algorithms, and Implementations", Prentice Hall of India, First edition, 2005
9. Philippe Coiffet, Michel Chirouze, "An Introduction to Robot Technology", Tata McGraw Hill, First Edition, 1983
10. Jacob Rosen, Blake Hannaford & Richard M Satava, "Surgical Robotics: System Applications & Visions", Springer 2011
11. Jocelyn Troccaz, Medical Robotics, Wiley, 2012
12. Achim Schweikard, Floris Ernst, Medical Robotics, Springer, 2015

VE4202

EMBEDDED AUTOMATION

L T P C
3 0 0 3

COURSE OBJECTIVES:

- To learn about the process involved in the design and development of real-time embedded system
- To develop the embedded C programming skills on 8-bit microcontroller
- To study about the interfacing mechanism of peripheral devices with 8-bit microcontrollers
- To learn about the tools, firmware related to microcontroller programming
- To build a home automation system

UNIT - I INTRODUCTION TO EMBEDDED C PROGRAMMING

9

C Overview and Program Structure - C Types, Operators and Expressions - C Control Flow - C Functions and Program Structures - C Pointers And Arrays - FIFO and LIFO - C Structures - Development Tools

UNIT - II AVR MICROCONTROLLER

9

ATMEGA 16 Architecture - Nonvolatile and Data Memories - Port System - Peripheral Features : Time Base, Timing Subsystem, Pulse Width Modulation, USART, SPI, Two Wire Serial Interface, ADC, Interrupts - Physical and Operating Parameters

UNIT – III HARDWARE AND SOFTWARE INTERFACING WITH 8-BIT SERIES CONTROLLERS

9

Lights and Switches - Stack Operation - Implementing Combinational Logic - Expanding I/O - Interfacing Analog To Digital Convertors - Interfacing Digital To Analog Convertors - LED Displays : Seven Segment Displays, Dot Matrix Displays - LCD Displays - Driving Relays - Stepper Motor Interface - Serial EEPROM - Real Time Clock - Accessing Constants Table - Arbitrary Waveform Generation - Communication Links - System Development Tools

UNIT – IV VISION SYSTEM**9**

Fundamentals of Image Processing - Filtering - Morphological Operations - Feature Detection and Matching - Blurring and Sharpening - Segmentation - Thresholding - Contours - Advanced Contour Properties - Gradient - Canny Edge Detector - Object Detection - Background Subtraction

UNIT – V HOME AUTOMATION**9**

Home Automation - Requirements - Water Level Notifier - Electric Guard Dog - Tweeting Bird Feeder - Package Delivery Detector - Web Enabled Light Switch - Curtain Automation - Android Door Lock - Voice Controlled Home Automation - Smart Lighting - Smart Mailbox - Electricity Usage Monitor - Proximity Garage Door Opener - Vision Based Authentic Entry System

TOTAL: 45 PERIODS**COURSE OUTCOMES:**

On successful completion of this course, students will be able to

CO1: analyze the 8-bit series microcontroller architecture, features and pin details

CO2: write embedded C programs for embedded system application

CO3: design and develop real time systems using AVR microcontrollers

CO4: design and develop the systems based on vision mechanism

CO5: design and develop a real time home automation system

REFERENCES:

1. Dhananjay V. Gadre, "Programming and Customizing the AVR Microcontroller", McGraw-Hill, 2001.
2. Joe Pardue, "C Programming for Microcontrollers ", Smiley Micros, 2005.
3. Steven F. Barrett, Daniel J. Pack, "ATMEL AVR Microcontroller Primer : Programming and Interfacing", Morgan & Claypool Publishers, 2012
4. Mike Riley, "Programming Your Home - Automate With Arduino, Android and Your Computer", the Pragmatic Programmers, Llc, 2012.
5. Richard Szeliski, "Computer Vision: Algorithms and Applications", Springer, 2011.
6. Kevin P. Murphy, "Machine Learning - a Probabilistic Perspective", the MIT Press Cambridge, Massachusetts, London, 2012.

CX4016**ENVIRONMENTAL SUSTAINABILITY**

L	T	P	C
3	0	0	3

UNIT I INTRODUCTION**9**

Valuing the Environment: Concepts, Valuing the Environment: Methods, Property Rights, Externalities, and Environmental Problems

UNIT II CONCEPT OF SUSTAINABILITY**9**

Sustainable Development: Defining the Concept, the Population Problem, Natural Resource Economics: An Overview, Energy, Water, Agriculture

UNIT III SIGNIFICANCE OF BIODIVERSITY**9**

Biodiversity, Forest Habitat, Commercially Valuable Species, Stationary - Source Local Air Pollution, Acid Rain and Atmospheric Modification, Transportation

UNIT IV POLLUTION IMPACTS 9
Water Pollution, Solid Waste and Recycling, Toxic Substances and Hazardous Wastes, Global Warming.

UNIT V ENVIRONMENTAL ECONOMICS 9
Development, Poverty, and the Environment, Visions of the Future, Environmental economics and policy by Tom Tietenberg, Environmental Economics

TOTAL : 45 PERIODS

REFERENCES

1. Andrew Hoffman, Competitive Environmental Strategy - A Guide for the Changing Business Landscape, Island Press.
2. Stephen Doven, Environment and Sustainability Policy: Creation, Implementation, Evaluation, the Federation Press, 2005
3. Robert Brinkmann., Introduction to Sustainability, Wiley-Blackwell., 2016
4. Niko Roorda., Fundamentals of Sustainable Development, 3rd Edn, Routledge, 2020
5. Bhavik R Bakshi., Sustainable Engineering: Principles and Practice, Cambridge University Press, 2019

TX4092 TEXTILE REINFORCED COMPOSITES L T P C
3 0 0 3

UNIT I REINFORCEMENTS 9
Introduction – composites –classification and application; reinforcements- fibres and its properties; preparation of reinforced materials and quality evaluation; preforms for various composites

UNIT II MATRICES 9
Preparation, chemistry, properties and applications of thermoplastic and thermoset resins; mechanism of interaction of matrices and reinforcements; optimization of matrices

UNIT III COMPOSITE MANUFACTURING 9
Classification; methods of composites manufacturing for both thermoplastics and thermosets- Hand layup, Filament Winding, Resin transfer moulding, prepregs and autoclave moulding, pultrusion, vacuum impregnation methods, compression moulding; post processing of composites and composite design requirements

UNIT IV TESTING 9
Fibre volume and weight fraction, specific gravity of composites, tensile, flexural, impact, compression, inter laminar shear stress and fatigue properties of thermoset and thermoplastic composites.

UNIT V MECHANICS 9
Micro mechanics, macro mechanics of single layer, macro mechanics of laminate, classical lamination theory, failure theories and prediction of inter laminar stresses using at ware

TOTAL: 45 PERIODS

REFERENCES

1. BorZ.Jang, "Advanced Polymer composites", ASM International, USA, 1994.
2. Carlsson L.A. and Pipes R.B., "Experimental Characterization of advanced composite Materials", Second Edition, CRC Press, New Jersey, 1996.
3. George Lubin and Stanley T. Peters, "Handbook of Composites", Springer Publications, 1998.
4. Mel. M. Schwartz, "Composite Materials", Vol. 1 & 2, Prentice Hall PTR, New Jersey, 1997.
5. Richard M. Christensen, "Mechanics of composite materials", Dover Publications, 2005.
6. Sanjay K. Mazumdar, "Composites Manufacturing: Materials, Product, and Process Engineering", CRC Press, 2001

NT4002

NANOCOMPOSITE MATERIALS

L T P C

3 0 0 3

UNIT I BASICS OF NANOCOMPOSITES 9

Nomenclature, Properties, features and processing of nanocomposites. Sample Preparation and Characterization of Structure and Physical properties. Designing, stability and mechanical properties and applications of super hard nanocomposites.

UNIT II METAL BASED NANOCOMPOSITES 9

Metal-metal nanocomposites, some simple preparation techniques and their properties. Metal-Oxide or Metal-Ceramic composites, Different aspects of their preparation techniques and their final properties and functionality. Fractal based glass-metal nanocomposites, its designing and fractal dimension analysis. Core-Shell structured nanocomposites

UNIT III POLYMER BASED NANOCOMPOSITES 9

Preparation and characterization of diblock Copolymer based nanocomposites; Polymer Carbon nanotubes based composites, their mechanical properties, and industrial possibilities.

UNIT IV NANOCOMPOSITE FROM BIOMATERIALS 9

Natural nanocomposite systems - spider silk, bones, shells; organic-inorganic nanocomposite formation through self-assembly. Biomimetic synthesis of nanocomposites material; Use of synthetic nanocomposites for bone, teeth replacement.

UNIT V NANOCOMPOSITE TECHNOLOGY 9

Nanocomposite membrane structures- Preparation and applications. Nanotechnology in Textiles and Cosmetics-Nano-fillers embedded polypropylene fibers – Soil repellence, Lotus effect - Nano finishing in textiles (UV resistant, anti-bacterial, hydrophilic, self-cleaning, flame retardant finishes), Sun-screen dispersions for UV protection using titanium oxide – Colour cosmetics. Nanotechnology in Food Technology - Nanopackaging for enhanced shelf life - Smart/Intelligent packaging.

TOTAL : 45 PERIODS

REFERENCES:

1. Introduction to Nanocomposite Materials. Properties, Processing, Characterization- Thomas E. Twardowski. 2007. DEStech Publications. USA.
2. Nanocomposites Science and Technology - P. M. Ajayan, L.S. Schadler, P. V. Braun 2006.
3. Physical Properties of Carbon Nanotubes- R. Saito 1998.
4. Carbon Nanotubes (Carbon , Vol 33) - M. Endo, S. Iijima, M.S. Dresselhaus 1997.
5. The search for novel, superhard materials- Stan Vepřek (Review Article) JVST A, 1999
6. Nanometer versus micrometer-sized particles-Christian Brosseau, Jamal BeN Youssef, Philippe Talbot, Anne-Marie Konn, (Review Article) J. Appl. Phys, Vol 93, 2003
7. Diblock Copolymer, - Aviram (Review Article), Nature, 2002
8. Bikramjit Basu, Kantesh Balani Advanced Structural Ceramics, A John Wiley & Sons, Inc.,
9. P. Brown and K. Stevens, Nanofibers and Nanotechnology in Textiles, Woodhead publication, London, 2006

BY4016

IPR, BIOSAFETY AND ENTREPRENEURSHIP

LT PC
3 0 0 3

UNIT I IPR

9

Intellectual property rights – Origin of the patent regime – Early patents act & Indian pharmaceutical industry – Types of patents – Patent Requirements – Application preparation filing and prosecution – Patentable subject matter – Industrial design, Protection of GMO's IP as a factor in R&D, IP's of relevance to biotechnology and few case studies.

UNIT II AGREEMENTS, TREATIES AND PATENT FILING PROCEDURES 9

History of GATT Agreement – Madrid Agreement – Hague Agreement – WIPO Treaties – Budapest Treaty – PCT – Ordinary – PCT – Conventional – Divisional and Patent of Addition – Specifications – Provisional and complete – Forms and fees Invention in context of “prior art” – Patent databases – Searching International Databases – Country-wise patent searches (USPTO, espacenet(EPO)) – PATENT Scope (WIPO) – IPO, etc National & PCT filing procedure – Time frame and cost – Status of the patent applications filed – Precautions while patenting – disclosure/non-disclosure – Financial assistance for patenting – Introduction to existing schemes Patent licensing and agreement Patent infringement – Meaning, scope, litigation, case studies

UNIT III BIOSAFETY

9

Introduction – Historical Background – Introduction to Biological Safety Cabinets – Primary Containment for Biohazards – Biosafety Levels – Biosafety Levels of Specific Microorganisms – Recommended Biosafety Levels for Infectious Agents and Infected Animals – Biosafety guidelines – Government of India.

UNIT IV GENETICALLY MODIFIED ORGANISMS

9

Definition of GMOs & LMOs – Roles of Institutional Biosafety Committee – RCGM – GEAC etc. for GMO applications in food and agriculture – Environmental release of GMOs – Risk Analysis – Risk Assessment – Risk management and communication – Overview of National Regulations and relevant International Agreements including Cartagena Protocol.

UNIT V ENTREPRENEURSHIP DEVELOPMENT

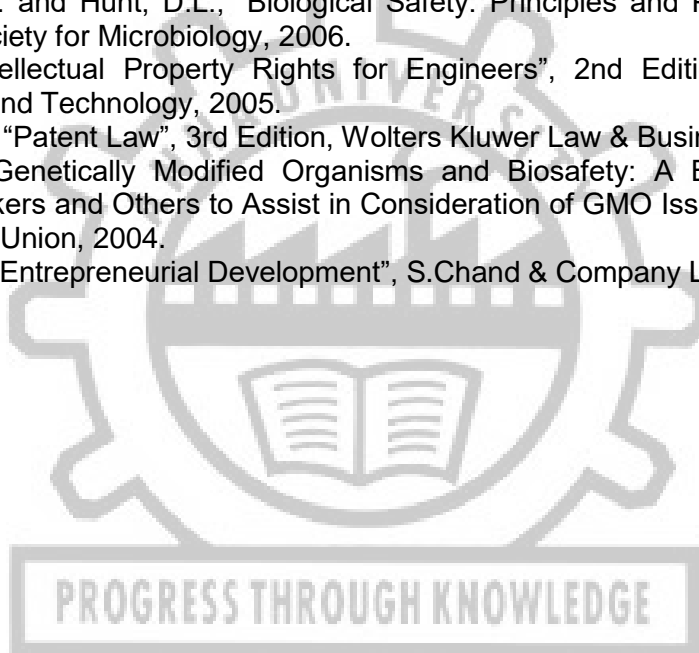
9

Introduction – Entrepreneurship Concept – Entrepreneurship as a career – Entrepreneurial personality – Characteristics of successful Entrepreneur – Factors affecting entrepreneurial growth – Entrepreneurial Motivation – Competencies – Mobility – Entrepreneurship Development Programmes (EDP) - Launching Of Small Enterprise - Definition, Characteristics – Relationship between small and large units – Opportunities for an Entrepreneurial career – Role of small enterprise in economic development – Problems of small scale industries – Institutional finance to entrepreneurs - Institutional support to entrepreneurs.

TOTAL : 45 PERIODS

REFERENCES

1. Bouchoux, D.E., “Intellectual Property: The Law of Trademarks, Copyrights, Patents, and Trade Secrets for the Paralegal”, 3rd Edition, Delmar Cengage Learning, 2008.
2. Fleming, D.O. and Hunt, D.L., “Biological Safety: Principles and Practices”, 4th Edition, American Society for Microbiology, 2006.
3. Irish, V., “Intellectual Property Rights for Engineers”, 2nd Edition, The Institution of Engineering and Technology, 2005.
4. Mueller, M.J., “Patent Law”, 3rd Edition, Wolters Kluwer Law & Business, 2009.
5. Young, T., “Genetically Modified Organisms and Biosafety: A Background Paper for Decision- Makers and Others to Assist in Consideration of GMO Issues” 1st Edition, World Conservation Union, 2004.
6. S.S Khanka, “Entrepreneurial Development”, S.Chand & Company LTD, New Delhi, 2007.



ANNA UNIVERSITY, CHENNAI
NON - AUTONOMOUS COLLEGES AFFILIATED ANNA UNIVERSITY
M.E. COMPUTER SCIENCE AND ENGINEERING
REGULATIONS – 2021
CHOICE BASED CREDIT SYSTEM

1. PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

- I. Develop proficiency as a computer science engineer with an ability to solve a wide range of computational problems and have sustainable development in industry or any other work environment.
- II. Analyze and adapt quickly to new environments and technologies, gather new information, and work on emerging technologies to solve multidisciplinary engineering problems.
- III. Possess the ability to think analytically and logically to understand technical problems with computational systems for a lifelong learning which leads to pursuing research.
- IV. Adopt ethical practices to collaborate with team members and team leaders to build technology with cutting-edge technical solutions for computing systems
- V. Strongly focus on design thinking and critical analysis to create innovative products and become entrepreneurs.

2. PROGRAM OUTCOMES (POs):

1. An ability to independently carry out research / investigation and development work to solve practical problems.
2. An ability to write and present a substantial technical report/document.
3. Students should be able to demonstrate a degree of mastery over the area of Computer Science and Engineering.
4. Efficiently design, build and develop system application software for distributed and centralized computing environments in varying domains and platforms.
5. Understand the working of current Industry trends, the new hardware architectures, the software components and design solutions for real world problems by Communicating and effectively working with professionals in various engineering fields and pursue research orientation for a lifelong professional development in computer and automation arenas.
6. Model a computer based automation system and design algorithms that explore the understanding of the tradeoffs involved in digital transformation.

PEO/PO Mapping:

PEO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
I.	1	2	3	4	5	6
II.	3	2	3	3	3	3
III.	3	3	3	3	2	3
IV.	3	3	2	3	3	2
V.	1	2	3	2	2	2

Contribution 1: Reasonable 2: Significant 3: Strong

MAPPING OF COURSE OUTCOMES AND PROGRAMME OUTCOMES

		COURSE NAME	PO1	PO2	PO3	PO4	PO5	PO6
YEAR I	SEMESTER I	MA4151 Applied Probability and Statistics for Computer Science Engineers	2.00	1.67	2.00	2.00	2.00	2.00
		RM4151 Research Methodology and IPR	3.00	2.00	2.00	1.67	1.20	2.00
		CP4151 Advanced Data Structures and Algorithms	3.00	2.00	1.25	1.67	1.67	2.00
		CP4152 Database Practices	2.40	2.00	1.50	1.60	1.00	1.20
		CP4153 Network Technologies	1.00	2.80	2.20	1.75	1.50	1.50
		CP4154 Principles of Programming Languages	1.00	1.67	1.00	1.00	1.50	2.00
		CP4161 Advanced Data Structures and Algorithms Laboratory	1.00	1.50	1.75	1.40	2.00	1.00
	SEMESTER II	CP4291 Internet of Things	1.60	1.80	1.60	1.40	2.00	2.20
		CP4292 Multicore Architecture and Programming	1.80	1.00	1.50	1.25	1.60	2.20
		CP4252 Machine Learning	1.80	2.20	1.25	1.75	1.00	2.20
		SE4151 Advanced Software Engineering	2	2.75	2	2.4	2.67	2
		CP4211 Term Paper Writing and seminar						
		CP4212 Software Engineering Laboratory	2.5	2.5	2.25	2.5	2	2.34
YEAR II	SEMESTER III	CP4391 Security Practices	1.50	1.67	1.60	1.60	1.80	2.40
	SEMESTER IV	CP4411 Project Work II						

PROFESSIONAL ELECTIVE COURSES [PEC]

S. NO.	CODE	COURSE TITLE	PO1	PO2	PO3	PO4	PO5	PO6
1.	MP4092	Human Computer Interaction	2	2.75	2	2.4	2.67	2
2.	MP4251	Cloud Computing Technologies	2.6	2.5	2	2	1.5	2
3.	BD4151	Foundations of Data Science	1.75	1.5	2.7	3	2.5	2.5
4.	MP4152	Wireless Communications	2.5	2.7	2.7	2	3	2.75
5.	SE4071	Agile Methodologies	2.2	2	2.3	2.5	2.2	3
6.	CP4095	Performance Analysis of Computer Systems	1.6	1.75	2.2	1.33	2	1
7.	CP4001	Advanced Operating System	1.25	1.75	2.33	2	1.5	2
8.	MU4251	Digital Image Processing	2.4	2.3	2.5	2.4	2.3	3
9.	BD4071	High Performance Computing for Big Data	1.75	1.5	2	2	2.25	3
10.	CP4093	Information Retrieval Techniques	1.6	1.6	1.8	2.6	2.2	2.4
11.	CP4096	Software Quality Assurance	2.2	1.8	1.8	2.8	1.6	2.4
12.	CP4091	Autonomous Systems	1.8	1.5	2.25	2	2	2
13.	CP4097	Web Analytics	2.2	2	3	1.6	1.8	1.4
14.	MP4091	Cognitive Computing	1.5	2.3	2	1.5	2	1.5
15.	AP4093	Quantum Computing	1.75	1.7	2.4	2	2	2.73
16.	BD4251	Big Data Mining and Analytics	1.5	3	2	2	2.8	2.8
17.	CP4094	Mobile and Pervasive Computing	1.8	2.5	1.6	1.8	1.6	2
18.	MP4094	Web Services and API Design	1	3	2.4	3	1	2
19.	CP4092	Data Visualization Techniques	2.2	1	2.4	2.4	1.4	1.6
20.	IF4091	Compiler Optimization Techniques	2.6	2.6	2.8	3	2.5	2.6
21.	CP4002	Formal Models of Software Systems	2	1.4	2.33	2.67	1.8	3
22.	AP4094	Robotics	1.2	2.3	3	2.7	2.2	2
23.	ML4291	Natural Language Processing	1.75	2	2.4	2.6	1	3
24.	IF4093	GPU Computing	3	2	2.5	2.5	2.5	3
25.	IF4073	Devops and Microservices	3	2	1.5	2	2.6	3
26.	MP4292	Mobile Application Development	3	1.6	1.75	2.8	3	2.25
27.	IF4071	Deep Learning	2	2	1.6	3	2.6	2.6
28.	CP4072	Blockchain Technologies	2	1	2.5	2.25	2	2
29.	SE4073	Embedded Software Development	1.3	2	2	2	2.25	2
30.	IF4291	Full Stack Web Application Development	2.33	3	1.75	3	3	3
31.	CP4071	Bioinformatics	1	1.6	1.5	1.67	2	2.6
32.	MP4291	Cyber Physical Systems	2.3	2.5	2.6	1.7	1.7	1.7
33.	MU4291	Mixed Reality	3	1	3	1	1	2

ANNA UNIVERSITY, CHENNAI
NON - AUTONOMOUS COLLEGES AFFILIATED ANNA UNIVERSITY
M.E. COMPUTER SCIENCE AND ENGINEERING
REGULATIONS – 2021
CHOICE BASED CREDIT SYSTEM
I TO IV SEMESTERS CURRICULA AND SYLLABI
SEMESTER I

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	MA4151	Applied Probability and Statistics for Computer Science Engineers	FC	3	1	0	4	4
2.	RM4151	Research Methodology and IPR	RMC	2	0	0	2	2
3.	CP4151	Advanced Data Structures and Algorithms	PCC	3	0	0	3	3
4.	CP4152	Database Practices	PCC	3	0	2	5	4
5.	CP4153	Network Technologies	PCC	3	0	0	3	3
6.	CP4154	Principles of Programming Languages	PCC	3	0	0	3	3
7.		Audit Course – I*	AC	2	0	0	2	0
TOTAL				19	1	6	26	21

*Audit course is optional

SEMESTER II

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	CP4291	Internet of Things	PCC	3	0	2	5	4
2.	CP4292	Multicore Architecture and Programming	PCC	3	0	2	5	4
3.	CP4252	Machine Learning	PCC	3	0	2	5	4
4.	SE4151	Advanced Software Engineering	PCC	3	0	0	3	3
5.		Professional Elective I	PEC	3	0	0	3	3
6.		Professional Elective II	PEC	3	0	0	3	3
7.		Audit Course – II*	AC	2	0	0	2	0
PRACTICALS								
8.	CP4211	Term Paper Writing and seminar	EEC	0	0	2	2	1
9.	CP4212	Software Engineering Laboratory	PCC	0	0	2	2	1
TOTAL				20	0	10	30	23

*Audit course is optional

SEMESTER III

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	CP4391	Security Practices	PCC	3	0	0	3	3
2.		Professional Elective III	PEC	3	0	0	3	3
3.		Professional Elective IV	PEC	3	0	2	5	4
4.		Open Elective	OEC	3	0	0	3	3
PRACTICALS								
5.	CP4311	Project Work I	EEC	0	0	12	12	6
TOTAL				12	0	14	26	19

SEMESTER IV

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
PRACTICALS								
1.	CP4411	Project Work II	EEC	0	0	24	24	12
TOTAL				0	0	24	24	12

TOTAL NO. OF CREDITS: 75

**PROFESSIONAL ELECTIVES
SEMESTER II, ELECTIVE I**

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	MP4092	Human Computer Interaction	PEC	3	0	0	3	3
2.	MP4251	Cloud Computing Technologies	PEC	3	0	0	3	3
3.	BD4151	Foundations of Data Science	PEC	3	0	0	3	3
4.	MP4152	Wireless Communications	PEC	3	0	0	3	3
5.	SE4071	Agile Methodologies	PEC	3	0	0	3	3
6.	CP4095	Performance Analysis of Computer Systems	PEC	3	0	0	3	3
7.	CP4001	Advanced Operating System	PEC	3	0	0	3	3
8.	MU4251	Digital Image Processing	PEC	3	0	0	3	3

SEMESTER II, ELECTIVE II

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	BD4071	High Performance Computing for Big Data	PEC	3	0	0	3	3
2.	CP4093	Information Retrieval Techniques	PEC	3	0	0	3	3
3.	CP4096	Software Quality Assurance	PEC	3	0	0	3	3
4.	CP4091	Autonomous Systems	PEC	3	0	0	3	3
5.	CP4097	Web Analytics	PEC	3	0	0	3	3
6.	MP4091	Cognitive Computing	PEC	3	0	0	3	3
7.	AP4093	Quantum Computing	PEC	3	0	0	3	3
8.	BD4251	Big Data Mining and Analytics	PEC	3	0	0	3	3

SEMESTER III, ELECTIVE III

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CP4094	Mobile and Pervasive Computing	PEC	3	0	0	3	3
2.	MP4094	Web Services and API Design	PEC	3	0	0	3	3
3.	CP4092	Data Visualization Techniques	PEC	3	0	0	3	3
4.	IF4091	Compiler Optimization Techniques	PEC	3	0	0	3	3
5.	CP4002	Formal Models of Software Systems	PEC	3	0	0	3	3
6.	AP4094	Robotics	PEC	3	0	0	3	3
7.	ML4291	Natural Language Processing	PEC	2	0	2	4	3
8.	IF4093	GPU Computing	PEC	3	0	0	3	3

SEMESTER III, ELECTIVE IV

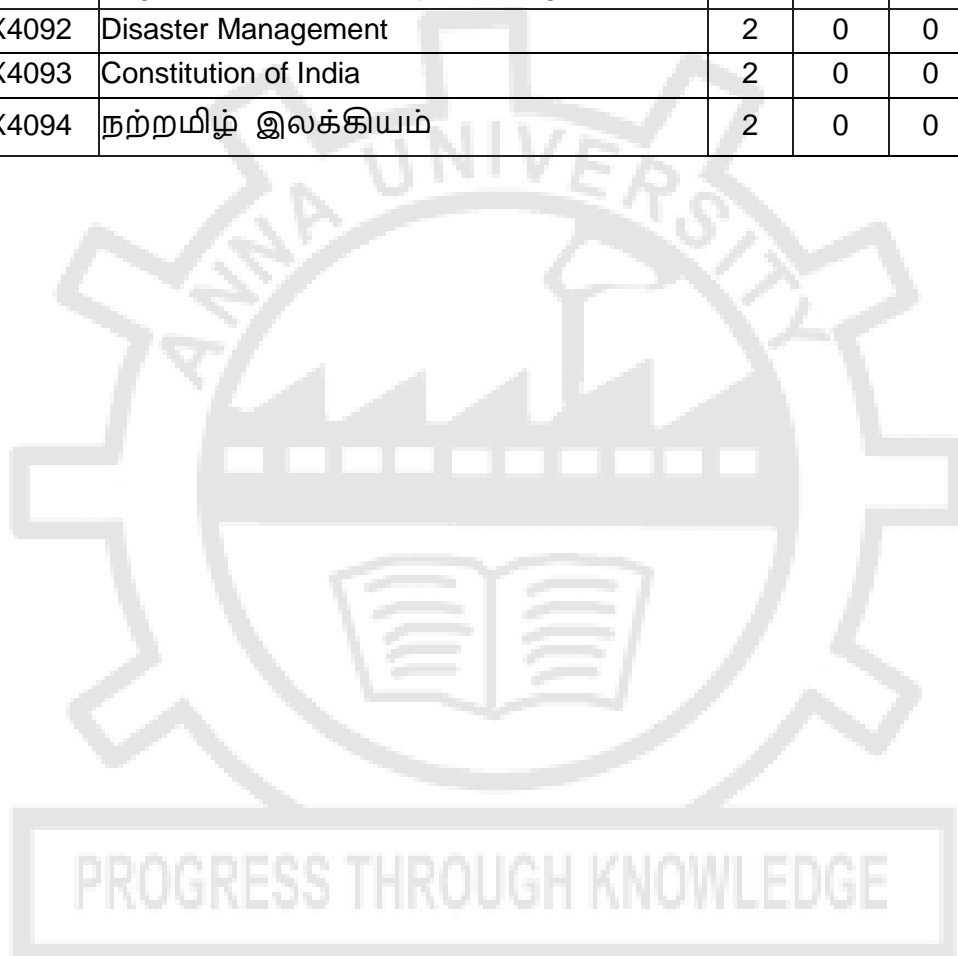
S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	IF4073	Devops and Microservices	PEC	3	0	2	5	4
2.	MP4292	Mobile Application Development	PEC	3	0	2	5	4
3.	IF4071	Deep Learning	PEC	3	0	2	5	4
4.	CP4072	Blockchain Technologies	PEC	3	0	2	5	4
5.	SE4073	Embedded Software Development	PEC	3	0	2	5	4
6.	IF4291	Full Stack Web Application Development	PEC	3	0	2	5	4

7.	CP4071	Bioinformatics	PEC	3	0	2	5	4
8.	MP4291	Cyber Physical Systems	PEC	3	0	2	5	4
9.	MU4291	Mixed Reality	PEC	3	0	2	5	4

AUDIT COURSES (AC)

Registration for any of these courses is optional to students

SL. NO.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS
			L	T	P	
1.	AX4091	English for Research Paper Writing	2	0	0	0
2.	AX4092	Disaster Management	2	0	0	0
3.	AX4093	Constitution of India	2	0	0	0
4.	AX4094	நற்றமிழ் இலக்கியம்	2	0	0	0



LIST OF OPEN ELECTIVES FOR PG PROGRAMMES

SL. NO.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS
			L	T	P	
1.	OCE431	Integrated Water Resources Management	3	0	0	3
2.	OCE432	Water, Sanitation and Health	3	0	0	3
3.	OCE433	Principles of Sustainable Development	3	0	0	3
4.	OCE434	Environmental Impact Assessment	3	0	0	3
5.	OME431	Vibration and Noise Control Strategies	3	0	0	3
6.	OME432	Energy Conservation and Management in Domestic Sectors	3	0	0	3
7.	OME433	Additive Manufacturing	3	0	0	3
8.	OME434	Electric Vehicle Technology	3	0	0	3
9.	OME435	New Product Development	3	0	0	3
10.	OBA431	Sustainable Management	3	0	0	3
11.	OBA432	Micro and Small Business Management	3	0	0	3
12.	OBA433	Intellectual Property Rights	3	0	0	3
13.	OBA434	Ethical Management	3	0	0	3
14.	ET4251	IoT for Smart Systems	3	0	0	3
15.	ET4072	Machine Learning and Deep Learning	3	0	0	3
16.	PX4012	Renewable Energy Technology	3	0	0	3
17.	PS4093	Smart Grid	3	0	0	3
18.	DS4015	Big Data Analytics	3	0	0	3
19.	NC4201	Internet of Things and Cloud	3	0	0	3
20.	MX4073	Medical Robotics	3	0	0	3
21.	VE4202	Embedded Automation	3	0	0	3
22.	CX4016	Environmental Sustainability	3	0	0	3
23.	TX4092	Textile Reinforced Composites	3	0	0	3
24.	NT4002	Nanocomposite Materials	3	0	0	3
25.	BY4016	IPR, Biosafety and Entrepreneurship	3	0	0	3

PROGRESS THROUGH KNOWLEDGE

FOUNDATION COURSES (FC)

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	Sem
			Lecture	Tutorial	Practical		
1.	MA4153	Advanced Mathematical Methods	3	1	0	4	1

PROFESSIONAL CORE COURSES (PCC)

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEM 1
			Lecture	Tutorial	Practical		
1.	CP4151	Advanced Data Structures and Algorithms	3	0	0	3	I
2.	CP4152	Database Practices	3	0	2	4	I
3.	CP4153	Network Technologies	3	0	0	3	I
4.	CP4154	Principles of Programming	3	0	0	3	I
5.	CP4161	Advanced Data Structures and Algorithms Laboratory	0	0	4	2	I
6.	CP4291	Internet of Things	3	0	2	4	II
7.	CP4292	Multicore Architecture and Programming	3	0	2	4	II
8.	CP4252	Machine Learning	3	0	2	4	II
9.	SE4151	Advanced Software Engineering	3	0	0	3	II
10.	CP4212	Software Engineering Laboratory	0	0	2	1	II
11.	CP4391	Security Practices	3	0	0	3	III

RESEARCH METHODOLOGY AND IPR COURSES (RMC)

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	RM4151	Research Methodology and IPR	2	0	0	2	I

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	CP4211	Technical Seminar	0	0	2	1	1
2.	CP4311	Project Work I	0	0	12	6	3
3.	CP4411	Project Work II	0	0	24	12	4

SUMMARY

Sl. No.	NAME OF THE PROGRAMME: M.E COMPUTER SCIENCE AND ENGINEERING					
	SUBJECT AREA	CREDITS PER SEMESTER				CREDITS TOTAL
		I	II	III	IV	
1.	FC	04	00	00	00	04
2.	PCC	15	16	03	00	34
3.	PEC	00	06	07	00	13
4.	RMC	02	00	00	00	02
5.	OEC	00	00	03	00	03
6.	EEC	00	01	06	12	19
7.	Non Credit/Audit Course	✓	✓	00	00	
8.	TOTAL CREDIT	21	23	19	12	75



COURSE OBJECTIVES:

- To encourage students to develop a working knowledge of the central ideas of Linear Algebra.
- To enable students to understand the concepts of Probability and Random Variables.
- To understand the basic probability concepts with respect to two dimensional random variables along with the relationship between the random variables and the significance of the central limit theorem.
- To apply the small / large sample tests through Tests of hypothesis.
- To enable the students to use the concepts of multivariate normal distribution and principal components analysis.

UNIT I LINEAR ALGEBRA 12

Vector spaces – norms – Inner Products – Eigenvalues using QR transformations – QR factorization – generalized eigenvectors – Canonical forms – singular value decomposition and applications – pseudo inverse – least square approximations.

UNIT II PROBABILITY AND RANDOM VARIABLES 12

Probability – Axioms of probability – Conditional probability – Baye’s theorem – Random variables – Probability function – Moments – Moment generating functions and their properties – Binomial, Poisson , Geometric, Uniform, Exponential, Gamma and Normal distributions – Function of a random variable.

UNIT III TWO DIMENSIONAL RANDOM VARIABLES 12

Joint distributions – Marginal and conditional distributions – Functions of two-dimensional random variables – Regression curve – Correlation.

UNIT IV TESTING OF HYPOTHESIS 12

Sampling distributions – Type I and Type II errors – Small and Large samples – Tests based on Normal, t, Chi square and F distributions for testing of mean , variance and proportions – Tests for independence of attributes and goodness of fit.

UNIT V MULTIVARIATE ANALYSIS 12

Random vectors and matrices – Mean vectors and covariance matrices – Multivariate normal density and its properties – Principal components – Population principal components – Principal components from standardized variables.

TOTAL : 60 PERIODS

COURSE OUTCOMES:

At the end of the course, students will be able to

CO1:apply the concepts of Linear Algebra to solve practical problems.

CO2:use the ideas of probability and random variables in solving engineering problems.

CO3:be familiar with some of the commonly encountered two dimensional random variables and be equipped for a possible extension to multivariate analysis.

CO4:use statistical tests in testing hypotheses on data.

CO5:develop critical thinking based on empirical evidence and the scientific approach to knowledge development.

REFERENCES:

1. Dallas E Johnson, “Applied multivariate methods for data Analysis”, Thomson and Duxbury press, Singapore, 1998.
2. Richard A. Johnson and Dean W. Wichern, “Applied multivariate statistical Analysis”, Pearson Education, Fifth Edition, 6th Edition, New Delhi, 2013.
3. Bronson, R.,”Matrix Operation” Schaum’s outline series, Tata McGraw Hill, New York, 2011.
4. Oliver C. Ibe, “Fundamentals of Applied probability and Random Processes”, Academic Press, Boston, 2014.
5. Johnson R. A. and Gupta C.B., “Miller and Freund’s Probability and Statistics for Engineers”, Pearson India Education, Asia, 9th Edition, New Delhi, 2017.

CO – PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	1	2	3	-	-	1
2	3	-	2	2	-	3
3	-	-	1	-	3	2
4	2	1	3	2	2	2
5	2	2	1	-	1	2
Avg	2	1.67	2	2	2	2

RM4151

RESEARCH METHODOLOGY AND IPR

L T P C
2 0 0 2

UNIT I

RESEARCH DESIGN

6

Overview of research process and design, Use of Secondary and exploratory data to answer the research question, Qualitative research, Observation studies, Experiments and Surveys.

UNIT II

DATA COLLECTION AND SOURCES

6

Measurements, Measurement Scales, Questionnaires and Instruments, Sampling and methods. Data - Preparing, Exploring, examining and displaying.

UNIT III

DATA ANALYSIS AND REPORTING

6

Overview of Multivariate analysis, Hypotheses testing and Measures of Association. Presenting Insights and findings using written reports and oral presentation.

UNIT IV

INTELLECTUAL PROPERTY RIGHTS

6

Intellectual Property – The concept of IPR, Evolution and development of concept of IPR, IPR development process, Trade secrets, utility Models, IPR & Biodiversity, Role of WIPO and WTO in

IPR establishments, Right of Property, Common rules of IPR practices, Types and Features of IPR Agreement, Trademark, Functions of UNESCO in IPR maintenance.

UNIT V PATENTS

6

Patents – objectives and benefits of patent, Concept, features of patent, Inventive step, Specification, Types of patent application, process E-filing, Examination of patent, Grant of patent, Revocation, Equitable Assignments, Licenses, Licensing of related patents, patent agents, Registration of patent agents.

TOTAL : 30 PERIODS

REFERENCES

1. Cooper Donald R, Schindler Pamela S and Sharma JK, “Business Research Methods”, Tata McGraw Hill Education, 11e (2012).
2. Catherine J. Holland, “Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets”, Entrepreneur Press, 2007.
3. David Hunt, Long Nguyen, Matthew Rodgers, “Patent searching: tools & techniques”, Wiley, 2007.
4. The Institute of Company Secretaries of India, Statutory body under an Act of parliament, “Professional Programme Intellectual Property Rights, Law and practice”, September 2013.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	3	2	2	3	2	3
2	3	-	-	-	1	3
3	3	-	-	1	1	2
4	3	-	-	-	1	1
5	3	-	-	1	1	1
Avg	3.00	2.00	2.00	1.67	1.20	2.00

CP4151

ADVANCED DATA STRUCTURES AND ALGORITHMS

L T P C
3 0 0 3

COURSE OBJECTIVES:

- To understand the usage of algorithms in computing
- To learn and use hierarchical data structures and its operations
- To learn the usage of graphs and its applications
- To select and design data structures and algorithms that is appropriate for problems
- To study about NP Completeness of problems.

UNIT I ROLE OF ALGORITHMS IN COMPUTING & COMPLEXITY ANALYSIS

9

Algorithms – Algorithms as a Technology -Time and Space complexity of algorithms- Asymptotic

analysis-Average and worst-case analysis-Asymptotic notation-Importance of efficient algorithms- Program performance measurement - Recurrences: The Substitution Method – The Recursion-Tree Method- Data structures and algorithms.

UNIT II HIERARCHICAL DATA STRUCTURES 9

Binary Search Trees: Basics – Querying a Binary search tree – Insertion and Deletion- Red Black trees: Properties of Red-Black Trees – Rotations – Insertion – Deletion -B-Trees: Definition of B -trees – Basic operations on B-Trees – Deleting a key from a B-Tree- Heap – Heap Implementation – Disjoint Sets - Fibonacci Heaps: structure – Mergeable-heap operations- Decreasing a key and deleting a node-Bounding the maximum degree.

UNIT III GRAPHS 9

Elementary Graph Algorithms: Representations of Graphs – Breadth-First Search – Depth-First Search – Topological Sort – Strongly Connected Components- Minimum Spanning Trees: Growing a Minimum Spanning Tree – Kruskal and Prim- Single-Source Shortest Paths: The Bellman-Ford algorithm – Single-Source Shortest paths in Directed Acyclic Graphs – Dijkstra's Algorithm; Dynamic Programming - All-Pairs Shortest Paths: Shortest Paths and Matrix Multiplication – The Floyd-Warshall Algorithm

UNIT IV ALGORITHM DESIGN TECHNIQUES 9

Dynamic Programming: Matrix-Chain Multiplication – Elements of Dynamic Programming – Longest Common Subsequence- Greedy Algorithms: – Elements of the Greedy Strategy- An Activity-Selection Problem - Huffman Coding.

UNIT V NP COMPLETE AND NP HARD 9

NP-Completeness: Polynomial Time – Polynomial-Time Verification – NP- Completeness and Reducibility – NP-Completeness Proofs – NP-Complete Problems.

TOTAL : 45 PERIODS

SUGGESTED ACTIVITIES:

1. Write an algorithm for Towers of Hanoi problem using recursion and analyze the complexity (No of disc-4)
2. Write any one real time application of hierarchical data structure
3. Write a program to implement Make_Set, Find_Set and Union functions for Disjoint Set Data Structure for a given undirected graph $G(V,E)$ using the linked list representation with simple implementation of Union operation
4. Find the minimum cost to reach last cell of the matrix from its first cell
5. Discuss about any NP completeness problem

COURSE OUTCOMES:

CO1: Design data structures and algorithms to solve computing problems.

CO2: Choose and implement efficient data structures and apply them to solve problems.

CO3: Design algorithms using graph structure and various string-matching algorithms to solve real-life problems.

CO4: Design one's own algorithm for an unknown problem.

CO5: Apply suitable design strategy for problem solving.

REFERENCES

1. S.Sridhar," Design and Analysis of Algorithms", Oxford University Press, 1st Edition, 2014.
2. Adam Drozdex, "Data Structures and algorithms in C++", Cengage Learning, 4th Edition, 2013.
3. T.H. Cormen, C.E.Leiserson, R.L. Rivest and C.Stein, "Introduction to Algorithms", Prentice Hall of India, 3rd Edition, 2012.
4. Mark Allen Weiss, "Data Structures and Algorithms in C++", Pearson Education, 3rd Edition, 2009.
5. E. Horowitz, S. Sahni and S. Rajasekaran, "Fundamentals of Computer Algorithms", University Press, 2nd Edition, 2008.
6. Alfred V. Aho, John E. Hopcroft, Jeffrey D. Ullman, "Data Structures and Algorithms", Pearson Education, Reprint 2006.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	3	2	2	3	1	3
2	3	1	-	-	2	3
3	3	-	1	1	-	2
4	3	2	1	-	2	1
5	3	3	1	1	-	1
Avg	3.00	2.00	1.25	1.67	1.67	2.00

CP4152

DATABASE PRACTICES

L T P C
3 0 2 4

COURSE OBJECTIVES

- Describe the fundamental elements of relational database management systems
- Explain the basic concepts of relational data model, entity-relationship model, relational database design, relational algebra and SQL.
- Understand query processing in a distributed database system
- Understand the basics of XML and create well-formed and valid XML documents.
- Distinguish the different types of NoSQL databases
- To understand the different models involved in database security and their applications in real time world to protect the database and information associated with them.

UNIT I RELATIONAL DATA MODEL

15

Entity Relationship Model – Relational Data Model – Mapping Entity Relationship Model to Relational Model – Relational Algebra – Structured Query Language – Database Normalization.

Suggested Activities:

Data Definition Language

- Create, Alter and Drop
- Enforce Primary Key, Foreign Key, Check, Unique and Not Null Constraints

- Creating Views

Data Manipulation Language

- Insert, Delete, Update
- Cartesian Product, Equi Join, Left Outer Join, Right Outer Join and Full Outer Join
- Aggregate Functions
- Set Operations
- Nested Queries

Transaction Control Language

- Commit, Rollback and Save Points

UNIT II DISTRIBUTED DATABASES, ACTIVE DATABASES AND OPEN DATABASE CONNECTIVITY 15

Distributed Database Architecture – Distributed Data Storage – Distributed Transactions – Distributed Query Processing – Distributed Transaction Management – Event Condition Action Model – Design and Implementation Issues for Active Databases – Open Database Connectivity.

Suggested Activities:

- Distributed Database Design and Implementation
- Row Level and Statement Level Triggers
- Accessing a Relational Database using PHP, Python and R

UNIT III XML DATABASES 15

Structured, Semi structured, and Unstructured Data – XML Hierarchical Data Model – XML Documents – Document Type Definition – XML Schema – XML Documents and Databases – XML Querying – XPath – XQuery

Suggested Activities:

- Creating XML Documents, Document Type Definition and XML Schema
- Using a Relational Database to store the XML documents as text
- Using a Relational Database to store the XML documents as data elements
- Creating or publishing customized XML documents from pre-existing relational databases
- Extracting XML Documents from Relational Databases
- XML Querying

UNIT IV NOSQL DATABASES AND BIG DATA STORAGE SYSTEMS 15

NoSQL – Categories of NoSQL Systems – CAP Theorem – Document-Based NoSQL Systems and MongoDB – MongoDB Data Model – MongoDB Distributed Systems Characteristics – NoSQL Key-Value Stores – DynamoDB Overview – Voldemort Key-Value Distributed Data Store – Wide Column NoSQL Systems – Hbase Data Model – Hbase Crud Operations – Hbase Storage and Distributed System Concepts – NoSQL Graph Databases and Neo4j – Cypher Query Language of Neo4j – Big Data – MapReduce – Hadoop – YARN.

Suggested Activities:

- Creating Databases using MongoDB, DynamoDB, Voldemort Key-Value Distributed Data Store Hbase and Neo4j.
- Writing simple queries to access databases created using MongoDB, DynamoDB, Voldemort Key-Value Distributed Data Store Hbase and Neo4j.

UNIT V DATABASE SECURITY**15**

Database Security Issues – Discretionary Access Control Based on Granting and Revoking Privileges – Mandatory Access Control and Role-Based Access Control for Multilevel Security – SQL Injection – Statistical Database Security – Flow Control – Encryption and Public Key Infrastructures – Preserving Data Privacy – Challenges to Maintaining Database Security – Database Survivability – Oracle Label-Based Security.

Suggested Activities:

Implementing Access Control in Relational Databases

TOTAL : 75 PERIODS**COURSE OUTCOMES**

At the end of the course, the students will be able to

CO1:Convert the ER-model to relational tables, populate relational databases and formulate SQL queries on data.

CO2:Understand and write well-formed XML documents

CO3:Be able to apply methods and techniques for distributed query processing.

CO4:Design and Implement secure database systems.

CO5:Use the data control, definition, and manipulation languages of the NoSQL databases

REFERENCES:

1. R. Elmasri, S.B. Navathe, "Fundamentals of Database Systems", Seventh Edition, Pearson Education 2016.
2. Henry F. Korth, Abraham Silberschatz, S. Sudharshan, "Database System Concepts", Seventh Edition, McGraw Hill, 2019.
3. C.J.Date, A.Kannan, S.Swamynathan, "An Introduction to Database Systems, Eighth Edition, Pearson Education, 2006
4. Raghu Ramakrishnan, Johannes Gehrke "Database Management Systems", Fourth Edition, McGraw Hill Education, 2015.
5. Harrison, Guy, "Next Generation Databases, NoSQL and Big Data", First Edition, Apress publishers, 2015
6. Thomas Cannolly and Carolyn Begg, "Database Systems, A Practical Approach to Design, Implementation and Management", Sixth Edition, Pearson Education, 2015

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	2	2	1	3	1	2
2	2	2	-	2	1	1
3	3	1	2	1	-	1
4	3	2	2	1	1	1
5	2	3	1	1	-	1
Avg	2.40	2.00	1.50	1.60	1.00	1.20

COURSE OBJECTIVES:

- To understand the basic concepts of networks
- To explore various technologies in the wireless domain
- To study about 4G and 5G cellular networks
- To learn about Network Function Virtualization
- To understand the paradigm of Software defined networks

UNIT I NETWORKING CONCEPTS 9

Peer To Peer Vs Client-Server Networks. Network Devices. Network Terminology. Network Speeds. Network throughput, delay. Osi Model. Packets, Frames, And Headers. Collision And Broadcast Domains. LAN Vs WAN. Network Adapter. Hub. Switch. Router. Firewall, IP addressing.

UNIT II WIRELESS NETWORKS 9

Wireless access techniques- IEEE 802.11a, 802.11g, 802.11e, 802.11n/ac/ax/ay/ba/be, QoS – Bluetooth – Protocol Stack – Security – Profiles – zigbee

UNIT III MOBILE DATA NETWORKS 9

4G Networks and Composite Radio Environment – Protocol Boosters – Hybrid 4G Wireless Networks Protocols – Green Wireless Networks – Physical Layer and Multiple Access – Channel Modelling for 4G – Concepts of 5G – channel access –air interface -Cognitive Radio-spectrum management – C-RAN architecture - Vehicular communications-protocol – Network slicing – MIMO, mmWave, Introduction to 6G.

UNIT IV SOFTWARE DEFINED NETWORKS 9

SDN Architecture. Characteristics of Software-Defined Networking. SDN- and NFV-Related Standards. SDN Data Plane. Data Plane Functions. Data Plane Protocols. OpenFlow Logical Network Device. Flow Table Structure. Flow Table Pipeline. The Use of Multiple Tables. Group Table. OpenFlow Protocol. SDN Control Plane Architecture. Control Plane Functions. Southbound Interface. Northbound Interface. Routing. ITU-T Model. OpenDaylight. OpenDaylight Architecture. OpenDaylight Helium. SDN Application Plane Architecture. Northbound Interface. Network Services Abstraction Layer. Network Applications. User Interface.

UNIT V NETWORK FUNCTIONS VIRTUALIZATION 9

Motivation-Virtual Machines –NFV benefits-requirements – architecture- NFV Infrastructure - Virtualized Network Functions - NFV Management and Orchestration- NFV Use Cases- NFV and SDN –Network virtualization – VLAN and VPN

TOTAL : 45 PERIODS**COURSE OUTCOMES:**

- CO1: Explain basic networking concepts
 CO2: Compare different wireless networking protocols
 CO3: Describe the developments in each generation of mobile data networks
 CO4: Explain and develop SDN based applications
 CO5: Explain the concepts of network function virtualization

SUGGESTED ACTIVITIES:

1. Execute various network utilities such as tracert, pathping, ipconfig
2. Implement the Software Defined Networking using Mininet
3. Implement routing in Mininet
4. Install a virtual machine and study network virtualization
5. Simulate various network topologies in Network Simulator

REFERENCES

1. James Bernstein, "Networking made Easy", 2018. (UNIT I)
2. HoudaLabiod, Costantino de Santis, HossamAffi "Wi-Fi, Bluetooth, Zigbee and WiMax", Springer 2007 (UNIT 2)
3. Erik Dahlman, Stefan Parkvall, Johan Skold, 4G: LTE/LTE-Advanced for Mobile Broadband, Academic Press, 2013 (UNIT 3)
4. Saad Z. Asif "5G Mobile Communications Concepts and Technologies" CRC press – 2019 (UNIT 3)
5. William Stallings "Foundations of Modern Networking: SDN, NFV, QoE, IoT, and Cloud" 1st Edition, Pearson Education, 2016.(Unit 4 and 5)
6. Thomas D.Nadeau and Ken Gray, SDN – Software Defined Networks, O'Reilly Publishers, 2013.
7. Guy Pujolle, "Software Networks", Second Edition, Wiley-ISTE, 2020

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	1	3	2	-	1	-
2	1	3	3	3	-	1
3	1	3	3	2	2	2
4	1	2	2	1	2	1
5	1	3	1	1	1	2
Avg	1.00	2.80	2.20	1.75	1.50	1.50

CP4154

PRINCIPLES OF PROGRAMMING LANGUAGES

L T P C

3 0 0 3

COURSE OBJECTIVES:

- To understand and describe syntax and semantics of programming languages
- To understand data, data types, and basic statements
- To understand call-return architecture and ways of implementing them
- To understand object-orientation, concurrency, and event handling in programming languages
- To develop programs in non-procedural programming paradigms

UNIT I	SYNTAX AND SEMANTICS	9
Evolution of programming languages – describing syntax – context – free grammars –attribute grammars – describing semantics – lexical analysis – parsing – recursive-descent – bottom- up parsing		
UNIT II	DATA, DATA TYPES, AND BASIC STATEMENTS	9
Names – variables – binding – type checking – scope – scope rules – lifetime and garbage collection –primitive data types–strings–array types– associative arrays–record types– union types – pointers and references – Arithmetic expressions – overloaded operators – type conversions – relational and boolean expressions – assignment statements – mixed- mode assignments – control structures – selection – iterations – branching – guarded statements		
UNIT III	SUBPROGRAMS AND IMPLEMENTATIONS	9
Subprograms – design issues – local referencing – parameter passing – overloaded methods – generic methods – design issues for functions – semantics of call and return – implementing simple subprograms – stack and dynamic local variables – nested subprograms – blocks – dynamic scoping		
UNIT IV	OBJECT-ORIENTATION, CONCURRENCY, AND EVENT HANDLING	9
Object-orientation – design issues for OOP languages – implementation of object-oriented constructs – concurrency – semaphores – monitors – message passing – threads – statement level concurrency – exception handling – event handling		
UNIT V	FUNCTIONAL AND LOGIC PROGRAMMING LANGUAGES	9
Introduction to lambda calculus – fundamentals of functional programming languages – Programming with Scheme – Programming with ML – Introduction to logic and logic programming – Programming with Prolog – multi-paradigm languages		

TOTAL : 45 PERIODS

COURSE OUTCOMES:

- CO1:** Describe syntax and semantics of programming languages
- CO2:** Explain data, data types, and basic statements of programming languages
- CO3:** Design and implement subprogram constructs
- CO4:** Apply object-oriented, concurrency, and event handling programming constructs
- CO5:** Develop programs in Scheme, ML, and Prolog and Understand and adopt new programming language

REFERENCES:

1. Robert W. Sebesta, "Concepts of Programming Languages", Eleventh Edition, Addison Wesley, 2012
2. W. F. Clocksin and C. S. Mellish, "Programming in Prolog: Using the ISO Standard", Fifth Edition, Springer, 2003
3. Michael L.Scott, "Programming Language Pragmatics", Fourth Edition, Morgan Kaufmann, 2009.
4. R.KentDybvig, "TheSchemeprogramminglanguage", FourthEdition, MITPress, 2009
5. Richard A. O'Keefe, "The craft of Prolog", MIT Press, 2009
6. W.F.ClocksinandC.S.Mellish, "ProgramminginProlog:UsingtheISOStandard", Fifth Edition, Springer, 2003

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	1	-	-	-	-	1
2	1	-	1	-	1	2
3	1	1	-	-	1	2
4	-	2	1	1	2	2
5	1	2	1	-	2	3
Avg	1.00	1.67	1.00	1.00	1.50	2.00

CP4161

ADVANCED DATA STRUCTURES AND ALGORITHMS LABORATORY

L T P C
0 0 4 2

COURSE OBJECTIVES:

- To acquire the knowledge of using advanced tree structures
- To learn the usage of heap structures
- To understand the usage of graph structures and spanning trees
- To understand the problems such as matrix chain multiplication, activity selection and Huffman coding
- To understand the necessary mathematical abstraction to solve problems.

LIST OF EXPERIMENTS:

- 1: Implementation of recursive function for tree traversal and Fibonacci
- 2: Implementation of iteration function for tree traversal and Fibonacci
- 3: Implementation of Merge Sort and Quick Sort
- 4: Implementation of a Binary Search Tree
- 5: Red-Black Tree Implementation
- 6: Heap Implementation
- 7: Fibonacci Heap Implementation
- 8: Graph Traversals
- 9: Spanning Tree Implementation
- 10: Shortest Path Algorithms (Dijkstra's algorithm, Bellman Ford Algorithm)
- 11: Implementation of Matrix Chain Multiplication
- 12: Activity Selection and Huffman Coding Implementation

HARDWARE/SOFTWARE REQUIREMENTS

1. 64-bit Open source Linux or its derivative
2. Open Source C++ Programming tool like G++/GCC

TOTAL : 60 PERIODS

COURSE OUTCOMES:

- CO1:** Design and implement basic and advanced data structures extensively
CO2: Design algorithms using graph structures

CO3: Design and develop efficient algorithms with minimum complexity using design techniques

CO4: Develop programs using various algorithms.

CO5: Choose appropriate data structures and algorithms, understand the ADT/libraries, and use it to design algorithms for a specific problem.

REFERENCES:

1. Lipschutz Seymour, "Data Structures Schaum's Outlines Series", Tata McGraw Hill, 3rd Edition, 2014.
2. Alfred V. Aho, John E. Hopcroft, Jeffrey D. Ullman, "Data Structures and Algorithms", Pearson Education, Reprint 2006.
3. <http://www.coursera.org/specializations/data-structures-algorithms>
4. http://www.tutorialspoint.com/data_structures_algorithms
5. <http://www.geeksforgeeks.org/data-structures/>

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	1	1	-	1	1	-
2	1	-	1	2	2	1
3	1	1	1	1	2	1
4	1	2	2	2	2	1
5	1	2	3	1	3	1
Avg	1.00	1.50	1.75	1.40	2.00	1.00

CP4291

INTERNET OF THINGS

L T P C
3 0 2 4

COURSE OBJECTIVES:

- To Understand the Architectural Overview of IoT
- To Understand the IoT Reference Architecture and Real World Design Constraints
- To Understand the various IoT levels
- To understand the basics of cloud architecture
- To gain experience in Raspberry PI and experiment simple IoT application on it

UNIT I INTRODUCTION

9+6

Internet of Things- Domain Specific IoTs - IoT and M2M-Sensors for IoT Applications–Structure of IoT– IoT Map Device- IoT System Management with NETCONF-YANG

UNIT II IoT ARCHITECTURE, GENERATIONS AND PROTOCOLS

9+6

IETF architecture for IoT - IoT reference architecture -First Generation – Description & Characteristics–Advanced Generation – Description & Characteristics–Integrated IoT Sensors –

Description & Characteristics

UNIT III IoT PROTOCOLS AND TECHNOLOGY 9+6

SCADA and RFID Protocols - BACnet Protocol - Zigbee Architecture - 6LowPAN - CoAP - Wireless Sensor Structure - Energy Storage Module - Power Management Module - RF Module - Sensing Module

UNIT IV CLOUD ARCHITECTURE BASICS 9+6

The Cloud types; IaaS, PaaS, SaaS.- Development environments for service development; Amazon, Azure, Google Appcloud platform in industry

UNIT V IOT PROJECTS ON RASPBERRY PI 9+6

Building IOT with RASPBERRY PI- Creating the sensor project - Preparing Raspberry Pi - Clayster libraries - Hardware Interacting with the hardware - Interfacing the hardware- Internal representation of sensor values - Persisting data - External representation of sensor values - Exporting sensor data

SUGGESTED ACTIVITIES:

1. Develop an application for LED Blink and Pattern using Arduino or Raspberry Pi
2. Develop an application for LED Pattern with Push Button Control using Arduino or Raspberry Pi
3. Develop an application for LM35 Temperature Sensor to display temperature values using arduino or Raspberry Pi
4. Develop an application for Forest fire detection end node using Raspberry Pi device and sensor
5. Develop an application for home intrusion detection web application
6. Develop an application for Smart parking application using python and Django for web application

COURSE OUTCOMES:

CO1: Understand the various concept of the IoT and their technologies

CO2: Develop the IoT application using different hardware platforms

CO3: Implement the various IoT Protocols

CO4: Understand the basic principles of cloud computing

CO5: Develop and deploy the IoT application into cloud environment

TOTAL: 75 PERIODS

REFERENCES:

1. Arshdeep Bahga, Vijay Madiseti, Internet of Things: A hands-on approach, Universities Press, 2015
2. Dieter Uckelmann, Mark Harrison, Florian Michahelles (Eds), Architecting the Internet of Things, Springer, 2011
3. Peter Waher, 'Learning Internet of Things', Packt Publishing, 2015
4. Ovidiu Vermesan Peter Friess, 'Internet of Things - From Research and Innovation to Market Deployment', River Publishers, 2014
5. N. Ida, Sensors, Actuators and Their Interfaces: A Multidisciplinary Introduction, 2nd Edition Scitech Publishers, 202014
6. Reese, G. (2009). Cloud Application Architectures: Building Applications and Infrastructure in the Cloud. Sebastopol, CA: O'Reilly Media, Inc. (2009)

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	1	1	2	1	1	3
2	3	2	1	2	3	2
3	1	1	2	1	3	3
4	2	3	2	1	2	2
5	1	2	1	2	1	1
Avg	1.60	1.80	1.60	1.40	2.00	2.20

CP4292

MULTICORE ARCHITECTURE AND PROGRAMMING

L T P C

3 0 2 4

COURSE OBJECTIVES:

- To understand the need for multi-core processors, and their architecture.
- To understand the challenges in parallel and multithreaded programming.
- To learn about the various parallel programming paradigms,
- To develop multicore programs and design parallel solutions.

UNIT I MULTICORE PROCESSORS

9

Single core to Multi-core architectures – SIMD and MIMD systems – Interconnection networks – Symmetric and Distributed Shared Memory Architectures – Cache coherence – Performance Issues – Parallel program design.

UNIT II PARALLEL PROGRAM CHALLENGES

9

Performance – Scalability – Synchronization and data sharing – Data races – Synchronization primitives (mutexes, locks, semaphores, barriers) – deadlocks and livelocks – communication between threads (condition variables, signals, message queues and pipes).

UNIT III SHARED MEMORY PROGRAMMING WITH OpenMP

9

OpenMP Execution Model – Memory Model – OpenMP Directives – Work-sharing Constructs – Library functions – Handling Data and Functional Parallelism – Handling Loops – Performance Considerations.

UNIT IV DISTRIBUTED MEMORY PROGRAMMING WITH MPI

9

MPI program execution – MPI constructs – libraries – MPI send and receive – Point-to-point and Collective communication – MPI derived datatypes – Performance evaluation

UNIT V PARALLEL PROGRAM DEVELOPMENT

9

Case studies – n-Body solvers – Tree Search – OpenMP and MPI implementations and comparison.

TOTAL: 45 PERIODS

PRACTICALS:

1. Write a simple Program to demonstrate an OpenMP Fork-Join Parallelism.
2. Create a program that computes a simple matrix-vector multiplication $b=Ax$, either in C/C++. Use OpenMP directives to make it run in parallel.
3. Create a program that computes the sum of all the elements in an array A (C/C++) or a program that finds the largest number in an array A. Use OpenMP directives to make it run in parallel.
4. Write a simple Program demonstrating Message-Passing logic using OpenMP.
5. Implement the All-Pairs Shortest-Path Problem (Floyd's Algorithm) Using OpenMP.
6. Implement a program Parallel Random Number Generators using Monte Carlo Methods in OpenMP.
7. Write a Program to demonstrate MPI-broadcast-and-collective-communication in C.
8. Write a Program to demonstrate MPI-scatter-gather-and-all gather in C.
9. Write a Program to demonstrate MPI-send-and-receive in C.
10. Write a Program to demonstrate by performing-parallel-rank-with-MPI in C.

TOTAL: 30 PERIODS**TOTAL:45+30=75 PERIODS****COURSE OUTCOMES:**

At the end of the course, the students should be able to:

CO1: Describe multicore architectures and identify their characteristics and challenges.

CO2: Identify the issues in programming Parallel Processors.

CO3: Write programs using OpenMP and MPI.

CO4: Design parallel programming solutions to common problems.

CO5: Compare and contrast programming for serial processors and programming for parallel processors.

REFERENCES:

1. Peter S. Pacheco, "An Introduction to Parallel Programming, Morgan-Kaufman/Elsevier, 2021.
2. Darryl Gove, "Multicore Application Programming for Windows, Linux, and Oracle Solaris, Pearson, 2011 (unit 2)
3. Michael J Quinn, "Parallel programming in C with MPI and OpenMP, Tata McGraw Hill,2003.
4. Victor Alessandrini, Shared Memory Application Programming, 1st Edition, Concepts and Strategies in Multicore Application Programming, Morgan Kaufmann, 2015.
5. Yan Solihin, Fundamentals of Parallel Multicore Architecture, CRC Press, 2015.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	1	2	3	4	5	6
2	1	1	1	2	1	2
3	2	1	-	-	2	2
4	1	-	2	1	1	2
5	2	1	1	1	2	2

	3	1	2	1	2	3
Avg	1.80	1.00	1.50	1.25	1.60	2.20

CP4252

MACHINE LEARNING

L T P C

3 0 2 4

COURSE OBJECTIVES:

- To understand the concepts and mathematical foundations of machine learning and types of problems tackled by machine learning
- To explore the different supervised learning techniques including ensemble methods
- To learn different aspects of unsupervised learning and reinforcement learning
- To learn the role of probabilistic methods for machine learning
- To understand the basic concepts of neural networks and deep learning

UNIT I INTRODUCTION AND MATHEMATICAL FOUNDATIONS

9

What is Machine Learning? Need –History – Definitions – Applications - Advantages, Disadvantages & Challenges -Types of Machine Learning Problems – Mathematical Foundations - Linear Algebra & Analytical Geometry -Probability and Statistics- Bayesian Conditional Probability -Vector Calculus & Optimization - Decision Theory - Information theory

UNIT II SUPERVISED LEARNING

9

Introduction-Discriminative and Generative Models -Linear Regression - Least Squares -Under-fitting / Overfitting -Cross-Validation – Lasso Regression- Classification - Logistic Regression- Gradient Linear Models -Support Vector Machines –Kernel Methods -Instance based Methods - K-Nearest Neighbors - Tree based Methods –Decision Trees –ID3 – CART - Ensemble Methods –Random Forest - Evaluation of Classification Algorithms

UNIT III UNSUPERVISED LEARNING AND REINFORCEMENT LEARNING

9

Introduction - Clustering Algorithms -K – Means – Hierarchical Clustering - Cluster Validity - Dimensionality Reduction –Principal Component Analysis – Recommendation Systems - EM algorithm. Reinforcement Learning – Elements -Model based Learning – Temporal Difference Learning

UNIT IV PROBABILISTIC METHODS FOR LEARNING

9

Introduction -Naïve Bayes Algorithm -Maximum Likelihood -Maximum Apriori -Bayesian Belief Networks -Probabilistic Modelling of Problems -Inference in Bayesian Belief Networks – Probability Density Estimation - Sequence Models – Markov Models – Hidden Markov Models

UNIT V NEURAL NETWORKS AND DEEP LEARNING

9

Neural Networks – Biological Motivation- Perceptron – Multi-layer Perceptron – Feed Forward Network – Back Propagation-Activation and Loss Functions- Limitations of Machine Learning – Deep Learning– Convolution Neural Networks – Recurrent Neural Networks – Use cases

45 PERIODS

SUGGESTED ACTIVITIES:

1. Give an example from our daily life for each type of machine learning problem

2. Study at least 3 Tools available for Machine Learning and discuss pros & cons of each
3. Take an example of a classification problem. Draw different decision trees for the example and explain the pros and cons of each decision variable at each level of the tree
4. Outline 10 machine learning applications in healthcare
5. Give 5 examples where sequential models are suitable.
6. Give at least 5 recent applications of CNN

PRACTICAL EXERCISES:

30 PERIODS

1. Implement a Linear Regression with a Real Dataset (<https://www.kaggle.com/harrywang/housing>). Experiment with different features in building a model. Tune the model's hyperparameters.
2. Implement a binary classification model. That is, answers a binary question such as "Are houses in this neighborhood above a certain price?"(use data from exercise 1). Modify the classification threshold and determine how that modification influences the model. Experiment with different classification metrics to determine your model's effectiveness.
3. Classification with Nearest Neighbors. In this question, you will use the scikit-learn's KNN classifier to classify real vs. fake news headlines. The aim of this question is for you to read the scikit-learn API and get comfortable with training/validation splits. Use California Housing Dataset
4. In this exercise, you'll experiment with validation sets and test sets using the dataset. Split a training set into a smaller training set and a validation set. Analyze deltas between training set and validation set results. Test the trained model with a test set to determine whether your trained model is overfitting. Detect and fix a common training problem.
5. Implement the k-means algorithm using <https://archive.ics.uci.edu/ml/datasets/Codon+usage> dataset
6. Implement the Naïve Bayes Classifier using <https://archive.ics.uci.edu/ml/datasets/Gait+Classification> dataset
7. Project - (in Pairs) Your project must implement one or more machine learning algorithms and apply them to some data.
 - a. Your project may be a comparison of several existing algorithms, or it may propose a new algorithm in which case you still must compare it to at least one other approach.
 - b. You can either pick a project of your own design, or you can choose from the set of pre-defined projects.
 - c. You are free to use any third-party ideas or code that you wish as long as it is publicly available.
 - d. You must properly provide references to any work that is not your own in the write-up.
 - e. Project proposal You must turn in a brief project proposal. Your project proposal should describe the idea behind your project. You should also briefly describe software you will need to write, and papers (2-3) you plan to read.

List of Projects (datasets available)

1. Sentiment Analysis of Product Reviews
2. Stock Prediction
3. Sales Forecasting
4. Music Recommendation
5. Handwriting Digit Classification
6. Fake News Detection
7. Sports Prediction
8. Object Detection

9. Disease Prediction

COURSE OUTCOMES:

Upon the completion of course, students will be able to

CO1: Understand and outline problems for each type of machine learning

CO2: Design a Decision tree and Random forest for an application

CO3: Implement Probabilistic Discriminative and Generative algorithms for an application and analyze the results.

CO4: Use a tool to implement typical Clustering algorithms for different types of applications.

CO5: Design and implement an HMM for a Sequence Model type of application and identify applications suitable for different types of Machine Learning with suitable justification.

TOTAL:75 PERIODS

REFERENCES

1. Stephen Marsland, "Machine Learning: An Algorithmic Perspective", Chapman & Hall/CRC, 2nd Edition, 2014.
2. Kevin Murphy, "Machine Learning: A Probabilistic Perspective", MIT Press, 2012
3. Ethem Alpaydin, "Introduction to Machine Learning", Third Edition, Adaptive Computation and Machine Learning Series, MIT Press, 2014
4. Tom M Mitchell, "Machine Learning", McGraw Hill Education, 2013.
5. Peter Flach, "Machine Learning: The Art and Science of Algorithms that Make Sense of Data", First Edition, Cambridge University Press, 2012.
6. Shai Shalev-Shwartz and Shai Ben-David, "Understanding Machine Learning: From Theory to Algorithms", Cambridge University Press, 2015
7. Christopher Bishop, "Pattern Recognition and Machine Learning", Springer, 2007.
8. Hal Daumé III, "A Course in Machine Learning", 2017 (freely available online)
9. Trevor Hastie, Robert Tibshirani, Jerome Friedman, "The Elements of Statistical Learning", Springer, 2009 (freely available online)
10. Aurélien Géron , Hands-On Machine Learning with Scikit-Learn and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems 2nd Edition, o'reilly, (2017)

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	1	2	1	3	1	1
2	2	3	1	2	1	2
3	1	1	2	1	-	2
4	2	2	-	-	-	3
5	3	3	1	1	1	3
Avg	1.80	2.20	1.25	1.75	1.00	2.20

COURSE OBJECTIVES:

- To understand the rationale for software development process models
- To understand why the architectural design of software is important;
- To understand the five important dimensions of dependability, namely, availability, reliability, safety, security, and resilience.
- To understand the basic notions of a web service, web service standards, and service-oriented architecture;
- To understand the different stages of testing from testing during development of a software system

UNIT I SOFTWARE PROCESS & MODELING 9

Prescriptive Process Models – Agility and Process – Scrum – XP – Kanban – DevOps – Prototype Construction – Prototype Evaluation – Prototype Evolution – Modelling – Principles – Requirements Engineering – Scenario-based Modelling – Class-based Modelling – Functional Modelling – Behavioural Modelling.

UNIT II SOFTWARE DESIGN 9

Design Concepts – Design Model – Software Architecture – Architectural Styles – Architectural Design – Component-Level Design – User Experience Design – Design for Mobility – Pattern-Based Design.

UNIT III SYSTEM DEPENDABILITY AND SECURITY 9

Dependable Systems – Dependability Properties – Sociotechnical Systems – Redundancy and Diversity – Dependable Processes – Formal Methods and Dependability – Reliability Engineering – Availability and Reliability – Reliability Requirements – Fault-tolerant Architectures – Programming for Reliability – Reliability Measurement – Safety Engineering – Safety-critical Systems – Safety Requirements – Safety Engineering Processes – Safety Cases – Security Engineering – Security and Dependability – Safety and Organizations – Security Requirements – Secure System Design – Security Testing and Assurance – Resilience Engineering – Cybersecurity – Sociotechnical Resilience – Resilient Systems Design.

UNIT IV SERVICE-ORIENTED SOFTWARE ENGINEERING, SYSTEMS ENGINEERING AND REAL-TIME SOFTWARE ENGINEERING 9

Service-oriented Architecture – RESTful Services – Service Engineering – Service Composition – Systems Engineering – Sociotechnical Systems – Conceptual Design – System Procurement – System Development – System Operation and Evolution – Real-time Software Engineering – Embedded System Design – Architectural Patterns for Real-time Software – Timing Analysis – Real-time Operating Systems.

UNIT V SOFTWARE TESTING AND SOFTWARE CONFIGURATION MANAGEMENT 9

Software Testing Strategy – Unit Testing – Integration Testing – Validation Testing – System Testing – Debugging – White-Box Testing – Basis Path Testing – Control Structure Testing – Black-Box Testing – Software Configuration Management (SCM) – SCM Repository – SCM Process – Configuration Management for Web and Mobile Apps.

SUGGESTED ACTIVITIES

1. Comparatively analysing different Agile methodologies.

2. Describing the scenarios where 'Scrum' and 'Kanban' are used.
3. Mapping the data flow into suitable software architecture.
4. Developing behavioural representations for a class or component.
5. Implementing simple applications as RESTful service.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

The Students will be able to

CO1:Identify appropriate process models based on the Project requirements

CO2:Understand the importance of having a good Software Architecture.

CO3:Understand the five important dimensions of dependability, namely, availability, reliability, safety, security, and resilience.

CO4:Understand the basic notions of a web service, web service standards, and service-oriented architecture;

CO5:Be familiar with various levels of Software testing

REFERENCES:

1. Software Engineering: A Practitioner's Approach, 9th Edition. Roger Pressman and Bruce Maxim, McGraw-Hill 2019.
2. Software Engineering, 10th Edition, Ian Somerville, Pearson Education Asia 2016.
3. Software Architecture In Practice, 3rd Edition, Len Bass, Paul Clements and Rick Kazman, Pearson India 2018
4. An integrated approach to Software Engineering, 3rd Edition, Pankaj Jalote, Narosa Publishing House, 2018
5. Fundamentals of Software Engineering, 5th Edition, Rajib Mall, PHI Learning Private Ltd, 2018

CP4211

TERM PAPER WRITING AND SEMINAR

**L T P C
0 0 2 1**

In this course, students will develop their scientific and technical reading and writing skills that they need to understand and construct research articles. A term paper requires a student to obtain information from a variety of sources (i.e., Journals, dictionaries, reference books) and then place it in logically developed ideas. The work involves the following steps:

1. Selecting a subject, narrowing the subject into a topic
2. Stating an objective.
3. Collecting the relevant bibliography (atleast 15 journal papers)
4. Preparing a working outline.
5. Studying the papers and understanding the authors contributions and critically analysing each paper.
6. Preparing a working outline
7. Linking the papers and preparing a draft of the paper.
8. Preparing conclusions based on the reading of all the papers.
9. Writing the Final Paper and giving final Presentation

Please keep a file where the work carried out by you is maintained.

Activities to be carried out

Activity	Instructions	Submission week	Evaluation
Selection of area of interest and Topic Stating an Objective	You are requested to select an area of interest, topic and state an objective	2 nd week	3 % Based on clarity of thought, current relevance and clarity in writing
Collecting Information about your area & topic	<ol style="list-style-type: none"> 1. List 1 Special Interest Groups or professional society 2. List 2 journals 3. List 2 conferences, symposia or workshops 4. List 1 thesis title 5. List 3 web presences (mailing lists, forums, news sites) 6. List 3 authors who publish regularly in your area 7. Attach a call for papers (CFP) from your area. 	3 rd week	3% (the selected information must be area specific and of international and national standard)
Collection of Journal papers in the topic in the context of the objective – collect 20 & then filter	<ul style="list-style-type: none"> • You have to provide a complete list of references you will be using- Based on your objective -Search various digital libraries and Google Scholar • When picking papers to read - try to: <ul style="list-style-type: none"> • Pick papers that are related to each other in some ways and/or that are in the same field so that you can write a meaningful survey out of them, • Favour papers from well-known journals and conferences, • Favour “first” or “foundational” papers in the field (as indicated in other people’s survey paper), • Favour more recent papers, • Pick a recent survey of the field so you can quickly gain an overview, • Find relationships with respect to each other and to your topic area (classification scheme/categorization) • Mark in the hard copy of papers whether complete work or section/sections of the paper are being considered 	4 th week	6% (the list of standard papers and reason for selection)
Reading and notes for first 5 papers	<p>Reading Paper Process</p> <ul style="list-style-type: none"> • For each paper form a Table answering the following questions: • What is the main topic of the 	5 th week	8% (the table given should indicate your understanding of the

	<p>article?</p> <ul style="list-style-type: none"> • What was/were the main issue(s) the author said they want to discuss? • Why did the author claim it was important? • How does the work build on other's work, in the author's opinion? • What simplifying assumptions does the author claim to be making? • What did the author do? • How did the author claim they were going to evaluate their work and compare it to others? • What did the author say were the limitations of their research? • What did the author say were the important directions for future research? <p>Conclude with limitations/issues not addressed by the paper (from the perspective of your survey)</p>		<p>paper and the evaluation is based on your conclusions about each paper)</p>
Reading and notes for next 5 papers	Repeat Reading Paper Process	6 th week	8% (the table given should indicate your understanding of the paper and the evaluation is based on your conclusions about each paper)
Reading and notes for final 5 papers	Repeat Reading Paper Process	7 th week	8% (the table given should indicate your understanding of the paper and the evaluation is based on your conclusions about each paper)
Draft outline 1 and Linking papers	Prepare a draft Outline, your survey goals, along with a classification / categorization diagram	8 th week	8% (this component will be evaluated based on the linking and classification among the papers)
Abstract	Prepare a draft abstract and give a presentation	9 th week	6% (Clarity, purpose and conclusion) 6% Presentation & Viva Voce
Introduction Background	Write an introduction and background sections	10 th week	5% (clarity)

Sections of the paper	Write the sections of your paper based on the classification / categorization diagram in keeping with the goals of your survey	11 th week	10% (this component will be evaluated based on the linking and classification among the papers)
Your conclusions	Write your conclusions and future work	12 th week	5% (conclusions – clarity and your ideas)
Final Draft	Complete the final draft of your paper	13 th week	10% (formatting, English, Clarity and linking) 4% Plagiarism Check Report
Seminar	A brief 15 slides on your paper	14 th & 15 th week	10% (based on presentation and Viva-voce)

TOTAL: 30 PERIODS

CP4212

SOFTWARE ENGINEERING LABORATORY

L T P C

0 0 2 1

LAB OBJECTIVE:

The Software Engineering Lab has been developed by keeping in mind the following objectives:

- To impart state-of-the-art knowledge on Software Engineering and UML in an interactive manner through the Web.
- Present case studies to demonstrate practical applications of different concepts.
- Provide a scope to students where they can solve small, real-life problems.

LIST OF EXPERIMENTS:

1. Write a Problem Statement to define a title of the project with bounded scope of project
2. Select relevant process model to define activities and related task set for assigned project
3. Prepare broad SRS (Software Requirement Specification) for the above selected projects
4. Prepare USE Cases and Draw Use Case Diagram using modelling Tool
5. Develop the activity diagram to represent flow from one activity to another for software development
6. Develop data Designs using DFD Decision Table & ER Diagram.
7. Draw class diagram, sequence diagram, Collaboration Diagram, State Transition Diagram for the assigned project
8. Write Test Cases to Validate requirements of assigned project from SRS Document
9. Evaluate Size of the project using function point metric for the assigned project
10. Estimate cost of the project using COCOMO and COCOMOII for the assigned project
11. Use CPM/PERT for scheduling the assigned project
12. Use timeline Charts or Gantt Charts to track progress of the assigned project

TOTAL:30 PERIODS

LAB OUTCOME:

CO1: Can produce the requirements and use cases the client wants for the software being Produced.

CO2: Participate in drawing up the project plan. The plan will include at least extent and work assessments of the project, the schedule, available resources, and risk management can model and specify the requirements of mid-range software and their architecture.

CO3: create and specify such a software design based on the requirement specification that the software can be implemented based on the design.

CO4: Can assess the extent and costs of a project with the help of several different assessment methods.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	3	3	3	3	3	3
2	2	3	3	3	2	2
3	3	1	2	2	1	2
4	2	3	1	2	-	-
Avg	2.5	2.5	2.25	2.5	2	2.34

CP4391

SECURITY PRACTICES

L T P C
3 0 0 3

COURSE OBJECTIVES:

- To learn the core fundamentals of system and web security concepts
- To have through understanding in the security concepts related to networks
- To deploy the security essentials in IT Sector
- To be exposed to the concepts of Cyber Security and cloud security
- To perform a detailed study of Privacy and Storage security and related Issues

UNIT I

SYSTEM SECURITY

9

Model of network security – Security attacks, services and mechanisms – OSI security architecture - A Cryptography primer- Intrusion detection system- Intrusion Prevention system - Security web applications- Case study: OWASP - Top 10 Web Application Security Risks.

UNIT II

NETWORK SECURITY

9

Internet Security - Intranet security- Local Area Network Security - Wireless Network Security - Wireless Sensor Network Security- Cellular Network Security - Mobile security - IOT security - Case Study - Kali Linux.

UNIT III

SECURITY MANAGEMENT

9

Information security essentials for IT Managers- Security Management System - Policy Driven System Management- IT Security - Online Identity and User Management System. Case study: Metasploit

UNIT IV

CYBER SECURITY AND CLOUD SECURITY

9

Cyber Forensics- Disk Forensics – Network Forensics – Wireless Forensics – Database Forensics – Malware Forensics – Mobile Forensics – Email Forensics- Best security practices for automate

Cloud infrastructure management – Establishing trust in IaaS, PaaS, and SaaS Cloud types. Case study: DVWA

UNIT V PRIVACY AND STORAGE SECURITY 9

Privacy on the Internet - Privacy Enhancing Technologies - Personal privacy Policies - Detection of Conflicts in security policies- privacy and security in environment monitoring systems. Storage Area Network Security - Storage Area Network Security Devices - Risk management - Physical Security Essentials.

COURSE OUTCOMES:

- CO1:** Understand the core fundamentals of system security
- CO2:** Apply the security concepts to wired and wireless networks
- CO3:** Implement and Manage the security essentials in IT Sector
- CO4:** Explain the concepts of Cyber Security and Cyber forensics
- CO5:** Be aware of Privacy and Storage security Issues.

TOTAL: 45 PERIODS

REFERENCES

1. John R. Vacca, Computer and Information Security Handbook, Third Edition, Elsevier 2017
2. Michael E. Whitman, Herbert J. Mattord, Principles of Information Security, Seventh Edition, Cengage Learning, 2022
3. Richard E. Smith, Elementary Information Security, Third Edition, Jones and Bartlett Learning, 2019
4. Mayor, K.K.Mookhey, Jacopo Cervini, Fairuzan Roslan, Kevin Beaver, Metasploit Toolkit for Penetration Testing, Exploit Development and Vulnerability Research, Syngress publications, Elsevier, 2007. ISBN : 978-1-59749-074-0
5. John Sammons, "The Basics of Digital Forensics- The Primer for Getting Started in Digital Forensics", Syngress, 2012
6. Cory Altheide and Harlan Carvey, "Digital Forensics with Open Source Tools",2011 Syngress, ISBN: 9781597495875.
7. Siani Pearson, George Yee "Privacy and Security for Cloud Computing" Computer Communications and Networks, Springer, 2013.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	1	2	1	1	2	1
2	2	1	3	1	1	2
3	-	-	2	3	3	3
4	2	2	1	2	1	3
5	1	-	1	1	2	3
Avg	1.50	1.67	1.60	1.60	1.80	2.40

COURSE OBJECTIVES:

- To learn the foundations of Human Computer Interaction
- Understanding Interaction Styles and to become familiar with the design technologies for individuals and persons with disabilities.
- To understand the process of Evaluation of Interaction Design.
- To clarify the significance of task analysis for ubiquitous computing
- To get insight on web and mobile interaction.

UNIT I FOUNDATIONS OF HCI 9

Context of Interaction –Ergonomics - Designing Interactive systems – Understanding Users- cognition and cognitive frameworks, User Centred approaches Usability, Universal Usability, Understanding and conceptualizing interaction, Guidelines, Principles and Theories. Importance of User Interface: Definition-Importance of good design-Benefits of good design-Human-centered development and Evaluation-Human Performance models-A Brief history of screen design.

UNIT II INTERACTION STYLES 9

GUI: Popularity of graphics - The concept of direct manipulation - Graphical system - Characteristics - Web user - Interface Popularity - Characteristics and Principles of User Interface. Understanding interaction styles, Direct Navigation and Immersive environments, Fluid navigation, Expressive Human and Command Languages, Communication and Collaboration Advancing the user experience, Timely user Experience, Information search, Data Visualization Design process: Human Interaction with computers - Importance of Human Characteristics - Human Consideration - Human Interaction Speeds and Understanding Business Junctions.

UNIT III EVALUATION OF INTERACTION 9

Evaluation Techniques- assessing user experience- usability testing – Heuristic evaluation and walkthroughs, analytics predictive models. Cognitive models, Socio-organizational issues and stakeholder requirements, Communication and collaboration models

UNIT IV MODELS AND THEORIES 9

Task analysis, dialog notations and design, Models of the system, Modeling rich interaction, Ubiquitous computing

UNIT V WEB AND MOBILE INTERACTION 9

Hypertext, Multimedia and WWW, Designing for the web Direct Selection, Contextual Tools, Overlays, Inlays and Virtual Pages, Process Flow. Use Transitions-Lookup patterns-Feedback patterns Mobile apps, Mobile navigation, content and control idioms, Multi-touch gestures, Inter-app integration, Mobile web

COURSE OUTCOMES:

CO1: Understand the basics of human computer interactions via usability engineering and cognitive modeling.

CO2: Understand the basic design paradigms, complex interaction styles.

CO3: Understand the models and theories for user interaction

CO4: Examine the evaluation of interaction designs and implementations.

CO5: Elaborate the above issues for web and mobile applications.

TOTAL: 45 PERIODS

REFERENCES

1. Ben Shneiderman, Catherine Plaisant, Maxine Cohen, Steven Jacobs, NiklasElmqvist, "Designing the User Interface: Strategies for Effective Human-Computer Interaction", Sixth Edition, Pearson Education, 2016.
2. Alan Dix, Janet Finlay, G D Abowd and Russel Beale, "Human Computer Interaction", Pearson Education, Third Edition, 2004.
3. Helen Sharp Jennifer Preece Yvonne Rogers, "Interaction Design: Beyond Human-Computer Interaction", Wiley, 5th Edition, 2019.
4. Alan Cooper,RobertReimann, David Cronin, Christopher Noessel,"About Face: The Essentials of Interaction Design", 4th Edition, Wiley, 2014.
5. Donald A. Norman, "Design of Everyday Things", MIT Press, 2013.
6. Wilbert O Galitz, "The Essential Guide to User Interface Design", Third Edition, Wiley India Pvt., Ltd., 2007.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	3	3	3	3	3	3
2	1	-	1	2	2	1
3	2	3	2	2	-	1
4	2	3	1	2	-	2
5	2	2	3	3	3	3
Avg	2	2.75	2	2.4	2.67	2

MP4251

CLOUD COMPUTING TECHNOLOGIES

L T P C
3 0 0 3

COURSE OBJECTIVES:

- To gain expertise in Virtualization, Virtual Machines and deploy practical virtualization solution
- To understand the architecture, infrastructure and delivery models of cloud computing.
- To explore the roster of AWS services and illustrate the way to make applications in AWS
- To gain knowledge in the working of Windows Azure and Storage services offered by Windows Azure
- To develop the cloud application using various programming model of Hadoop and Aneka

UNIT I VIRTUALIZATION AND VIRTUALIZATION INFRASTRUCTURE 6

Basics of Virtual Machines - Process Virtual Machines – System Virtual Machines –Emulation – Interpretation – Binary Translation - Taxonomy of Virtual Machines. Virtualization –Management Virtualization — Hardware Maximization – Architectures – Virtualization Management – Storage Virtualization – Network Virtualization- Implementation levels of virtualization – virtualization structure – virtualization of CPU, Memory and I/O devices – virtual clusters and Resource

9. Tom White, "Hadoop: The Definitive Guide", Yahoo Press, 2012.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	-	-	-	2	2	1
2	2	3	1	-	-	1
3	3	-	3	-	1	3
4	-	-	-	2	-	3
5	3	2	-	-	-	-
Avg	2.6	2.5	2	2	1.5	2

BD4151

FOUNDATIONS OF DATA SCIENCE

L T P C
3 0 0 3

COURSE OBJECTIVES:

- To apply fundamental algorithms to process data.
- Learn to apply hypotheses and data into actionable predictions.
- Document and transfer the results and effectively communicate the findings using visualization techniques.
- To learn statistical methods and machine learning algorithms required for Data Science.
- To develop the fundamental knowledge and understand concepts to become a data science professional.

UNIT I INTRODUCTION TO DATA SCIENCE 9

Data science process – roles, stages in data science project – working with data from files – working with relational databases – exploring data – managing data – cleaning and sampling for modeling and validation – introduction to NoSQL.

UNIT II MODELING METHODS 9

Choosing and evaluating models – mapping problems to machine learning, evaluating clustering models, validating models – cluster analysis – K-means algorithm, Naïve Bayes – Memorization Methods – Linear and logistic regression – unsupervised methods.

UNIT III INTRODUCTION TO R 9

Reading and getting data into R – ordered and unordered factors – arrays and matrices – lists and data frames – reading data from files – probability distributions – statistical models in R - manipulating objects – data distribution.

UNIT IV MAP REDUCE 9

Introduction – distributed file system – algorithms using map reduce, Matrix-Vector Multiplication by Map Reduce – Hadoop - Understanding the Map Reduce architecture - Writing Hadoop MapReduce Programs - Loading data into HDFS - Executing the Map phase - Shuffling and sorting - Reducing phase execution.

UNIT V DATA VISUALIZATION**9**

Documentation and deployment – producing effective presentations – Introduction to graphical analysis – plot() function – displaying multivariate data – matrix plots – multiple plots in one window - exporting graph using graphics parameters - Case studies.

TOTAL : 45 PERIODS**COURSE OUTCOMES:**

CO1: Obtain, clean/process and transform data.

CO2: Analyze and interpret data using an ethically responsible approach.

CO3: Use appropriate models of analysis, assess the quality of input, derive insight from results, and investigate potential issues.

CO4: Apply computing theory, languages and algorithms, as well as mathematical and statistical models, and the principles of optimization to appropriately formulate and use data analyses.

CO5: Formulate and use appropriate models of data analysis to solve business-related challenges.

REFERENCES:

1. Nina Zumel, John Mount, "Practical Data Science with R", Manning Publications, 2014.
2. Mark Gardener, "Beginning R - The Statistical Programming Language", John Wiley & Sons, Inc., 2012.
3. W. N. Venables, D. M. Smith and the R Core Team, "An Introduction to R", 2013.
4. Tony Ojeda, Sean Patrick Murphy, Benjamin Bengfort, Abhijit Dasgupta, "Practical Data Science Cookbook", Packt Publishing Ltd., 2014.
5. Nathan Yau, "Visualize This: The FlowingData Guide to Design, Visualization, and Statistics", Wiley, 2011.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	3	2	3	-	2	2
2	-	-	2	3	-	-
3	1	-	-	-	3	3
4	2	1	-	3	-	-
5	1	-	3	3	-	-
Avg	1.75	1.5	2.7	3	2.5	2.5

MP4152**WIRELESS COMMUNICATIONS****L T P C****3 0 0 3****COURSE OBJECTIVES:**

- To understand the basic concepts in cellular communication.
- To learn the characteristics of wireless channels.
- To understand the impact of digital modulation techniques in fading.
- To get exposed to diversity techniques in wireless communication.

- To acquire knowledge in multicarrier systems.

UNIT I CELLULAR CONCEPTS 9

Frequency Reuse – Channel Assignment Strategies – Handoff Strategies – Interference and system capacity- Co-Channel Interference- Adjacent Channel Interference – Trunking and Grade of service – Improving coverage & capacity in cellular systems-Cell Splitting- Sectoring- Repeaters for Range Extension-Microcell Zone Concept.

UNIT II THE WIRELESS CHANNEL 9

Overview of wireless systems – Physical modeling for wireless channels – Time and Frequency coherence – Statistical channel models – Capacity of wireless Channel- Capacity of Flat Fading Channel – Channel Side Information at Receiver – Channel Side Information at Transmitter and Receiver –Capacity comparisons – Capacity of Frequency Selective Fading channels.

UNIT III PERFORMANCE OF DIGITAL MODULATION OVER WIRELESS CHANNELS 9

Performance of flat fading and frequency selective fading – Impact on digital modulation techniques – Outage Probability– Average Probability of Error – Combined Outage and Average Error Probability – Doppler Spread – Inter symbol Interference.

UNIT IV DIVERSITY TECHNIQUES 9

Realization of Independent Fading Paths – Receiver Diversity – Selection Combining – Threshold Combining – Maximal-Ratio Combining – Equal - Gain Combining – Capacity with Receiver diversity – Transmitter Diversity – Channel known at Transmitter – Channel unknown at Transmitter – The Alamouti Scheme– Transmit & Receive Diversity-MIMO Systems.

UNIT V MULTICARRIER MODULATION 9

Data Transmission using Multiple Carriers – Multicarrier Modulation with Overlapping Sub channels – Mitigation of Subcarrier Fading – Discrete Implementation of Multicarrier Modulation – Peak to average Power Ratio- Frequency and Timing offset.

SUGGESTED ACTIVITIES:

- 1: Survey on various features of cellular networks
- 2: Study the nature of cellular networks
- 3: A comparative study on the performance of different digital modulation techniques
- 4: Perform a review of various diversity techniques in wireless communication
- 5: Presentation on design of multicarrier systems for 5G

COURSE OUTCOMES:

- CO1:** Design solutions for cellular communication
CO2: Determine the capacity of wireless channels
CO3: Analyze the performance of the digital modulation techniques in fading channels
CO4: Apply various diversity techniques in wireless communication
CO5: Design multicarrier systems in wireless communication

TOTAL: 45 PERIODS

REFERENCES:

1. Theodore.S. Rappaport, "Wireless Communications: Principles and Practice", 2nd Edition, Pearson Education, India, 2010.
2. Andrea Goldsmith, "Wireless Communications", Cambridge University Press, 2005.

3. David Tse and Pramod Viswanath, "Fundamentals of Wireless Communication", Wiley Series in Telecommunications, Cambridge University Press, 2005.
4. Saad Z. Asif, "5G Mobile Communications Concepts and Technologies" CRC press – 2019.
5. Keith Q. T. Zhang, "Wireless Communications: Principles, Theory and Methodology" 1st edition, John Wiley & Sons, 2016.
6. Ramjee Prasad, "OFDM for Wireless Communication Systems", Artech House, 2004.
6. Boris Lublinsky, Kevin T. Smith, Alexey Yakubovich, "Professional Hadoop Solutions", John Wiley & Sons Inc., 2013.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	-	-	2	2	3	2
2	3	2	3	-	-	-
3	2	-	-	2	3	3
4	3	3	-	2	3	3
5	2	3	3	2	3	3
Avg	2.5	2.7	2.7	2	3	2.75

SE4071

AGILE METHODOLOGIES

L T P C
3 0 0 3

COURSE OBJECTIVES:

- To learn the fundamental principles and practices associated with each of the agile development methods
- To apply the principles and practices of agile software development on a project of interest and relevance to the student.
- To provide a good understanding of software design and a set of software technologies and APIs.
- To do a detailed examination and demonstration of Agile development and testing techniques.
- To understand Agile development and testing.

UNIT I AGILE SOFTWARE DEVELOPMENT

9

Basics and Fundamentals of Agile Process Methods, Values of Agile, Principles of Agile, stakeholders, Challenges . Lean Approach: Waste Management, Kaizen and Kanban, add process and products add value. Roles related to the lifecycle, differences between Agile and traditional plans, differences between Agile plans at different lifecycle phases. Testing plan links between testing, roles and key techniques, principles, understand as a means of assessing the initial status of a project/ How Agile helps to build quality

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	3	1	3	-	2	3
2	2	-	3	3	1	3
3	3	-	-	-	3	3
4	2	-	1	2	3	3
5	1	3	-	-	2	3
Avg	2.2	2	2.3	2.5	2.2	3

CP4095

PERFORMANCE ANALYSIS OF COMPUTER SYSTEMS

L T P C
3 0 0 3

COURSE OBJECTIVES:

- To understand the mathematical foundations needed for performance evaluation of computer systems
- To understand the metrics used for performance evaluation
- To understand the analytical modeling of computer systems
- To enable the students to develop new queuing analysis for both simple and complex systems
- To appreciate the use of smart scheduling and introduce the students to analytical techniques for evaluating scheduling policies

UNIT I OVERVIEW OF PERFORMANCE EVALUATION 9

Need for Performance Evaluation in Computer Systems – Overview of Performance Evaluation Methods – Introduction to Queuing – Probability Review – Generating Random Variables for Simulation – Sample Paths, Convergence and Averages – Little’s Law and other Operational Laws – Modification for Closed Systems.

UNIT II MARKOV CHAINS AND SIMPLE QUEUES 9

Discrete-Time Markov Chains – Ergodicity Theory – Real World Examples – Google, Aloha – Transition to Continuous-Time Markov Chain – M/M/1.

UNIT III MULTI-SERVER AND MULTI-QUEUE SYSTEMS 9

Server Farms: M/M/k and M/M/k/k – Capacity Provisioning for Server Farms – Time Reversibility and Burke’s Theorem – Networks of Queues and Jackson Product Form – Classed and Closed Networks of Queues.

UNIT IV REAL-WORLD WORKLOADS 9

Case Study of Real-world Workloads – Phase-Type Distributions and Matrix-Analytic Methods – Networks with Time-Sharing Servers – M/G/1 Queue and the Inspection Paradox – Task Assignment Policies for Server Farms.

UNIT V SMART SCHEDULING IN THE M/G/1**9**

Performance Metrics – Scheduling Non-Preemptive and Preemptive Non-Size-Based Policies - .
Scheduling Non-Preemptive and Preemptive Size-Based Policies – Scheduling - SRPT and Fairness.

TOTAL : 45 PERIODS**COURSE OUTCOMES:**

Upon completion of this course, the students should be able to

CO1: Identify the need for performance evaluation and the metrics used for it

CO2: Distinguish between open and closed queuing networks

CO3: Apply Little'e law and other operational laws to open and closed systems

CO4: Use discrete-time and continuous-time Markov chains to model real world systems

CO5: Develop analytical techniques for evaluating scheduling policies

REFERENCES:

1. K. S. Trivedi, "Probability and Statistics with Reliability, Queueing and Computer Science Applications", John Wiley and Sons, 2001.
2. Krishna Kant, "Introduction to Computer System Performance Evaluation", McGraw-Hill, 1992.
3. Lieven Eeckhout, "Computer Architecture Performance Evaluation Methods", Morgan and Claypool Publishers, 2010.
4. Mor Harchol - Balter, "Performance Modeling and Design of Computer Systems – Queueing Theory in Action", Cambridge University Press, 2013.
5. Paul J. Fortier and Howard E. Michel, "Computer Systems Performance Evaluation and Prediction", Elsevier, 2003.
6. Raj Jain, "The Art of Computer Systems Performance Analysis: Techniques for Experimental Design, Measurement, Simulation and Modeling", Wiley-Interscience, 1991.
7. Raj Jain, "Art of Computer Systems Performance Analysis: Techniques For Experimental Design Measurements Simulation and Modeling", 2nd edition, Wiley, 2015

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	1	1	1	1	1	1
2	2	2	3	2	2	1
3	2	2	2		2	
4	1		3		3	1
5	2	2	2	1	2	
Avg	1.60	1.75	2.20	1.33	2.00	1.00

CP4001**ADVANCED OPERATING SYSTEM**

L T P C
3 0 0 3

COURSE OBJECTIVES

- To get a comprehensive knowledge of the architecture of distributed systems.

- To understand the deadlock and shared memory issues and their solutions in distributed environments.
- To know the security issues and protection mechanisms for distributed environments.
- To get a knowledge of multiprocessor operating systems and database operating systems.

UNIT I INTRODUCTION 9

Architectures of Distributed Systems - System Architecture types - issues in distributed operating systems - communication networks – communication primitives. Theoretical Foundations - inherent limitations of a distributed system – lamport's logical clocks – vector clocks – causal ordering of messages – global state – cuts of a distributed computation – termination detection. Distributed Mutual Exclusion – introduction – the classification of mutual exclusion and associated algorithms – a comparative performance analysis.

UNIT II DISTRIBUTED DEADLOCK DETECTION AND RESOURCE MANAGEMENT 9

Distributed Deadlock Detection -Introduction - deadlock handling strategies in distributed systems – issues in deadlock detection and resolution – control organizations for distributed deadlock detection – centralized and distributed deadlock detection algorithms –hierarchical deadlock detection algorithms. Agreement protocols – introduction-the system model, a classification of agreement problems, solutions to the Byzantine agreement problem, applications of agreement algorithms. Distributed resource management: introduction-architecture – mechanism for building distributed file systems – design issues – log structured file systems.

UNIT III DISTRIBUTED SHARED MEMORY AND SCHEDULING 9

Distributed shared memory-Architecture– algorithms for implementing DSM – memory coherence and protocols – design issues. Distributed Scheduling – introduction – issues in load distributing – components of a load distributing algorithm – stability – load distributing algorithms – performance comparison – selecting a suitable load sharing algorithm – requirements for load distributing -task migration and associated issues. Failure Recovery and Fault tolerance: introduction– basic concepts – classification of failures – backward and forward error recovery, backward error recovery- recovery in concurrent systems – consistent set of checkpoints – synchronous and asynchronous checkpointing and recovery – checkpointing for distributed database systems- recovery in replicated distributed databases.

UNIT IV DATA SECURITY 9

Protection and security -preliminaries, the access matrix model and its implementations.-safety in matrix model- advanced models of protection. Data security – cryptography: Model of cryptography, conventional cryptography- modern cryptography, private key cryptography, data encryption standard- public key cryptography – multiple encryption – authentication in distributed systems.

UNIT-V MULTIPROCESSOR AND DATABASE OPERATING SYSTEM 9

Multiprocessor operating systems - basic multiprocessor system architectures – interconnection networks for multiprocessor systems – caching – hypercube architecture. Multiprocessor Operating System - structures of multiprocessor operating system, operating system design issues- threads-process synchronization and scheduling. Database Operating systems :Introduction- requirements of a database operating system Concurrency control : theoretical aspects – introduction, database systems – a concurrency control model of database systems- the problem of concurrency control – serializability theory- distributed database systems, concurrency control algorithms – introduction, basic synchronization primitives, lock based algorithms-timestamp based algorithms,

optimistic algorithms – concurrency control algorithms: data replication.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After the completion of this course, student will be able to

CO1:Understand and explore the working of Theoretical Foundations of OS.

CO2:Analyze the working principles of Distributed Deadlock Detection and resource management

CO3:Understand the concepts of distributed shared memory and scheduling mechanisms

CO4:Understand and analyze the working of Data security

CO5:Apply the learning into multiprocessor system architectures.

REFERENCES:

1. Mukesh Singhal, Niranjana G.Shivaratri, "Advanced concepts in operating systems: Distributed, Database and multiprocessor operating systems", TMH, 2001
2. Andrew S.Tanenbaum, "Modern operating system", PHI, 2003
3. Pradeep K.Sinha, "Distributed operating system-Concepts and design", PHI, 2003.
4. Andrew S.Tanenbaum, "Distributed operating system", Pearson education, 2003.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	1	3	2	2	1	3
2	2	2	3	2	1	-
3	1	1	-	3	2	1
4	1	1	2	1	2	2
5	-	-	-	-	-	-
Avg	1.25	1.75	2.33	2.00	1.50	2.00

MU4251

DIGITAL IMAGE PROCESSING

**L T P C
3 0 0 3**

COURSE OBJECTIVES:

- To study fundamental concepts of digital image processing.
- To understand and learn image processing operations and restoration.
- To use the concepts of Feature Extraction
- To study the concepts of Image Compression.
- To expose students to current trends in the field of image segmentation.

UNIT I INTRODUCTION

9

Examples of fields that use digital image processing, fundamental steps in digital image processing, components of image processing system. Digital Image Fundamentals: A simple image formation model, image sampling and quantization, basic relationships between pixels.

Image enhancement in the spatial domain: Basic gray-level transformation, histogram processing, enhancement using arithmetic and logic operators, basic spatial filtering, smoothing, and sharpening spatial filters, combining the spatial enhancement methods.

Suggested Activities:

- Discussion of Mathematical Transforms.
- Numerical problem solving using Fourier Transform.
- Numerical problem solving in Image Enhancement.
- External learning – Image Noise and its types.

Suggested Evaluation Methods:

- Tutorial – Image transforms.
- Assignments on histogram specification, histogram equalization and spatial filters.
- Quizzes on noise modeling.

UNIT II IMAGE RESTORATION

9

A model of the image degradation/restoration process, noise models, restoration in the presence of noise—only spatial filtering, Wiener filtering, constrained least squares filtering, geometric transforms; Introduction to the Fourier transform and the frequency domain, estimating the degradation function. Color Image Processing: Color fundamentals, color models, pseudo color image processing, basics of full-color image processing, color transforms, smoothing and sharpening, color segmentation

Suggested Activities:

- Discussion on Image Artifacts and Blur.
- Discussion of Role of Wavelet Transforms in Filter and Analysis.
- Numerical problem solving in Wavelet Transforms.
- External learning – Image restoration algorithms.

Suggested Evaluation Methods:

- Tutorial – Wavelet transforms.
- Assignment problems on order statistics and multi-resolution expansions.
- Quizzes on wavelet transforms.

UNIT III FEATURE EXTRACTION

9

Detection of discontinuities – Edge linking and Boundary detection- Thresholding- -Edge based segmentation-Region based Segmentation- matching-Advanced optimal border and surface detection- Use of motion in segmentation. Image Morphology – Boundary descriptors- Regional descriptors.

Suggested Activities:

- External learning – Feature selection and reduction.
- External learning – Image salient features.
- Assignment on numerical problems in texture computation.

Suggested Evaluation Methods:

- Assignment problems on feature extraction and reduction.
- Quizzes on feature selection and extraction.

UNIT IV IMAGE COMPRESSION

9

Fundamentals, image compression models, error-free compression, lossy predictive coding, image compression standards Morphological Image Processing: Preliminaries, dilation, erosion, open and closing, hit or miss transformation, basic morphological algorithms

Suggested Activities:

- Flipped classroom on different image coding techniques.
- Practical – Demonstration of EXIF format for given camera.
- Practical – Implementing effects quantization, color change.
- Case study of Google's WebP image format.

Suggested Evaluation Methods:

- Evaluation of the practical implementations.
- Assignment on image file formats

UNIT V IMAGE SEGMENTATION

9

Detection of discontinuous, edge linking and boundary detection, thresholding, region-based segmentation. Object Recognition: Patterns and patterns classes, recognition based on decision-theoretic methods, matching, optimum statistical classifiers, neural networks, structural methods – matching shape numbers, string matching.

Suggested Activities:

- Flipped classroom on importance of segmentation.

Suggested Evaluation Methods:

- Tutorial – Image segmentation and edge detection.

COURSE OUTCOMES:

CO1: Apply knowledge of Mathematics for image processing operations

CO2: Apply techniques for image restoration.

CO3: Identify and extract salient features of images.

CO4: Apply the appropriate tools (Contemporary) for image compression and analysis.

CO5: Apply segmentation techniques and do object recognition.

TOTAL: 45 PERIODS

REFERENCES

1. Digital Image Processing, Rafeal C.Gonzalez, Richard E.Woods, Second Edition, Pearson Education/PHI., 2002
2. Digital Image Processing, Sridhar S, Second Edition, Oxford University Press, 2016
3. Introduction to Digital Image Processing with Matlab, Alasdair McAndrew, Thomson Course Technology, .Brooks/Cole 2004
4. Milan Sonka, Vaclav Hlavac, Roger Boyle, "Image Processing, Analysis and Machine Vision", Second Edition, Thompson Learning, 2007.
5. Digital Image Processing using Matlab, Rafeal C.Gonzalez, Richard E.Woods, Steven L. Eddins, Pearson Education.Second Edition, 2017

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	2	2	-	3	-	-
2	2	-	3	3	2	3
3	3	3	-	2	-	-
4	3	-	-	2	3	3
5	2	2	2	2	2	3
Avg	2.4	2.3	2.5	2.4	2.3	3

BD4071

HIGH PERFORMANCE COMPUTING FOR BIG DATA

L T P C

3 0 0 3

COURSE OBJECTIVES:

- To learn the fundamental concepts of High Performance Computing.
- To learn the network & software infrastructure for high performance computing.
- To understand real time analytics using high performance computing.
- To learn the different ways of security perspectives and technologies used in HPC.
- To understand the emerging big data applications.

UNIT I INTRODUCTION

9

The Emerging IT Trends- IOT/IOE-Apache Hadoop for big data analytics-Big data into big insights and actions – Emergence of BDA discipline – strategic implications of big data – BDA Challenges – HPC paradigms – Cluster computing – Grid Computing – Cloud computing – Heterogeneous computing – Mainframes for HPC - Supercomputing for BDA – Appliances for BDA.

UNIT II NETWORK & SOFTWARE INFRASTRUCTURE FOR HIGH PERFORMANCE BDA

9

Design of Network Infrastructure for high performance BDA – Network Virtualization – Software Defined Networking – Network Functions Virtualization – WAN optimization for transfer of big data – started with SANs- storage infrastructure requirements for storing big data – FC SAN – IP SAN – NAS – GFS – Panasas – Luster file system – Introduction to cloud storage.

UNIT III REAL TIME ANALYTICS USING HIGH PERFORMANCE COMPUTING

9

Technologies that support Real time analytics – MOA: Massive online analysis – GPFS: General parallel file system – Client case studies – Key distinctions – Machine data analytics – operational analytics – HPC Architecture models – In Database analytics – In memory analytics

UNIT IV SECURITY AND TECHNOLOGIES

9

Security, Privacy and Trust for user – generated content: The challenges and solutions – Role of real time big data processing in the IoT – End to End Security Framework for big sensing data streams – Clustering in big data.

UNIT V EMERGING BIG DATA APPLICATIONS**9**

Deep learning Accelerators – Accelerators for clustering applications in machine learning - Accelerators for classification algorithms in machine learning – Accelerators for Big data Genome Sequencing

TOTAL: 45 PERIODS**COURSE OUTCOMES:**

Upon completion of the course, the student should be able to:

CO1: Understand the basics concepts of High Performance computing systems.

CO2: Apply the concepts of network and software infrastructure for high performance computing

CO3: Use real time analytics using high performance computing.

CO4: Apply the security models and big data applications in high performance computing

CO5: Understand the emerging big data applications.

REFERENCES:

1. Pethuru Raj, Anupama Raman, Dhivya Nagaraj and Siddhartha Duggirala, "High-Performance Big-Data Analytics: Computing Systems and Approaches", Springer, 1st Edition, 2015.
2. "Big Data Management and Processing", Kuan-Ching Li , Hai Jiang, Albert Y. Zomaya, CRC Press,1st Edition,2017.
3. "High Performance Computing for Big Data: Methodologies and Applications", Chao wang ,CRC Press,1st Edition,2018
4. "High-Performance Data Mining And Big Data Analytics" , Khosrow Hassibi, Create Space Independent Publishing Platform,!st Edition,2014
5. "High performance computing: Modern systems and practices", Thomas Sterling, Matthew Anderson, Morgan Kaufmann publishers,1st Edition,2017

WEB REFERENCES:

1. <https://www.hpcwire.com/>

ONLINE RESOURCES:

1. http://hpc.fs.uni-lj.si/sites/default/files/HPC_for_dummies.pdf
2. <https://www.nics.tennessee.edu/computing-resources/what-is-hpc>

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	2	2	3	1	-	-
2	-	-	2	3	2	3
3	1	-	1	-	1	3
4	3	1	-	-	3	-
5	1	-	-	2	3	-
Avg	1.75	1.5	2	2	2.25	3

COURSE OBJECTIVES:

- To understand the basics of information retrieval with pertinence to modeling, query operations and indexing
- To get an understanding of machine learning techniques for text classification and clustering.
- To understand the various applications of information retrieval giving emphasis to multimedia IR, web search
- To get an understanding of machine learning techniques for text classification and clustering.
- To understand the concepts of digital libraries

UNIT I INTRODUCTION: MOTIVATION**9**

Basic Concepts – Practical Issues - Retrieval Process – Architecture - Boolean Retrieval – Retrieval Evaluation – Open-Source IR Systems–History of Web Search – Web Characteristics–The impact of the web on IR —IR Versus Web Search–Components of a Search engine.

UNIT II MODELING**9**

Taxonomy and Characterization of IR Models – Boolean Model – Vector Model - Term Weighting – Scoring and Ranking –Language Models – Set Theoretic Models - Probabilistic Models – Algebraic Models – Structured Text Retrieval Models – Models for Browsing

UNIT III INDEXING**9**

Static and Dynamic Inverted Indices – Index Construction and Index Compression. Searching - Sequential Searching and Pattern Matching. Query Operations -Query Languages – Query Processing - Relevance Feedback and Query Expansion - Automatic Local and Global Analysis – Measuring Effectiveness and Efficiency

UNIT IV EVALUATION AND PARALLEL INFORMATION RETRIEVAL**9**

Traditional Effectiveness Measures – Statistics in Evaluation – Minimizing Adjudication Effect – Nontraditional Effectiveness Measures – Measuring Efficiency – Efficiency Criteria –Queueing Theory – Query Scheduling – Parallel Information Retrieval – Parallel Query Processing – MapReduce

UNIT V SEARCHING THE WEB**9**

Searching the Web –Structure of the Web –IR and web search – Static and Dynamic Ranking – Web Crawling and Indexing – Link Analysis - XML Retrieval Multimedia IR: Models and Languages – Indexing and Searching Parallel and Distributed IR – Digital Libraries.

COURSE OUTCOMES:

CO1: Build an Information Retrieval system using the available tools.

CO2: Identify and design the various components of an Information Retrieval system.

CO3: Categorize the different types of IR Models.

CO4: Apply machine learning techniques to text classification and clustering which is used for efficient Information Retrieval.

CO5: Design an efficient search engine and analyze the Web content structure.

TOTAL: 45 PERIODS

REFERENCES

1. Christopher D. Manning, Prabhakar Raghavan, Hinrich Schutze, "Introduction to Information Retrieval, Cambridge University Press, First South Asian Edition, 2008.
2. Stefan Buttcher, Implementing and Evaluating Search Engines, The MIT Press, Cambridge, Massachusetts London, England, 2016.
3. Ricardo Baeza – Yates, Berthier Ribeiro – Neto, "Modern Information Retrieval: The concepts and Technology behind Search (ACM Press Books), Second Edition, 2011.
4. Stefan Buttcher, Charles L. A. Clarke, Gordon V. Cormack, "Information Retrieval

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	2	2	1	3	3	2
2	1	1	1	3	2	1
3	2	1	2	3	3	3
4	1	2	2	1	2	3
5	2	2	3	3	1	3
Avg	1.60	1.60	1.80	2.60	2.20	2.40

CP4096

SOFTWARE QUALITY ASSURANCE

L T P C
3 0 0 3

COURSE OBJECTIVES:

- Be exposed to the software quality factors, Quality Assurance (SQA) architecture and SQA components.
- Understand the integration of SQA components into the project life cycle.
- Be familiar with the software quality infrastructure.
- Be exposed to the management components of software quality.
- Be familiar with the Quality standards, certifications and assessments

UNIT I INTRODUCTION TO SOFTWARE QUALITY & ARCHITECTURE

9

Need for Software quality – Software quality assurance (SQA) – Software quality factors- McCall’s quality model – SQA system components – Pre project quality components – Development and quality plans.

UNIT II SQA COMPONENTS AND PROJECT LIFE CYCLE 9

Integrating quality activities in the project life cycle – Reviews – Software Testing – Quality of software maintenance components – Quality assurance for external participants contribution – CASE tools for software quality Management.

UNIT III SOFTWARE QUALITY INFRASTRUCTURE 9

Procedures and work instructions – Supporting quality devices - Staff training and certification - Corrective and preventive actions – Configuration management – Software change control – Configuration management audit -Documentation control.

UNIT IV SOFTWARE QUALITY MANAGEMENT & METRICS 9

Project process control – Software quality metrics – Cost of software quality – Classical quality cost model – Extended model – Application and Problems in application of Cost model

UNIT V STANDARDS, CERTIFICATIONS & ASSESSMENTS 9

Quality management standards – ISO 9001 and ISO 9000-3 –Capability Maturity Models – CMM and CMMI assessment methodologies - Bootstrap methodology – SPICE Project – SQA project process standards – Organization of Quality Assurance – Role of management in SQA – SQA units and other actors in SQA systems.

COURSE OUTCOMES:

CO1: Utilize the concepts of SQA in software development life cycle

CO2: Demonstrate their capability to adopt quality standards.

CO3: Assess the quality of software products.

CO4: Apply the concepts in preparing the quality plan & documents.

CO5: Ensure whether the product meets company's quality standards and client's expectations and demands

TOTAL: 45 PERIODS

REFERENCES

1. Daniel Galin, "Software Quality Assurance", Pearson Publication, 2009.
2. Alan C. Gillies, "Software Quality: Theory and Management", International Thomson Computer Press, 2011.
3. Kshirasagar Naim and Priyadarshi Tripathy, "Software Testing and Quality Assurance Theory and Practice", John Wiley & Sons Inc., 2008
4. Mordechai Ben-Menachem "Software Quality: Producing Practical Consistent Software", International Thompson Computer Press, 2014

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	3	3	3	3	2	3
2	2	2	2	3	2	3
3	3	1	1	2	1	3

4	2	2	2	3	2	1
5	1	1	1	3	1	2
Avg	2.20	1.80	1.80	2.80	1.60	2.40

CP4091

AUTONOMOUS SYSTEMS

L T P C
3 0 0 3

COURSE OBJECTIVES:

- To impart knowledge on the functional architecture of autonomous vehicles
- To impart knowledge on Localization and mapping fundamentals
- To impart knowledge on process end effectors and robotic controls
- To learn Robot cell design, Robot Transformation and Sensors
- To learn Micro/Nano Robotic Systems

UNIT I INTRODUCTION AND FUNCTIONAL ARCHITECTURE 9

Functional architecture - Major functions in an autonomous vehicle system, Motion Modeling - Coordinate frames and transforms, point mass model, Vehicle modeling (kinematic and dynamic bicycle model - two-track models), Sensor Modeling - encoders, inertial sensors, GPS.

UNIT II PERCEPTION FOR AUTONOMOUS SYSTEMS 9

SLAM - Localization and mapping fundamentals, LIDAR and visual SLAM, Navigation – Global path planning, Local path planning, Vehicle control - Control structures, PID control, Linear quadratic regulator, Sample controllers.

UNIT III ROBOTICS INTRODUCTION, END EFFECTORS AND CONTROL 9

Robot anatomy-Definition, law of robotics, Simple problems Specifications of Robot-Speed of Robot-Robot joints and links-Robot classifications-Architecture of robotic systems, Mechanical grippers-Slider crank mechanism, Screw type, Rotary actuators, cam type-Magnetic grippers-Vacuum grippers-Air operated grippers-Gripper force analysis-Gripper design-Simple problems-Robot controls-Point to point control, Continuous path control, Intelligent robotControl system for robot joint-Control actions-Feedback devices-Encoder, Resolver, LVDTMotion Interpolations-Adaptive control.

UNIT IV ROBOT TRANSFORMATIONS, SENSORS AND ROBOT CELL DESIGN 9

Robot kinematics-Types- 2D, 3D Transformation-Scaling, Rotation, Translation- Homogeneous coordinates, multiple transformation-Simple problems. Sensors in robot – Touch sensors-Tactile, Robot work cell design and control-Sequence control, Operator interface, Safety monitoring devices in Robot-Mobile robot working principle, actuation using MATLAB, NXT Software.

UNIT V MICRO/NANO ROBOTICS SYSTEM 9

Micro/Nano robotics system overview-Scaling effect-Top down and bottom up approach Actuators of Micro/Nano robotics system-Nano robot communication techniques-Fabrication of micro/nano grippers-Wall climbing micro robot working principles-Biomimetic robot-Swarm robot-Nano robot in targeted drug delivery system.

COURSE OUTCOMES:

- CO1:** Understand architecture and modeling of autonomous systems.
CO2: Employ localization mapping techniques for autonomous systems
CO3: Design solutions for autonomous systems control.
CO4: Analyze Robot Transformations, Sensors and Cell Design
CO5: Explain the working principles of Micro/Nano Robotic system

TOTAL: 45 PERIODS**REFERENCES**

1. S.R. Deb, Robotics Technology and flexible automation, Tata McGraw-Hill Education.,2009
2. Mikell P Groover & Nicholas G Odrey, Mitchel Weiss, Roger N Nagel, Ashish Dutta, Industrial Robotics, Technology programming and Applications, McGraw Hill, 2012.
3. Karsten Berns, Ewald Puttkamer, Springer, Autonomous Land Vehicles: Steps towards Service Robots, 2009
4. Sebastian Thrun, Wolfram Burgard, Dieter Fox., Probabilistic robotics. MIT Press, 2005
5. Steven M. LaValle., Planning algorithms, Cambridge University Press, 2006
6. Daniel Watzenig and Martin Horn (Eds.), Automated Driving: Safer and More Efficient Future Driving, Springer, 2017
7. Markus Maurer, Autonomous driving: technical, legal and social aspects. Springer, 2016
8. Jha, Theory, Design and Applications of Unmanned Aerial Vehicles, CRC Press, 2016

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	1	2	3	2	3	3
2	2	1	2	3	2	2
3	1	2	2	-	1	1
4	2	1	2	2	2	-
5	3	-	-	1	-	2
Avg	1.80	1.50	2.25	2.00	2.00	2.00

CP4097**WEB ANALYTICS****L T P C
3 0 0 3****COURSE OBJECTIVES:**

- To understand the Web analytics platform, and their evolution.
- To learn about the various Data Streams Data.
- To learn about the benefits of surveys and capturing of data
- To understand Common metrics of web as well as KPI related concepts.
- To learn about the various Web analytics versions.

UNIT I INTRODUCTION**9**

Definition, Process, Key terms: Site references, Keywords and Key phrases; building block terms: Visit characterization terms, Content characterization terms, Conversion metrics; Categories: Offsite web, on site web; Web analytics platform, Web analytics evolution, Need for web analytics, Advantages, Limitations.

UNIT II DATA COLLECTION**9**

Click stream Data: Web logs, Web Beacons, JavaScript tags, Packet Sniffing; Outcomes Data: E-commerce, Lead generation, Brand/Advocacy and Support; Research data: Mindset, Organizational structure, Timing; Competitive Data: Panel-Based measurement, ISP-based measurement, Search Engine data.

UNIT III QUALITATIVE ANALYSIS**9**

Heuristic evaluations: Conducting a heuristic evaluation, Benefits of heuristic evaluations; Site Visits: Conducting a site visit, Benefits of site visits; Surveys: Website surveys, Post-visit surveys, creating and running a survey, Benefits of surveys. Capturing data: Web logs or JavaScript's tags, Separate data serving and data capture, Type and size of data, Innovation, Integration, Selecting optimal web analytic tool, Understanding click stream data quality, Identifying unique page definition, Using cookies, Link coding issues.

UNIT IV WEB METRICS**9**

Common metrics: Hits, Page views, Visits, Unique visitors, Unique page views, Bounce, Bounce rate, Page/visit, Average time on site, New visits; Optimization (e-commerce, non e-commerce sites): Improving bounce rates, Optimizing adwords campaigns; Real time report, Audience report, Traffic source report, Custom campaigns, Content report, Google analytics, Introduction to KPI, characteristics, Need for KPI, Perspective of KPI, Uses of KPI. Relevant Technologies: Internet & TCP/IP, Client / Server Computing, HTTP (Hypertext Transfer Protocol), Server Log Files & Cookies, Web Bugs.

UNIT V WEB ANALYTICS 2.0**9**

Web analytics 1.0, Limitations of web analytics 1.0, Introduction to analytic 2.0, Competitive intelligence analysis : CI data sources, Toolbar data, Panel data ,ISP data, Search engine data, Hybrid data, Website traffic analysis: Comparing long term traffic trends, Analyzing competitive site overlap and opportunities. Google Analytics: Brief introduction and working, Adwords, Benchmarking, Categories of traffic: Organic traffic, Paid traffic; Google website optimizer, Implementation technology, Limitations, Performance concerns, Privacy issues.

TOTAL: 45 PERIODS**COURSE OUTCOMES**

Upon completion of this course, the students should be able to:

CO1: Understand the Web analytics platform, and their evolution.

CO2: Use the various Data Streams Data.

CO3: Know how the survey of capturing of data will benefit.

CO4: Understand Common metrics of web as well as KPI related concepts.

CO5: Apply various Web analytics versions in existence.

REFERENCES:

1. Clifton B., Advanced Web Metrics with Google Analytics, Wiley Publishing, Inc.2nd ed, 2012.

2. Kaushik A., Web Analytics 2.0, The Art of Online Accountability and Science of Customer Centricity, Wiley Publishing, Inc. 1st ed, 2010.
3. Sterne J., Web Metrics: Proven methods for measuring web site success, John Wiley and Sons, 2002

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	3	-	3	2	3	2
2	2	2	3	1	1	1
3	3	-	3	2	2	2
4	1	2	3	1	1	1
5	2	-	3	2	2	1
Avg	2.20	2.00	3.00	1.60	1.80	1.40

MP4091

COGNITIVE COMPUTING

L T P C
3 0 0 3

COURSE OBJECTIVES:

- To familiarize Use the Innovation Canvas to justify potentially successful products.
- To learn various ways in which to develop a product idea.
- To understand about how Big Data can play vital role in Cognitive Computing
- To know about the business applications of Cognitive Computing
- To get into all applications of Cognitive Computing

UNIT I FOUNDATION OF COGNITIVE COMPUTING

9

Foundation of Cognitive Computing: cognitive computing as a new generation, the uses of cognitive systems, system cognitive, gaining insights from data, Artificial Intelligence as the foundation of cognitive computing, understanding cognition Design Principles for Cognitive Systems: Components of a cognitive system, building the corpus, bringing data into cognitive system, machine learning, hypotheses generation and scoring, presentation, and visualization services

UNIT II NATURAL LANGUAGE PROCESSING IN COGNITIVE SYSTEMS

9

Natural Language Processing in support of a Cognitive System: Role of NLP in a cognitive system, semantic web, Applying Natural language technologies to Business problems Representing knowledge in Taxonomies and Ontologies: Representing knowledge, Defining Taxonomies and Ontologies, knowledge representation, models for knowledge representation, implementation considerations

UNIT III BIG DATA AND COGNITIVE COMPUTING 9

Relationship between Big Data and Cognitive Computing: Dealing with human-generated data, defining big data, architectural foundation, analytical data warehouses, Hadoop, data in motion and streaming data, integration of big data with traditional data Applying Advanced Analytics to cognitive computing: Advanced analytics is on a path to cognitive computing, Key capabilities in advanced analytics, using advanced analytics to create value, Impact of open source tools on advanced analytics

UNIT IV BUSINESS IMPLICATIONS OF COGNITIVE COMPUTING 9

Preparing for change ,advantages of new disruptive models , knowledge meaning to business, difference with a cognitive systems approach , meshing data together differently, using business knowledge to plan for the future , answering business questions in new ways , building business specific solutions , making cognitive computing a reality , cognitive application changing the market The process of building a cognitive application: Emerging cognitive platform, defining the objective, defining the domain, understanding the intended users and their attributes, questions and exploring insights, training and testing

UNIT V APPLICATION OF COGNITIVE COMPUTING 9

Building a cognitive health care application: Foundations of cognitive computing for healthcare, constituents in healthcare ecosystem, learning from patterns in healthcare Data, Building on a foundation of big data analytics, cognitive applications across the health care eco system, starting with a cognitive application for healthcare, using cognitive applications to improve health and wellness, using a cognitive application to enhance the electronic medical record Using cognitive application to improve clinical teaching

COURSE OUTCOMES:

- CO1:** Explain applications in Cognitive Computing.
- CO2:** Describe Natural language processor role in Cognitive computing.
- CO3:** Explain future directions of Cognitive Computing
- CO4:** Evaluate the process of taking a product to market
- CO5:** Comprehend the applications involved in this domain.

TOTAL:45 PERIODS

REFERENCES

1. Judith H Hurwitz, Marcia Kaufman, Adrian Bowles, "Cognitive computing and Big Data Analytics", Wiley, 2015
2. Robert A. Wilson, Frank C. Keil, "The MIT Encyclopedia of the Cognitive Sciences", The MIT Press, 1999.
3. Noah D. Goodman, Joshua B. Tenenbaum, The ProbMods Contributors, "Probabilistic Models of Cognition", Second Edition, 2016, <https://probmods.org/>.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	1	3	2	-	2	-
2	2	-	3	1	3	-

3	1	2	-	-	3	-
4	-	-	2	2	1	1
5	2	2	1	-	1	2
Avg	1.5	2.3	2	1.5	2	1.5

AP4093

QUANTUM COMPUTING

LT P C
3 0 0 3

COURSE OBJECTIVES:

- To introduce the building blocks of Quantum computers and highlight the paradigm change between conventional computing and quantum computing
- To understand the Quantum state transformations and the algorithms
- To understand entangled quantum subsystems and properties of entangled states
- To explore the applications of quantum computing

UNIT I QUANTUM BUILDING BLOCKS 9

The Quantum Mechanics of Photon Polarization, Single-Qubit Quantum Systems, Quantum State Spaces, Entangled States, Multiple-Qubit Systems, Measurement of Multiple-Qubit States, EPR Paradox and Bell's Theorem, Bloch sphere

UNIT II QUANTUM STATE TRANSFORMATIONS 9

Unitary Transformations, Quantum Gates, Unitary Transformations as Quantum Circuits, Reversible Classical Computations to Quantum Computations, Language for Quantum Implementations.

UNIT III QUANTUM ALGORITHMS 9

Computing with Superpositions, Quantum Subroutines, Quantum Fourier Transformations, Shor's Algorithm and Generalizations, Grover's Algorithm and Generalizations

UNIT IV ENTANGLED SUBSYSTEMS AND ROBUST QUANTUM COMPUTATION 9

Quantum Subsystems, Properties of Entangled States, Quantum Error Correction, Graph states and codes, CSS Codes, Stabilizer Codes, Fault Tolerance and Robust Quantum Computing

UNIT V QUANTUM INFORMATION PROCESSING 9

Limitations of Quantum Computing, Alternatives to the Circuit Model of Quantum Computation, Quantum Protocols, Building Quantum, Computers, Simulating Quantum Systems, Bell states. Quantum teleportation. Quantum Cryptography, no cloning theorem

COURSE OUTCOMES:

At the end of the course, the student will be able to

CO1: Understand the basic principles of quantum computing.

CO2: Gain knowledge of the fundamental differences between conventional computing and quantum computing.

CO3: Understand several basic quantum computing algorithms.

CO4: Understand the classes of problems that can be expected to be solved well by quantum computers.

CO5: Simulate and analyze the characteristics of Quantum Computing Systems.

TOTAL: 45 PERIODS

REFERENCES:

1. John Gribbin, Computing with Quantum Cats: From Colossus to Qubits, 2021
2. William (Chuck) Easttom, Quantum Computing Fundamentals, 2021
3. Parag Lala, Quantum Computing, 2019
4. Eleanor Rieffel and Wolfgang Polak, QUANTUM COMPUTING A Gentle Introduction, 2011
5. Nielsen M. A., Quantum Computation and Quantum Information, Cambridge University Press.2002
6. Benenti G., Casati G. and Strini G., Principles of Quantum Computation and Information, Vol. I: Basic Concepts, Vol II: Basic Tools and Special Topics, World Scientific. 2004
7. Pittenger A. O., An Introduction to Quantum Computing Algorithms 2000

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	1	2	3	-	1	-
2	1	2	3	-	2	-
3	-	1	3	2	3	2
4	2	-	2	2	1	3
5	3	-	1	2	3	3
Avg	1.75	1.7	2.4	2	2	2.73

BD4251

BIG DATA MINING AND ANALYTICS

**LT PC
3 0 0 3**

PROGRESS THROUGH KNOWLEDGE

COURSE OBJECTIVES:

- To understand the computational approaches to Modeling, Feature Extraction
- To understand the need and application of Map Reduce
- To understand the various search algorithms applicable to Big Data
- To analyze and interpret streaming data
- To learn how to handle large data sets in main memory and learn the various clustering techniques applicable to Big Data

UNIT I DATA MINING AND LARGE SCALE FILES

9

Introduction to Statistical modeling – Machine Learning – Computational approaches to modeling – Summarization – Feature Extraction – Statistical Limits on Data Mining - Distributed File Systems – Map-reduce – Algorithms using Map Reduce – Efficiency of Cluster Computing Techniques.

UNIT II SIMILAR ITEMS 9

Nearest Neighbor Search – Shingling of Documents – Similarity preserving summaries – Locality sensitive hashing for documents – Distance Measures – Theory of Locality Sensitive Functions – LSH Families – Methods for High Degree of Similarities.

UNIT III MINING DATA STREAMS 9

Stream Data Model – Sampling Data in the Stream – Filtering Streams – Counting Distance Elements in a Stream – Estimating Moments – Counting Ones in Window – Decaying Windows.

UNIT IV LINK ANALYSIS AND FREQUENT ITEMSETS 9

Page Rank –Efficient Computation - Topic Sensitive Page Rank – Link Spam – Market Basket Model – A-priori algorithm – Handling Larger Datasets in Main Memory – Limited Pass Algorithm – Counting Frequent Item sets.

UNIT V CLUSTERING 9

Introduction to Clustering Techniques – Hierarchical Clustering –Algorithms – K-Means – CURE – Clustering in Non -- Euclidean Spaces – Streams and Parallelism – Case Study: Advertising on the Web – Recommendation Systems.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of this course, the students will be able to

CO1: Design algorithms by employing Map Reduce technique for solving Big Data problems.

CO2: Design algorithms for Big Data by deciding on the apt Features set .

CO3: Design algorithms for handling petabytes of datasets

CO4: Design algorithms and propose solutions for Big Data by optimizing main memory consumption

CO5: Design solutions for problems in Big Data by suggesting appropriate clustering techniques.

REFERENCES:

1. Jure Leskovec, AnandRajaraman, Jeffrey David Ullman, “Mining of Massive Datasets”, Cambridge University Press, 3rd Edition, 2020.
2. Jiawei Han, MichelineKamber, Jian Pei, “Data Mining Concepts and Techniques”, Morgan Kaufman Publications, Third Edition, 2012.
3. Ian H.Witten, Eibe Frank “Data Mining – Practical Machine Learning Tools and Techniques”, Morgan Kaufman Publications, Third Edition, 2011.
4. David Hand, HeikkiMannila and Padhraic Smyth, “Principles of Data Mining”, MIT PRESS, 2001

WEB REFERENCES:

1. https://swayam.gov.in/nd2_arp19_ap60/preview
2. https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/106104189/lec1.pdf

ONLINE RESOURCES:

1. <https://examupdates.in/big-data-analytics/>
2. https://www.tutorialspoint.com/big_data_analytics/index.htm
3. https://www.tutorialspoint.com/data_mining/index.htm

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	-	-	-	2	3	3
2	-	-	-	-	2	2
3	-	-	-	2	3	3
4	1	-	2	2	3	3
5	2	3	2	2	3	3
Avg	1.5	3	2	2	2.8	2.8

CP4094

MOBILE AND PERVASIVE COMPUTING

L T P C
3 0 0 3

COURSE OBJECTIVES:

- To understand the basics of Mobile Computing and Personal Computing
- To learn the role of cellular networks in Mobile and Pervasive Computing
- To expose to the concept of sensor and mesh networks
- To expose to the context aware and wearable computing
- To learn to develop applications in mobile and pervasive computing environment

UNIT I INTRODUCTION

9

Differences between Mobile Communication and Mobile Computing – Contexts and Names – Functions – Applications and Services – New Applications – Making Legacy Applications Mobile Enabled – Design Considerations – Integration of Wireless and Wired Networks – Standards Bodies – Pervasive Computing – Basics and Vision – Principles of Pervasive Computing – Categories of Pervasive Devices

UNIT II 3G AND 4G CELLULAR NETWORKS

9

Migration to 3G Networks – IMT 2000 and UMTS – UMTS Architecture – User Equipment – Radio Network Subsystem – UTRAN – Node B – RNC functions – USIM – Protocol Stack – CS and PS Domains – IMS Architecture – Handover – 3.5G and 3.9G a brief discussion – 4G LAN and Cellular Networks – LTE – Control Plane – NAS and RRC – User Plane – PDCP, RLC and MAC – WiMax IEEE 802.16d/e – WiMax Internetworking with 3GPP

UNIT III SENSOR AND MESH NETWORKS

9

Sensor Networks – Role in Pervasive Computing – In Network Processing and Data Dissemination – Sensor Databases – Data Management in Wireless Mobile Environments – Wireless Mesh Networks – Architecture – Mesh Routers – Mesh Clients – Routing – Cross Layer Approach – Security Aspects of Various Layers in WMN – Applications of Sensor and Mesh networks

UNIT IV CONTEXT AWARE COMPUTING & WEARABLE COMPUTING

9

Adaptability – Mechanisms for Adaptation - Functionality and Data – Transcoding – Location Aware Computing – Location Representation – Localization Techniques – Triangulation and Scene

Analysis – Delaunay Triangulation and Voronoi graphs – Types of Context – Role of Mobile Middleware – Adaptation and Agents – Service Discovery Middleware Health BAN- Medical and Technological Requirements-Wearable Sensors-Intra-BAN communications

UNIT V APPLICATION DEVELOPMENT

9

Three tier architecture - Model View Controller Architecture - Memory Management – Information Access Devices – PDAs and Smart Phones – Smart Cards and Embedded Controls – J2ME – Programming for CLDC – GUI in MIDP – Application Development ON Android and iPhone

COURSE OUTCOMES:

CO1: Design a basic architecture for a pervasive computing environment

CO2: Design and allocate the resources on the 3G-4G wireless networks

CO3: Analyze the role of sensors in Wireless networks

CO4: Work out the routing in mesh network

CO5: Deploy the location and context information for application development

CO6: Develop mobile computing applications based on the paradigm of context aware computing and wearable computing

TOTAL:45 PERIODS

REFERENCES

1. Asoke K Talukder, Hasan Ahmed, Roopa R Yavagal, “Mobile Computing: Technology, Applications and Service Creation”, 2nd ed, Tata McGraw Hill, 2017.
2. Reto Meier, “Professional Android 2 Application Development”, Wrox Wiley,2010.
3. Pei Zheng and Lionel M Li, ‘Smart Phone & Next Generation Mobile Computing’, Morgan Kaufmann Publishers, 2006.
4. Frank Adelstein, ‘Fundamentals of Mobile and Pervasive Computing’, TMH, 2005
5. Jochen Burthardt et al, ‘Pervasive Computing: Technology and Architecture of Mobile Internet Applications’, Pearson Education, 2003
6. Feng Zhao and Leonidas Guibas, ‘Wireless Sensor Networks’, Morgan Kaufmann Publishers, 2004
7. Uwe Hansmaan et al, ‘Principles of Mobile Computing’, Springer, 2nd edition,2006
8. Reto Meier, “Professional Android 2 Application Development”, Wrox Wiley,2010.
9. Mohammad s. Obaidat et al, “Pervasive Computing and Networking” ,John wiley, 2011
10. Stefan Poslad, “Ubiquitous Computing: Smart Devices, Environments and Interactions”, Wiley, 2009
11. Frank Adelstein Sandeep K. S. Gupta Golden G. Richard III Loren Schwiebert “Fundamentals of Mobile and Pervasive Computing, “, McGraw-Hill, 2005

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	3	3	1	3	1	3
2	2	2	2	2	2	2
3	1	3	1	1	2	2
4	1	2	2	2	1	1

5	2		2	1	2	2
Avg	1.80	2.50	1.60	1.80	1.60	2.00

MP4094

WEB SERVICES AND API DESIGN

L T P C

3 0 0 3

COURSE OBJECTIVES:

- To learn the basics of Web service.
- To become familiar with the Web Services building blocks
- To learn to work with RESTful web services.
- To implement the RESTful web services.
- To understand resource oriented Architecture.

UNIT I INTRODUCTION TO WEB SERVICE 9

Overview – Web service-Architecture – Service-Oriented Architecture (SOA), Architecting Web Services: Web Services Technology Stack, Logical Architectural View, Deployment Architectural View, and Process Architectural View.

UNIT II WEB SERVICE BUILDING BLOCKS 9

Introduction to SOAP: SOAP Syntax- Sending SOAP Messages - SOAP Implementations - Introduction to WSDL: WSDL Syntax - SOAP Binding - WSDL Implementations - Introduction to UDDI: The UDDI API - Implementations - The Future of UDDI

UNIT III RESTFUL WEB SERVICES 9

Programmable Web - HTTP: Documents in Envelopes - Method Information - Scoping Information - The Competing Architectures - Technologies on the Programmable Web -Leftover Terminology - Writing Web Service Clients: The Sample Application - Making the Request: HTTP Libraries - Processing the Response: XML Parsers - JSON Parsers: Handling Serialized Data - Clients Made Easy with WADL.

UNIT IV IMPLEMENTATION OF RESTFUL WEB SERVICES 9

Introducing the Simple Storage Service - Object-Oriented Design of S3 - Resources - HTTP Response Codes Resource- URIs - Addressability - Statelessness - Representations - Links and Connectedness - The Uniform Interface – Spring Web Services – Spring MVC Components - Spring Web Flow - A Service Implementation using Spring Data REST.

UNIT V RESOURCE ORIENTED ARCHITECTURE 9

Resource- URIs - Addressability - Statelessness - Representations - Links and Connectedness - The Uniform Interface- Designing Read-Only Resource-Oriented Services : Resource Design - Turning Requirements Into Read-Only Resources - Figure Out the Data Set- Split the Data Set into Resources- Name the Resources - Design Representation- Link the Resources to Each Other- The HTTP Response

COURSE OUTCOMES:

CO1: Explain how to write XML documents.

CO2: Apply the web service building blocks such as SOAP, WSDL and UDDI

CO3: Describe the RESTful web services.

CO4: Implement the RESTful web service with Spring Boot MVC

CO5: Discuss Resource-oriented Architecture.

TOTAL: 45 PERIODS

REFERENCES

1. Leonard Richardson and Sam Ruby, RESTful Web Services, O’Reilly Media, 2007
2. McGovern, et al., "Java Web Services Architecture", Morgan Kaufmann Publishers,2005.
3. Lindsay Bassett, Introduction to JavaScript Object Notation, O’Reilly Media, 2015
4. Craig Walls, “Spring in Action, Fifth Edition”, Manning Publications, 2018
5. Raja CSP Raman, Ludovic Dewailly, “Building A RESTful Web Service with Spring 5”, Packt Publishing, 2018.
6. Bogunuva Mohanram Balachandar, “Restful Java Web Services, Third Edition: A pragmatic guide to designing and building RESTful APIs using Java”, Ingram short title, 3rd Edition, 2017.
7. Mario-Leander Reimer, “Building RESTful Web Services with Java EE 8: Create modern RESTful web services with the Java EE 8 API”, Packt publishing, 2018.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	1	3	3	-	-	-
2	1	-	3	3	1	2
3	-	3	3	-	-	-
4	1	-	2	3	1	2
5	1	-	1	-	1	-
Avg	1	3	2.4	3	1	2

CP4092

DATA VISUALIZATION TECHNIQUES

L T P C
3 0 0 3

COURSE OBJECTIVES:

- To develop skills to both design and critique visualizations.
- To introduce visual perception and core skills for visual analysis.
- To understand technological advancements of data visualization
- To understand various data visualization techniques
- To understand the methodologies used to visualize large data sets

UNIT I INTRODUCTION AND DATA FOUNDATION

9

Basics - Relationship between Visualization and Other Fields -The Visualization Process - Pseudo code Conventions - The Scatter plot. Data Foundation - Types of Data - Structure within and between Records - Data Preprocessing - Data Sets

UNIT II FOUNDATIONS FOR VISUALIZATION 9

Visualization stages - Semiology of Graphical Symbols - The Eight Visual Variables – Historical Perspective - Taxonomies - Experimental Semiotics based on Perception Gibson's Affordance theory – A Model of Perceptual Processing.

UNIT III VISUALIZATION TECHNIQUES 9

Spatial Data: One-Dimensional Data - Two-Dimensional Data – Three Dimensional Data - Dynamic Data - Combining Techniques. Geospatial Data : Visualizing Spatial Data - Visualization of Point Data -Visualization of Line Data - Visualization of Area Data – Other Issues in Geospatial Data Visualization Multivariate Data : Point-Based Techniques - LineBased Techniques - Region-Based Techniques - Combinations of Techniques – Trees Displaying Hierarchical Structures – Graphics and Networks- Displaying Arbitrary Graphs/Networks.

UNIT IV INTERACTION CONCEPTS AND TECHNIQUES 9

Text and Document Visualization: Introduction - Levels of Text Representations - The Vector Space Model - Single Document Visualizations -Document Collection Visualizations – Extended Text Visualizations Interaction Concepts: Interaction Operators - Interaction Operands and Spaces - A Unified Framework. Interaction Techniques: Screen Space - Object-Space –Data Space - Attribute Space- Data Structure Space - Visualization Structure – Animating Transformations - Interaction Control.

UNIT V RESEARCH DIRECTIONS IN VISUALIZATIONS 9

Steps in designing Visualizations – Problems in designing effective Visualizations- Issues of Data. Issues of Cognition, Perception, and Reasoning. Issues of System Design Evaluation , Hardware and Applications

COURSE OUTCOMES:

CO1: Visualize the objects in different dimensions.

CO2: Design and process the data for Visualization.

CO3:Apply the visualization techniques in physical sciences, computer science, applied mathematics and medical sciences.

CO4: Apply the virtualization techniques for research projects.

CO5: Identify appropriate data visualization techniques given particular requirements imposed by the data.

PROGRESS THROUGH KNOWLEDGE

TOTAL: 45 PERIODS

REFERENCES

1. Matthew Ward, Georges Grinstein and Daniel Keim, "Interactive Data Visualization Foundations, Techniques, Applications", 2010.
2. Colin Ware, "Information Visualization Perception for Design", 4th edition, Morgan Kaufmann Publishers, 2021.
3. Robert Spence "Information visualization – Design for interaction", Pearson Education, 2nd Edition, 2007.
4. Alexandru C. Telea, "Data Visualization: Principles and Practice," A. K. Peters Ltd, 2008.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	3	1	2	2	1	2
2	2	1	2	3	2	2
3	1	-	2	2	1	1
4	3	1	3	3	2	2
5	2	1	3	2	1	1
Avg	2.20	1.00	2.40	2.40	1.40	1.60

IF4091

COMPILER OPTIMIZATION TECHNIQUES

L T P C
3 0 0 3

COURSE OBJECTIVES:

- To understand the optimization techniques used in compiler design.
- To be aware of the various computer architectures that support parallelism.
- To become familiar with the theoretical background needed for code optimization.
- To understand the techniques used for identifying parallelism in a sequential program.
- To learn the various optimization algorithms.

UNIT I INTRODUCTION

9

Language Processors - The Structure of a Compiler – The Evolution of Programming Languages- The Science of Building a Compiler – Applications of Compiler Technology Programming Language Basics - The Lexical Analyzer Generator -Parser Generator - Overview of Basic Blocks and Flow Graphs - Optimization of Basic Blocks - Principle Sources of Optimization.

UNIT II INSTRUCTION-LEVEL PARALLELISM

9

Processor Architectures – Code-Scheduling Constraints – Basic-Block Scheduling –Global Code Scheduling – Advanced code motion techniques – Interaction with Dynamic Schedulers- Software Pipelining.

UNIT III OPTIMISING FOR PARALLELISM AND LOCALITY-THEORY

9

Basic Concepts – Matrix-Multiply: An Example - Iteration Spaces - Affine Array Indexes – Data Reuse- Array data dependence Analysis.

UNIT IV OPTIMISING FOR PARALLELISM AND LOCALITY – APPLICATION

9

Finding Synchronisation - Free Parallelism – Synchronisation Between Parallel Loops – Pipelining – Locality Optimizations – Other Uses of Affine Transforms.

UNIT V INTERPROCEDURAL ANALYSIS

9

Basic Concepts – Need for Interprocedural Analysis – A Logical Representation of Data Flow – A

Simple Pointer-Analysis Algorithm – Context Insensitive Interprocedural Analysis - Context-Sensitive Pointer-Analysis - Datalog Implementation by Binary Decision Diagrams.

COURSE OUTCOMES:

- CO1:** Design and implement techniques used for optimization by a compiler.
- CO2:** Modify the existing architecture that supports parallelism.
- CO3:** Modify the existing data structures of an open source optimising compiler.
- CO4:** Design and implement new data structures and algorithms for code optimization.
- CO5:** Critically analyse different data structures and algorithms used in the building of an optimising compiler.

TOTAL : 45 PERIODS

REFERENCES

1. Alfred V. Aho, Monica S.Lam, Ravi Sethi, Jeffrey D.Ullman, “Compilers:Principles, Techniques and Tools”, Second Edition, Pearson Education,2008.
2. Randy Allen, Ken Kennedy, “Optimizing Compilers for Modern Architectures: A Dependence-based Approach”, Morgan Kaufmann Publishers, 2002.
3. Steven S. Muchnick, “Advanced Compiler Design and Implementation”,Morgan Kaufmann Publishers - Elsevier Science, India, 2007
4. John Hopcroft, Rajeev Motwani, Jeffrey Ullman, “Introduction To Automata Theory Languages, and Computation”, Third Edition, Pearson Education, 2007.
5. Torbengidius Mogensen, “Basics of Compiler Design”, Springer, 2011.
6. Charles N, Ron K Cytron, Richard J LeBlanc Jr., “Crafting a Compiler”, Pearson Education, 2010.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	2	2	2	3	2	2
2	-	-	3	3	-	3
3	3	-	3	3	-	3
4	3	3	3	3	-	-
5	-	3	3	3	3	-
Avg	2.6	2.6	2.8	3	2.5	2.6

CP4002

FORMAL MODELS OF SOFTWARE SYSTEMS

**L T P C
3 0 0 3**

COURSE OBJECTIVES:

- To understand the goals, complexity of software systems, the role of Specification activities and qualities to control complexity.
- To understand the fundamentals of abstraction and formal systems
- To learn fundamentals of logic reasoning- Propositional Logic, temporal logic and apply to

- models systems
- To understand formal specification models based on set theory, calculus and algebra and apply to a case study
- To learn Z, Object Z and B Specification languages with case studies.

UNIT I SPECIFICATION FUNDAMENTALS 9

Role of Specification- Software Complexity - Size, Structural, Environmental, Application, domain, Communication Complexity, How to Control Complexity. Software specification, Specification Activities-Integrating Formal Methods into the Software Lifecycle. Specification Qualities- Process Quality Attributes of Formal Specification Languages, Model of Process Quality, Product Quality and Utility, Conformance to Stated Goals Quality Dimensions and Quality Model.

UNIT II FORMAL METHODS 9

Abstraction- Fundamental Abstractions in Computing. Abstractions for Software Construction. Formalism Fundamentals - Formal Systems, Formalization Process in Software Engineering Components of a Formal System- Syntax, Semantics, and Inference Mechanism. Properties of Formal Systems - Consistency. Automata-Deterministic Finite Accepters, State Machine Modeling Nondeterministic Finite Accepters, Finite State Transducers Extended Finite State Machine. Case Study—Elevator Control. Classification of C Methods-Property-Oriented Specification Methods, Model-Based Specification Techniques.

UNIT III LOGIC 9

Propositional Logic - Reasoning Based on Adopting a Premise, Inference Based on Natural Deduction. Predicate Logic - Syntax and Semantics, Policy Language Specification, knowledge Representation Axiomatic Specification. Temporal Logic -. Temporal Logic for Specification and Verification, Temporal Abstraction Propositional Temporal Logic (PTL), First Order Temporal Logic (FOTL). Formal Verification, Verification of Simple FOTL, Model Checking, Program Graphs, Transition Systems.

UNIT IV SPECIFICATION MODELS 9

Mathematical Abstractions for Model-Based Specifications-Formal Specification Based on Set Theory, Relations and Functions. Property-Oriented Specifications- Algebraic Specification, Properties of Algebraic Specifications, Reasoning, Structured Specifications. Case Study—A Multiple Window Environment: requirements, Modeling Formal Specifications. Calculus of Communicating Systems: Specific Calculus for Concurrency. Operational Semantics of Agents, Simulation and Equivalence, Derivation Trees, Labeled Transition Systems.

UNIT V FORMAL LANGUAGES 9

The Z Notation, abstractions in Z, Representational Abstraction, Types, Relations and Functions, Sequences, Bags. Free Types-Schemas, Operational Abstraction -Operations Schema Decorators, Generic Functions, Proving Properties from Z specifications, Consistency of Operations. Additional Features in Z. Case Study: An Automated Billing System. The Object-Z Specification Language- Basic Structure of an Object-Z, Specification. Parameterized Class, Object-Orientation, composition of Operations-Parallel Communication Operator, Nondeterministic Choice Operator, and Environment Enrichment. The B-Method -Abstract Machine Notation (AMN), Structure of a B Specification, arrays, statements. Structured Specifications, Case Study- A Ticketing System in a Parking.

COURSE OUTCOMES:

CO1: Understand the complexity of software systems, the need for formal specifications activities and qualities to control complexity.

CO2: Gain knowledge on fundamentals of abstraction and formal systems

CO3: Learn the fundamentals of logic reasoning- Propositional Logic, temporal logic and apply to models systems

CO4: Develop formal specification models based on set theory, calculus and algebra and apply to a typical case study

CO5: Have working knowledge on Z, Object Z and B Specification languages with case studies.

TOTAL: 45 PERIODS

REFERENCES

1. Mathematical Logic for computer science ,second edition, M.Ben-Ari ,Springer,2012.
2. Logic in Computer Science- modeling and reasoning about systems, 2 nd Edition, Cambridge University Press, 2004.
3. Specification of Software Systems, V.S. Alagar, K. Periyasamy, David Grises and Fred B Schneider, Springer –Verlag London, 2011
4. The ways Z: Practical programming with formal methods, Jonathan Jacky, Cambridge University Press,1996.
5. Using Z-Specification Refinement and Proof,Jim Woodcock and Jim Devies Prentice Hall, 1996
6. Markus Roggenbach ,Antonio Cerone, Bernd-Holger Schlingloff, Gerardo Schneider , Siraj Ahmed Shaikh, Formal Methods for Software Engineering: Languages, Methods, Application Domains (Texts in Theoretical Computer Science. An EATCS Series) 1st ed. 2022 Edition

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	1	1	3	-	2	3
2	2	1	-	2	1	3
3	3	1	2	3	2	3
4	-	2	2	-	1	3
5	2	2	-	3	3	3
Avg	2.00	1.40	2.33	2.67	1.80	3.00

AP4094

ROBOTICS

L T P C
3 0 0 3

COURSE OBJECTIVES:

- To Introduce the concepts of Robotic systems
- To understand the concepts of Instrumentation and control related to Robotics
- To understand the kinematics and dynamics of robotics
- To explore robotics in Industrial applications

UNIT I	INTRODUCTION TO ROBOTICS	9
Robotics -History - Classification and Structure of Robotic Systems - Basic components -Degrees of freedom - Robot joints coordinates- Reference frames - workspace- Robot languages- Robotic sensors- proximity and range sensors, ultrasonic sensor, touch and slip sensor.		
UNIT II	ROBOT KINEMATICS AND DYNAMICS	9
Kinematic Modelling: Translation and Rotation Representation, Coordinate transformation, DH parameters, Forward and inverse kinematics, Jacobian, Dynamic Modelling: Forward and inverse dynamics, Equations of motion using Euler-Lagrange formulation, Newton Euler formulation.		
UNIT III	ROBOTICS CONTROL	9
Control of robot manipulator - state equations - constant solutions -linear feedback systems, single-axis PID control - PD gravity control -computed torque control, variable structure control and impedance control.		
UNIT IV	ROBOT INTELLIGENCE AND TASK PLANNING	9
Artificial Intelligence - techniques - search problem reduction - predicate logic means and end analysis -problem solving -robot learning - task planning - basic problems in task planning - AI in robotics and Knowledge Based Expert System in robotics		
UNIT V	INDUSTRIAL ROBOTICS	9
Robot cell design and control - cell layouts - multiple robots and machine interference - work cell design - work cell control - interlocks – error detection deduction and recovery - work cell controller - robot cycle time analysis. Safety in robotics, Applications of robot and future scope.		

COURSE OUTCOMES:

At the end of the course the student will be able to

- CO1:** Describe the fundamentals of robotics
- CO2:** Understand the concept of kinematics and dynamics in robotics.
- CO3:** Discuss the robot control techniques
- CO4:** Explain the basis of intelligence in robotics and task planning
- CO5:** Discuss the industrial applications of robotics

TOTAL:45 PERIODS

REFERENCE:

1. John J. Craig, 'Introduction to Robotics (Mechanics and Control)', Addison-Wesley, 2nd Edition, 2004.
2. Richard D. Klafter, Thomas A. Chmielewski, Michael Negin, 'Robotics Engineering: An Integrated Approach', PHI Learning, New Delhi, 2009.
3. K.S.Fu, R.C.Gonzalez and C.S.G.Lee, 'Robotics Control, Sensing, Vision and Intelligence', Tata McGraw Hill, 2nd Reprint,2008.
4. Reza N.Jazar, 'Theory of Applied Robotics Kinematics, Dynamics and Control', Springer, 1st Indian Reprint, 2010.
5. Mikell. P. Groover, Michell Weis, Roger. N. Nagel, Nicolous G.Odrey, 'Industrial Robotics Technology, Programming and Applications ', McGraw Hill, Int 2012.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	1	3	3	-	2	-
2	1	2	3	2	1	1
3	1	2	-	3	3	2
4	2	-	3	-	2	-
5	1	-	-	3	3	3
Avg	1.2	2.3	3	2.7	2.2	2

ML4291

NATURAL LANGUAGE PROCESSING

L T P C
2 0 2 3

COURSE OBJECTIVES:

- To understand basics of linguistics, probability and statistics
- To study statistical approaches to NLP and understand sequence labeling
- To outline different parsing techniques associated with NLP
- To explore semantics of words and semantic role labeling of sentences
- To understand discourse analysis, question answering and chatbots

UNIT I INTRODUCTION 6

Natural Language Processing – Components - Basics of Linguistics and Probability and Statistics – Words-Tokenization-Morphology-Finite State Automata

UNIT II STATISTICAL NLP AND SEQUENCE LABELING 6

N-grams and Language models –Smoothing -Text classification- Naïve Bayes classifier – Evaluation - Vector Semantics – TF-IDF - Word2Vec- Evaluating Vector Models -Sequence Labeling – Part of Speech – Part of Speech Tagging -Named Entities –Named Entity Tagging

UNIT III CONTEXTUAL EMBEDDING 6

Constituency –Context Free Grammar –Lexicalized Grammars- CKY Parsing – Earley's algorithm-Evaluating Parsers -Partial Parsing – Dependency Relations- Dependency Parsing - Transition Based - Graph Based

UNIT IV COMPUTATIONAL SEMANTICS 6

Word Senses and WordNet – Word Sense Disambiguation – Semantic Role Labeling – Proposition Bank- FrameNet- Selectional Restrictions - Information Extraction - Template Filling

UNIT V DISCOURSE ANALYSIS AND SPEECH PROCESSING 6

Discourse Coherence – Discourse Structure Parsing – Centering and Entity Based Coherence – Question Answering –Factoid Question Answering – Classical QA Models – Chatbots and Dialogue systems – Frame-based Dialogue Systems – Dialogue–State Architecture

TOTAL : 30 PERIODS

SUGGESTED ACTIVITIES:

1. Probability and Statistics for NLP Problems
2. Carry out Morphological Tagging and Part-of-Speech Tagging for a sample text
3. Design a Finite State Automata for more Grammatical Categories
4. Problems associated with Vector Space Model
5. Hand Simulate the working of a HMM model
6. Examples for different types of work sense disambiguation
7. Give the design of a Chatbot

PRACTICAL EXERCISES:

PERIODS : 30

1. Download nltk and packages. Use it to print the tokens in a document and the sentences from it.
2. Include custom stop words and remove them and all stop words from a given document using nltk or spaCY package
3. Implement a stemmer and a lemmatizer program.
4. Implement a simple Part-of-Speech Tagger
5. Write a program to calculate TFIDF of documents and find the cosine similarity between any two documents.
6. Use nltk to implement a dependency parser.
7. Implement a semantic language processor that uses WordNet for semantic tagging.
8. Project - (in Pairs) Your project must use NLP concepts and apply them to some data.
 - a. Your project may be a comparison of several existing systems, or it may propose a new system in which case you still must compare it to at least one other approach.
 - b. You are free to use any third-party ideas or code that you wish as long as it is publicly available.
 - c. You must properly provide references to any work that is not your own in the write-up.
 - d. Project proposal You must turn in a brief project proposal. Your project proposal should describe the idea behind your project. You should also briefly describe software you will need to write, and papers (2-3) you plan to read.

List of Possible Projects

1. Sentiment Analysis of Product Reviews
2. Information extraction from News articles
3. Customer support bot
4. Language identifier
5. Media Monitor
6. Paraphrase Detector
7. Identification of Toxic Comment
8. Spam Mail Identification

COURSE OUTCOMES:

CO1: Understand basics of linguistics, probability and statistics associated with NLP

CO2: Implement a Part-of-Speech Tagger

CO3: Design and implement a sequence labeling problem for a given domain

CO4: Implement semantic processing tasks and simple document indexing and searching system using the concepts of NLP

CO5:: Implement a simple chatbot using dialogue system concepts

TOTAL : 60 PERIODS

REFERENCES

1. Daniel Jurafsky and James H.Martin, “Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech Recognition” (Prentice Hall Series in Artificial Intelligence), 2020
2. Jacob Eisenstein. “Natural Language Processing “, MIT Press, 2019
3. Samuel Burns “Natural Language Processing: A Quick Introduction to NLP with Python and NLTK, 2019
4. Christopher Manning, “Foundations of Statistical Natural Language Processing”, MIT Press, 2009.
5. Nitin Indurkha, Fred J. Damerau, “Handbook of Natural Language Processing”, Second edition, Chapman & Hall/CRC: Machine Learning & Pattern Recognition, Hardcover, 2010
6. Deepti Chopra, Nisheeth Joshi, “Mastering Natural Language Processing with Python”, Packt Publishing Limited, 2016
7. Mohamed Zakaria Kurdi “Natural Language Processing and Computational Linguistics: Speech, Morphology and Syntax (Cognitive Science)”, ISTE Ltd., 2016
8. Atefeh Farzindar, Diana Inkpen, “Natural Language Processing for Social Media (Synthesis Lectures on Human Language Technologies)”, Morgan and Claypool Life Sciences, 2015

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	-	2	3	1	1	-
2	2	2	2	3	-	3
3	3	-	3	3	-	3
4	1	-	2	3	-	3
5	1	-	2	3	-	3
Avg	1.75	2	2.4	2.6	1	3

IF4093

GPU COMPUTING

**L T P C
3 0 0 3**

COURSE OBJECTIVES:

- To understand the basics of GPU architectures
- To understand CPU GPU Program Partitioning
- To write programs for massively parallel processors
- To understand the issues in mapping algorithms for GPUs
- To introduce different GPU programming models

UNIT I GPU ARCHITECTURE 9

Evolution of GPU architectures - Understanding Parallelism with GPU –Typical GPU Architecture - CUDA Hardware Overview - Threads, Blocks, Grids, Warps, Scheduling - Memory Handling with CUDA: Shared Memory, Global Memory, Constant Memory and Texture Memory.

UNIT II CUDA PROGRAMMING 9

Using CUDA - Multi GPU - Multi GPU Solutions - Optimizing CUDA Applications: Problem Decomposition, Memory Considerations, Transfers, Thread Usage, Resource Contentions.

UNIT III PROGRAMMING ISSUES 9

Common Problems: CUDA Error Handling, Parallel Programming Issues, Synchronization, Algorithmic Issues, Finding and Avoiding Errors.

UNIT IV OPENCL BASICS 9

OpenCL Standard – Kernels – Host Device Interaction – Execution Environment – Memory Model – Basic OpenCL Examples.

UNIT V ALGORITHMS ON GPU 9

Parallel Patterns: Convolution, Prefix Sum, Sparse Matrix - Matrix Multiplication - Programming Heterogeneous Cluster.

SUGGESTED ACTIVITIES:

1. Debugging Lab
2. Performance Lab
3. Launching Nsight
4. Running Performance Analysis
5. Understanding Metrics
6. NVIDIA Visual Profiler
7. Matrix Transpose Optimization
8. Reduction Optimization

COURSE OUTCOMES:

CO1: Describe GPU Architecture

CO2: Write programs using CUDA, identify issues and debug them

CO3: Implement efficient algorithms in GPUs for common application kernels, such as matrix multiplication

CO4: Write simple programs using OpenCL

CO5: Identify efficient parallel programming patterns to solve problems

TOTAL: 45 PERIODS

REFERENCES

1. Shane Cook, CUDA Programming: “A Developer's Guide to Parallel Computing with GPUs (Applications of GPU Computing), First Edition, Morgan Kaufmann, 2012.
2. David R. Kaeli, Perhaad Mistry, Dana Schaa, Dong Ping Zhang, “Heterogeneous computing with OpenCL, 3rd Edition, Morgan Kauffman, 2015.
3. Nicholas Wilt, “CUDA Handbook: A Comprehensive Guide to GPU Programming, Addison - Wesley, 2013.
4. Jason Sanders, Edward Kandrot, “CUDA by Example: An Introduction to General Purpose

GPU Programming, Addison - Wesley, 2010.

5. David B. Kirk, Wen-mei W. Hwu, Programming Massively Parallel Processors - A Hands-on Approach, Third Edition, Morgan Kaufmann, 2016.
6. http://www.nvidia.com/object/cuda_home_new.html
7. <http://www.openCL.org>

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	3	-	-	-	-	-
2	-	-	2	-	-	-
3	-	-	3	-	3	3
4	-	2	-	3	2	-
5	-	-	-	2	-	3
Avg	3	2	2.5	2.5	2.5	3

IF4073

DEVOPS AND MICROSERVICES

L T P C
3 0 2 4

COURSE OBJECTIVES:

- To learn the basic concepts and terminology of DevOps
- To gain knowledge on DevOps platform
- To understand building and deployment of code
- To be familiar with DevOps automation tools
- To learn basics of MLOps

UNIT I INTRODUCTION

9+6

Software Engineering - traditional and Agile process models - DevOps -Definition - Practices - DevOps life cycle process - need for DevOps –Barriers

UNIT II DEVOPS PLATFORM AND SERVICES

9+6

Cloud as a platform - IaaS, PaaS, SaaS - Virtualization - Containers –Supporting Multiple Data Centers - Operation Services - Hardware provisioning- software Provisioning - IT services - SLA - capacity planning - security - Service Transition - Service Operation Concepts.

UNIT III BUILDING , TESTING AND DEPLOYMENT

9+6

Microservices architecture - coordination model - building and testing - Deployment pipeline - Development and Pre-commit Testing -Build and Integration Testing - continuous integration - monitoring - security - Resources to Be Protected - Identity Management

UNIT IV DEVOPS AUTOMATION TOOLS

9+6

Infrastructure Automation- Configuration Management - Deployment Automation - Performance Management - Log Management -Monitoring.

UNIT V MLOPS**9+6**

MLOps - Definition - Challenges -Developing Models - Deploying to production - Model Governance - Real world examples

SUGGESTED ACTIVITIES:

1. Creating a new Git repository, cloning existing repository, Checking changes into a Git repository, Pushing changes to a Git remote, Creating a Git branch
2. Installing Docker container on windows/Linux, issuing docker commands
3. Building Docker Images for Python Application
4. Setting up Docker and Maven in Jenkins and First Pipeline Run
5. Running Unit Tests and Integration Tests in Jenkins Pipelines

COURSE OUTCOMES:**CO1:** Implement modern software Engineering process**CO2:** work with DevOps platform**CO3:** build, test and deploy code**CO4:** Explore DevOps tools**CO5:** Correlate MLOps concepts with real time examples**TOTAL:75 PERIODS****REFERENCES**

1. Len Bass, Ingo Weber and Liming Zhu, —"DevOps: A Software Architect's Perspective", Pearson Education, 2016
2. Joakim Verona - "Practical DevOps" - Packet Publishing , 2016
3. Viktor Farcic -"The DevOps 2.1 Toolkit: Docker Swarm" - Packet Publishing, 2017
4. Mark Treveil, and the Dataiku Team-"Introducing MLOps" - O'Reilly Media- 2020

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	3	2	1	2	3	-
2	3	2	-	--	3	-
3	3	2	2	3	2	3
4	3	2	1	2	3	-
5	3	2	2	1	2	3
Avg	3	2	1.5	2	2.6	3

MP4292**MOBILE APPLICATION DEVELOPMENT****L T P C****3 0 2 4****COURSE OBJECTIVES:**

- To facilitate students to understand android SDK
- To help students to gain basic understanding of Android application development

- To understand how to work with various mobile application development frameworks
- To inculcate working knowledge of Android Studio development tool
- To learn the basic and important design concepts and issues of development of mobile applications

UNIT I MOBILE PLATFORM AND APPLICATIONS 9

Mobile Device Operating Systems — Special Constraints & Requirements — Commercial Mobile Operating Systems — Software Development Kit: iOS, Android, BlackBerry, Windows Phone — MCommerce — Structure — Pros & Cons — Mobile Payment System — Security Issues

UNIT II INTRODUCTION TO ANDROID 9

Introduction to Android: The Android Platform, Android SDK, Eclipse Installation, Android Installation, Building you First Android application, Understanding Anatomy of Android Application, Android Manifest file.

UNIT III ANDROID APPLICATION DESIGN ESSENTIALS 9

Anatomy of Android applications, Android terminologies, Application Context, Activities, Services, Intents, Receiving and Broadcasting Intents, Android Manifest File and its common settings, Using Intent Filter, Permissions.

UNIT IV ANDROID USER INTERFACE DESIGN & MULTIMEDIA 9

User Interface Screen elements, Designing User Interfaces with Layouts, Drawing and Working with Animation. Playing Audio and Video, Recording Audio and Video, Using the Camera to Take and Process Pictures

UNIT V ANDROID APIS 9

Using Android Data and Storage APIs, Managing data using Sqlite, Sharing Data between Applications with Content Providers, Using Android Networking APIs, Using Android Web APIs, Using Android Telephony APIs, Deploying Android Application to the World.

TOTAL:45 PERIODS

LIST OF EXPERIMENTS: (30)

1. Develop an application that uses GUI components, Font, Layout Managers and event listeners.
2. Develop an application that makes use of databases
3. Develop a native application that uses GPS location information
4. Implement an application that creates an alert upon receiving a message
5. Develop an application that makes use of RSS Feed.
6. Create an application using Sensor Manager
7. Create an android application that converts the user input text to voice.
8. Develop a Mobile application for simple and day to day needs (Mini Project)

COURSE OUTCOMES:

CO1: Identify various concepts of mobile programming that make it unique from programming for other platforms

CO2: Create, test and debug Android application by setting up Android development

CO3: Demonstrate methods in storing, sharing and retrieving data in Android applications

CO4: Utilize rapid prototyping techniques to design and develop sophisticated mobile interfaces
CO5: Create interactive applications in android using databases with multiple activities including audio, video and notifications and deploy them in marketplace

TOTAL: 75 PERIODS

REFERENCES

1. Lauren Darcey and Shane Conder, "Android Wireless Application Development", Pearson Education, 2nd ed. (2011)
2. Google Developer Training, "Android Developer Fundamentals Course – Concept Reference", Google Developer Training Team, 2017.
3. Prasanth Kumar Pattnaik,Rajib Mall,"Fundamentals of Mobile Computing",PHI Learning Pvt.Ltd,New Delhi-2012
4. Reto Meier, "Professional Android 2 Application Development", Wiley India Pvt Ltd, 2010
5. Mark L Murphy, "Beginning Android", Wiley India Pvt Ltd, 2009
6. Dawn Griffiths and David Griffiths, "Head First Android Development", 1st Edition, O'Reilly SPD Publishers, 2015. ISBN-13: 978-9352131341
7. Erik Hellman, "Android Programming – Pushing the Limits", 1st Edition, Wiley India Pvt Ltd, 2014. ISBN-13: 978-8126547197.
8. Bill Phillips, Chris Stewart and Kristin Marsicano, "Android Programming: The Big Nerd Ranch Guide", 4th Edition, Big Nerd Ranch Guides, 2019. ISBN-13: 978-0134706054

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	3	2	-	3	3	-
2	3	1	1	3	-	2
3	3	2	3	3	3	1
4	3	1	1	2	-	3
5	3	2	2	3	3	3
Avg	3	1.6	1.75	2.8	3	2.25

IF4071

DEEP LEARNING

**L T P C
3 0 2 4**

COURSE OBJECTIVES:

- Develop and Train Deep Neural Networks.
- Develop a CNN, R-CNN, Fast R-CNN, Faster-R-CNN, Mask-RCNN for detection and recognition
- Build and train RNNs, work with NLP and Word Embeddings
- The internal structure of LSTM and GRU and the differences between them
- The Auto Encoders for Image Processing

UNIT I DEEP LEARNING CONCEPTS**6**

Fundamentals about Deep Learning. Perception Learning Algorithms. Probabilistic modelling. Early Neural Networks. How Deep Learning different from Machine Learning. Scalars. Vectors. Matrixes, Higher Dimensional Tensors. Manipulating Tensors. Vector Data. Time Series Data. Image Data. Video Data.

UNIT II NEURAL NETWORKS**9**

About Neural Network. Building Blocks of Neural Network. Optimizers. Activation Functions. Loss Functions. Data Pre-processing for neural networks, Feature Engineering. Overfitting and Underfitting. Hyperparameters.

UNIT III CONVOLUTIONAL NEURAL NETWORK**10**

About CNN. Linear Time Invariant. Image Processing Filtering. Building a convolutional neural network. Input Layers, Convolution Layers. Pooling Layers. Dense Layers. Backpropagation Through the Convolutional Layer. Filters and Feature Maps. Backpropagation Through the Pooling Layers. Dropout Layers and Regularization. Batch Normalization. Various Activation Functions. Various Optimizers. LeNet, AlexNet, VGG16, ResNet. Transfer Learning with Image Data. Transfer Learning using Inception Oxford VGG Model, Google Inception Model, Microsoft ResNet Model. R-CNN, Fast R-CNN, Faster R-CNN, Mask-RCNN, YOLO

UNIT VI NATURAL LANGUAGE PROCESSING USING RNN**10**

About NLP & its Toolkits. Language Modeling . Vector Space Model (VSM). Continuous Bag of Words (CBOW). Skip-Gram Model for Word Embedding. Part of Speech (PoS) Global Co-occurrence Statistics–based Word Vectors. Transfer Learning. Word2Vec. Global Vectors for Word Representation GloVe. Backpropagation Through Time. Bidirectional RNNs (BRNN) . Long Short Term Memory (LSTM). Bi-directional LSTM. Sequence-to-Sequence Models (Seq2Seq). Gated recurrent unit GRU.

UNIT V DEEP REINFORCEMENT & UNSUPERVISED LEARNING**10**

About Deep Reinforcement Learning. Q-Learning. Deep Q-Network (DQN). Policy Gradient Methods. Actor-Critic Algorithm. About Autoencoding. Convolutional Auto Encoding. Variational Auto Encoding. Generative Adversarial Networks. Autoencoders for Feature Extraction. Auto Encoders for Classification. Denoising Autoencoders. Sparse Autoencoders

LIST OF EXPERIMENTS:**30**

1. Feature Selection from Video and Image Data
2. Image and video recognition
3. Image Colorization
4. Aspect Oriented Topic Detection & Sentiment Analysis
5. Object Detection using Autoencoder

COURSE OUTCOMES:**CO1:** Feature Extraction from Image and Video Data**CO2:** Implement Image Segmentation and Instance Segmentation in Images**CO3:** Implement image recognition and image classification using a pretrained network (Transfer Learning)**CO4:** Traffic Information analysis using Twitter Data**CO5:** Autoencoder for Classification & Feature Extraction

REFERENCES

1. Deep Learning A Practitioner's Approach Josh Patterson and Adam Gibson O'Reilly Media, Inc.2017
2. Learn Keras for Deep Neural Networks, Jojo Moolayil, Apress,2018
3. Deep Learning Projects Using TensorFlow 2, Vinita Silaparasetty, Apress, 2020
4. Deep Learning with Python, FRANÇOIS CHOLLET, MANNING SHELTER ISLAND,2017
5. Pro Deep Learning with TensorFlow, Santanu Pattanayak, Apress,2017

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	2	2	-	3	3	3
2	2	2	2	3	3	2
3	2	2	2	3	2	3
4	2	2	1	3	3	3
5	2	2	-	3	2	2
Avg	2	2	1.6	3	2.6	2.6

CP4072

BLOCKCHAIN TECHNOLOGIES**L T P C**
3 0 2 4**COURSE OBJECTIVES:**

- This course is intended to study the basics of Blockchain technology.
- During this course the learner will explore various aspects of Blockchain technology like application in various domains.
- By implementing, learners will have idea about private and public Blockchain, and smart contract.

UNIT I INTRODUCTION OF CRYPTOGRAPHY AND BLOCKCHAIN**9**

Introduction to Blockchain, Blockchain Technology Mechanisms & Networks, Blockchain Origins, Objective of Blockchain, Blockchain Challenges, Transactions and Blocks, P2P Systems, Keys as Identity, Digital Signatures, Hashing, and public key cryptosystems, private vs. public Blockchain.

UNIT II BITCOIN AND CRYPTOCURRENCY**9**

Introduction to Bitcoin, The Bitcoin Network, The Bitcoin Mining Process, Mining Developments, Bitcoin Wallets, Decentralization and Hard Forks, Ethereum Virtual Machine (EVM), Merkle Tree, Double-Spend Problem, Blockchain and Digital Currency, Transactional Blocks, Impact of Blockchain Technology on Cryptocurrency.

UNIT III INTRODUCTION TO ETHEREUM**9**

Introduction to Ethereum, Consensus Mechanisms, Metamask Setup, Ethereum Accounts, , Transactions, Receiving Ethers, Smart Contracts.

UNIT-IV INTRODUCTION TO HYPERLEDGER AND SOLIDITY PROGRAMMING 10

Introduction to Hyperledger, Distributed Ledger Technology & its Challenges, Hyperledger & Distributed Ledger Technology, Hyperledger Fabric, Hyperledger Composer. Solidity - Language of Smart Contracts, Installing Solidity & Ethereum Wallet, Basics of Solidity, Layout of a Solidity Source File & Structure of Smart Contracts, General Value Types.

UNIT V BLOCKCHAIN APPLICATIONS 8

Internet of Things, Medical Record Management System, Domain Name Service and Future of Blockchain, Alt Coins.

TOTAL: 45 PERIODS

LIST OF EXPERIMENTS:

1. Create a Simple Blockchain in any suitable programming language.
2. Use Geth to Implement Private Ethereum Block Chain.
3. Build Hyperledger Fabric Client Application.
4. Build Hyperledger Fabric with Smart Contract.
5. Create Case study of Block Chain being used in illegal activities in real world.
6. Using Python Libraries to develop Block Chain Application.

TOTAL: 30 PERIODS

SUPPLEMENTARY RESOURCES:

- NPTEL online course : <https://nptel.ac.in/courses/106/104/106104220/#>
- Udemy: <https://www.udemy.com/course/build-your-blockchain-az/>
- EDUXLABS Online training :<https://eduxlabs.com/courses/blockchain-technology-training/?tab=tab-curriculum>

TOTAL: 75 PERIODS

COURSE OUTCOMES:

After the completion of this course, student will be able to

CO1: Understand and explore the working of Blockchain technology

CO2: Analyze the working of Smart Contracts

CO3: Understand and analyze the working of Hyperledger

CO4: Apply the learning of solidity to build de-centralized apps on Ethereum

CO5: Develop applications on Blockchain

REFERENCES:

1. Imran Bashir, "Mastering Blockchain: Distributed Ledger Technology, Decentralization, and Smart Contracts Explained", Second Edition, Packt Publishing, 2018.
2. Narayanan, J. Bonneau, E. Felten, A. Miller, S. Goldfeder, "Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction" Princeton University Press, 2016
3. Antonopoulos, Mastering Bitcoin, O'Reilly Publishing, 2014. .
4. Antonopoulos and G. Wood, "Mastering Ethereum: Building Smart Contracts and Dapps", O'Reilly Publishing, 2018.
5. D. Drescher, Blockchain Basics. Apress, 2017.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	2	1	3	2	2	3
2	2	1	2	3	2	2
3	2	1	3	1	2	1
4	2	1	2	3	2	2
5	-	-	-	-	-	-
Avg	2.00	1.00	2.50	2.25	2.00	2.00

SE4073

EMBEDDED SOFTWARE DEVELOPMENT

L T P C

3 0 2 4

COURSE OBJECTIVES:

- To understand the architecture of embedded processor, microcontroller, and peripheral devices.
- To interface memory and peripherals with embedded systems.
- To study the embedded network environment.
- To understand challenges in Real time operating systems.
- To study, analyse and design applications on embedded systems.

UNIT I EMBEDDED PROCESSORS

9+6

Embedded Computers – Characteristics of Embedded Computing Applications – Challenges in Embedded Computing System Design – Embedded System Design Process- Formalism for System Design – Structural Description – Behavioural Description – ARM Processor – Intel ATOM Processor.

UNIT II EMBEDDED COMPUTING PLATFORM

9+6

CPU Bus Configuration – Memory Devices and Interfacing – Input/Output Devices and Interfacing – System Design – Development and Debugging – Emulator – Simulator – JTAG Design Example – Alarm Clock – Analysis and Optimization of Performance – Power and Program Size.

UNIT III EMBEDDED NETWORK ENVIRONMENT

9+6

Distributed Embedded Architecture – Hardware And Software Architectures – Networks for Embedded Systems – I2C – CAN Bus – SHARC Link Supports – Ethernet – Myrinet – Internet – Network-based Design – Communication Analysis – System Performance Analysis – Hardware Platform Design – Allocation and Scheduling – Design Example – Elevator Controller.

UNIT IV REAL-TIME CHARACTERISTICS

9+6

Clock Driven Approach – Weighted Round Robin Approach – Priority Driven Approach – Dynamic versus Static Systems – Effective Release Times and Deadlines – Optimality of the Earliest Deadline First (EDF) Algorithm – Challenges in Validating Timing Constraints in Priority Driven Systems – Off-Line versus On-Line Scheduling.

UNIT V SYSTEM DESIGN TECHNIQUES

9+6

Design Methodologies – Requirement Analysis – Specification – System Analysis and Architecture Design – Quality Assurance – Design Examples – Telephone PBX – Ink jet printer – Personal Digital Assistants – Set-Top Boxes.

SUGGESTED ACTIVITIES:

1. Study of ARM evaluation system
2. Interfacing ADC and DAC.
3. Interfacing LED and PWM.
4. Interfacing real time clock and serial port.
5. Interfacing keyboard and LCD.
6. Interfacing EPROM and interrupt.
7. Principles of Mailbox.
8. Interrupt performance characteristics of ARM and FPGA.
9. Flashing of LEDs.
10. Interfacing stepper motor and temperature sensor.

COURSE OUTCOMES:

CO1: Understand different architectures of embedded processor, microcontroller and peripheral devices. Interface memory and peripherals with embedded systems.

CO2: Interface memory and peripherals with embedded systems.

CO3: Work with embedded network environment.

CO4: Understand challenges in Real time operating systems.

CO5: Design and analyse applications on embedded systems.

TOTAL:75 PERIODS

REFERENCES

1. Adrian McEwen, Hakim Cassimally, "Designing the Internet of Things" Wiley Publication, First edition, 2013
2. Andrew N Sloss, D. Symes, C. Wright, Arm system developers guide, Morgan Kaufman/Elsevier, 2006.
3. ArshdeepBahga, Vijay Madiseti, " Internet of Things: A Hands-on-Approach" VPT First Edition, 2014
4. C. M. Krishna and K. G. Shin, "Real-Time Systems , McGraw-Hill, 1997
5. Frank Vahid and Tony Givargis, "Embedded System Design: A Unified Hardware/Software Introduction, John Wiley & Sons.1999
6. Jane.W.S. Liu, "Real-Time systems, Pearson Education Asia,2000
7. Michael J. Pont, "Embedded C, Pearson Education, 2007.
8. Muhammad Ali Mazidi , SarmadNaimi , SepehrNaimi, "The AVR Microcontroller and Embedded Systems: Using Assembly and C" Pearson Education, First edition, 2014
9. Steve Heath, "Embedded System Design, Elsevier, 2005
10. Wayne Wolf, "Computers as Components:Principles of Embedded Computer System Design, Elsevier, 2006.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	2	-	3	2	-	-
2	-	-	-	3	3	2
3	-	1	2	1	2	2
4	2	2	-	-	3	-
5	3	3	1	-	1	-
Avg	1.3	2	2	2	2.25	2

IF4291

FULL STACK WEB APPLICATION DEVELOPMENT

L T P C
3 0 2 4

COURSE OBJECTIVES:

- Develop TypeScript Application
- Develop Single Page Application (SPA)
- Able to communicate with a server over the HTTP protocol
- Learning all the tools need to start building applications with Node.js
- Implement the Full Stack Development using MEAN Stack

UNIT I FUNDAMENTALS & TYPESCRIPT LANGUAGE

10

Server-Side Web Applications. Client-Side Web Applications. Single Page Application. About TypeScript. Creating TypeScript Projects. TypeScript Data Types. Variables. Expression and Operators. Functions. OOP in Typescript. Interfaces. Generics. Modules. Enums. Decorators. Enums. Iterators. Generators.

UNIT II ANGULAR

10

About Angular. Angular CLI. Creating an Angular Project. Components. Components Interaction. Dynamic Components. Angular Elements. Angular Forms. Template Driven Forms. Property, Style, Class and Event Binding. Two way Bindings. Reactive Forms. Form Group. Form Controls. About Angular Router. Router Configuration. Router State. Navigation Pages. Router Link. Query Parameters. URL matching. Matching Strategies. Services. Dependency Injection. HttpClient. Read Data from the Server. CRUD Operations. Http Header Operations. Intercepting requests and responses.

UNIT III NODE.js

10

About Node.js. Configuring Node.js environment. Node Package Manager NPM. Modules. Asynchronous Programming. Call Stack and Event Loop. Callback functions. Callback errors. Abstracting callbacks. Chaining callbacks. File System. Synchronous vs. asynchronous I/O. Path and directory operations. File Handle. File Synchronous API. File Asynchronous API. File Callback API. Timers. Scheduling Timers. Timers Promises API. Node.js Events. Event Emitter. Event Target and Event API. Buffers. Buffers and TypedArrays. Buffers and iteration. Using buffers for binary data. Flowing vs. non-flowing streams. JSON.

UNIT IV EXPRESS.Js**7**

Express.js. How Express.js Works. Configuring Express.js App Settings. Defining Routes. Starting the App. Express.js Application Structure. Configuration, Settings. Middleware. body-parser. cookie-parser. express-session. response-time. Template Engine. Jade. EJS. Parameters. Routing. router.route(path). Router Class. Request Object. Response Object. Error Handling. RESTful.

UNIT V MONGODB**8**

Introduction to MongoDB. Documents. Collections. Subcollections. Database. Data Types. Dates. Arrays. Embedded Documents. CRUD Operations. Batch Insert. Insert Validation. Querying The Documents. Cursors. Indexing. Unique Indexes. Sparse Indexes. Special Index and Collection Types. Full-Text Indexes. Geospatial Indexing. Aggregation framework.

LIST OF EXPERIMENTS**30**

1. Accessing the Weather API from Angular
2. Accessing the Stock Market API from Angular
3. Call the Web Services of Express.js From Angular
4. Read the data in Node.js from MongoDB
5. CRUD operation in MongoDB using Angular

COURSE OUTCOMES:

CO1: Develop basic programming skills using Javascript

CO2: Implement a front-end web application using Angular.

CO3: Will be able to create modules to organise the server

CO4: Build RESTful APIs with Node, Express and MongoDB with confidence.

CO5: Will learn to Store complex, relational data in MongoDB using Mongoose

TOTAL : 45 + 30=75 PERIODS**REFERENCES**

1. Adam Freeman, Essential TypeScript, Apress, 2019
2. Mark Clow, Angular Projects, Apress, 2018
3. Alex R. Young, Marc Harter, Node.js in Practice, Manning Publication, 2014
4. Pro Express.js, Azat Mardan, Apress, 2015
5. MongoDB in Action, Kyle Banker, Peter Bakkum, Shaun Verch, Douglas Garrett, Tim Hawkins, Manning Publication, Second edition, 2016

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	-	-	2	3	3	3
2	-	-	2	3	3	3
3	2	-	1	-	3	3

4	2	-	2	-	3	3
5	3	3	-	-	3	3
Avg	2.33	3	1.75	3	3	3

CP4071

BIO INFORMATICS

L T P C
3 0 2 4

COURSE OBJECTIVES:

- Exposed to the need for Bioinformatics technologies
- Be familiar with the modeling techniques
- Learn microarray analysis
- Exposed to Pattern Matching and Visualization
- To know about Microarray Analysis

UNIT I INTRODUCTION

9

Need for Bioinformatics technologies – Overview of Bioinformatics technologies
Structural bioinformatics – Data format and processing – Secondary resources and applications –
Role of Structural bioinformatics – Biological Data Integration System.

UNIT II DATAWAREHOUSING AND DATAMINING IN BIOINFORMATICS

9

Bioinformatics data – Data warehousing architecture – data quality – Biomedical data analysis –
DNA data analysis – Protein data analysis – Machine learning – Neural network architecture
and applications in bioinformatics.

UNIT III MODELING FOR BIOINFORMATICS

9

Hidden Markov modeling for biological data analysis – Sequence identification –
Sequence classification – multiple alignment generation – Comparative modeling –Protein
modeling – genomic modeling – Probabilistic modeling – Bayesian networks – Boolean networks –
Molecular modeling – Computer programs for molecular modeling.

UNIT IV PATTERN MATCHING AND VISUALIZATION

9

Gene regulation – motif recognition – motif detection – strategies for motif detection – Visualization
– Fractal analysis – DNA walk models – one dimension – two dimension – higher dimension –
Game representation of biological sequences – DNA, Protein, Amino acid sequences.

UNIT V MICROARRAY ANALYSIS

9

Microarray technology for genome expression study – image analysis for data extraction –
preprocessing – segmentation – gridding – spot extraction – normalization, filtering – cluster
analysis – gene network analysis – Compared Evaluation of Scientific Data Management Systems
– Cost Matrix – Evaluation model – Benchmark – Tradeoffs.

TOTAL: 45 PERIODS

LIST OF EXPERIMENTS:

1. Manipulating DNA strings
2. Use Protein Data Bank to visualize and Analyze the Proteins from protein database
3. Explore the Human Genome with the SciPy Stack

4. Hidden Markov Model for Biological Sequence
5. Molecular Modeling using MMTK package
6. Sequence Alignment using Biopython, Pairwise and multiple sequence alignment using ClustalW and BLAST
7. Simple generation and manipulation of genome graphs
8. DNA data handling using Biopython
9. Chaos Game Representation of a genetic sequence
10. Visualize the microarray data using Heatmap

TOTAL: 30 PERIODS

COURSE OUTCOMES:

CO1: Understand the different Data formats

CO2: Develop machine learning algorithms.

CO3: Develop models for biological data.

CO4: Apply pattern matching techniques to bioinformatics data – protein data genomic data.

CO5: Apply micro array technology for genomic expression study.

TOTAL: 45 +30=75 PERIODS

REFERENCES

1. Yi-Ping Phoebe Chen (Ed), "Bioinformatics Technologies", First Indian Reprint, Springer Verlag, 2007.
2. Bryan Bergeron, "Bio Informatics Computing", Second Edition, Pearson Education, 2015.
3. Arthur M Lesk, "Introduction to Bioinformatics", Second Edition, Oxford University Press, 2019

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	1	1	-	-	-	3
2	1	1	2	2	1	2
3	1	2	1	1	3	3
4	1	2	2	2	2	2
5	1	2	1	-	2	3
Avg	1.00	1.60	1.50	1.67	2.00	2.60

MP4291

CYBER PHYSICAL SYSTEMS

**L T P C
3 0 2 4**

COURSE OBJECTIVES:

- To learn about the principles of cyber-physical systems
- To familiarize with the basic requirements of CPS.
- To know about CPS models
- To facilitate the students to understand the CPS foundations
- To make the students explore the applications and platforms.
- To provide introduction to practical aspects of cyber physical systems.
- To equip students with essential tools to implement CPS.

UNIT I INTRODUCTION TO CYBER-PHYSICAL SYSTEMS 6

Cyber-Physical Systems(CPS)-Emergence of CPS, Key Features of Cyber-Physical Systems,, CPS Drivers-Synchronous Model : Reactive Components, Properties of Components, Composing Components, Designs- Asynchronous Model of CPS: Processes, Design Primitives, Coordination Protocols

UNIT II CPS - REQUIREMENTS 12

Safety Specifications: Specifications, Verifying Invariants, Enumerative Search, Symbolic Search- Liveness Requirements: Temporal Logic, Model Checking, Proving Liveness

UNIT III CPS MODELS 9

Dynamical Systems: Continuous, Linear Systems-Time Models, Linear Systems, Designing Controllers, Analysis Techniques- Timed Model: Processes, Protocols, Automata- Hybrid Dynamical Models

UNIT IV CPS FOUNDATIONS 9

Symbolic Synthesis for CPS- Security in CPS-Synchronization of CPS-Real-Time Scheduling for CPS

UNIT V APPLICATIONS AND PLATFORMS 9

Medical CPS- CPS Built on Wireless Sensor Networks- CyberSim User Interface- iClebo Kobuki - iRobot Create- myRIO- Cybersim- Matlab toolboxes - Simulink.

LIST OF EXPERIMENTS (30)

1. Installation of Xilinx SDK, LABVIEW, MatLab and Cybersim
2. Installation of, myRIO iRobot Create Wiring, Kobuki Wiring
3. CPS DDesign with the iRobot Create
4. CPS Design with the Kobuki.
5. Write a program in MATLAB to implement open loop system stability.
6. Write a program in MATLAB to implement timed automation.

COURSE OUTCOMES:

CO1: Explain the core principles behind CPS

CO2: Discuss the requirements of CPS.

CO3: Explain the various models of CPS.

CO4: Describe the foundations of CPS.

CO5: Use the various platforms to implement the CPS.

TOTAL: 45+30=75 PERIODS

REFERENCES

1. Raj Rajkumar, Dionisio De Niz , and Mark Klein, Cyber-Physical Systems, Addison-Wesley Professional, 2016
2. Rajeev Alur, Principles of Cyber-Physical Systems, MIT Press, 2015.
3. Lee, Edward Ashford, and Sanjit Arunkumar Seshia. Introduction to embedded systems: A cyber physical systems approach. 2nd Edition, 2017
4. André Platzer, Logical Analysis of Hybrid Systems: Proving Theorems for Complex

Dynamics., Springer, 2010. 426 pages,ISBN 978-3-642-14508-7.

5. Jean J. Labrosse, Embedded Systems Building Blocks: Complete and Ready-To-Use Modules in C, The publisher, Paul Temme, 2011.
6. Jensen, Jeff, Lee, Edward, A Seshia, Sanjit, An Introductory Lab in Embedded and Cyber-Physical Systems, <http://leeseshia.org/lab>, 2014.
7. documentation | KOBUKI (yujinrobot.com)

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	3	3	3	-	1	-
2	2	2	2	-	1	--
3	-	-	3	1	-	1
4	-	-	3	1	-	1
5	2	-	2	3	3	3
Avg	2.3	2.5	2.6	1.7	1.7	1.7

MU4291

MIXED REALITY

**L T P C
3 0 2 4**

COURSE OBJECTIVES:

- To study about Fundamental Concept and Components of Virtual Reality
- To study about Interactive Techniques in Virtual Reality
- To study about Visual Computation in Virtual Reality
- To study about Augmented and Mixed Reality and Its Applications
- To know about I/O Interfaces and its functions.

UNIT I INTRODUCTION TO VIRTUAL REALITY

9

Introduction, Fundamental Concept and Components of Virtual Reality. Primary Features and Present Development on Virtual Reality. Computer graphics, Real time computer graphics, Flight Simulation, Virtual environment requirement, benefits of virtual reality, Historical development of VR, Scientific Landmark 3D Computer Graphics: Introduction, The Virtual world space, positioning the virtual observer, the perspective projection, human vision, stereo perspective projection, 3D clipping, Colour theory, Simple 3D modelling, Illumination models, Reflection models, Shading algorithms, Radiosity, Hidden Surface Removal, Realism Stereographic image.

Suggested Activities:

- Flipped classroom on uses of MR applications.
- Videos – Experience the virtual reality effect.
- Assignment on comparison of VR with traditional multimedia applications.

Suggested Evaluation Methods:

- Tutorial – Applications of MR.
- Quizzes on the displayed video and the special effects

UNIT II INTERACTIVE TECHNIQUES IN VIRTUAL REALITY 9

Introduction, from 2D to 3D, 3D spaces curves, 3D boundary representation Geometrical Transformations: Introduction, Frames of reference, Modeling transformations, Instances, Picking, Flying, Scaling the VE, Collision detection Generic VR system: Introduction, Virtual environment, Computer environment, VR technology, Model of interaction, VR Systems.

Suggested Activities:

- Flipped classroom on modeling three dimensional objects.
- External learning – Collision detection algorithms.
- Practical – Creating three dimensional models.

Suggested Evaluation Methods:

- Tutorial – Three dimensional modeling techniques.
- Brainstorming session on collision detection algorithms.
- Demonstration of three dimensional scene creation.

UNIT III VISUAL COMPUTATION IN VIRTUAL REALITY 9

Animating the Virtual Environment: Introduction, The dynamics of numbers, Linear and Nonlinear interpolation, the animation of objects, linear and non-linear translation, shape & object inbetweening, free from deformation, particle system. Physical Simulation: Introduction, Objects falling in a gravitational field, Rotating wheels, Elastic collisions, projectiles, simple pendulum, springs, Flight dynamics of an aircraft.

Suggested Activities:

- External learning – Different types of programming toolkits and Learn different types of available VR applications.
- Practical – Create VR scenes using any toolkit and develop applications.

Suggested Evaluation Methods:

- Tutorial – VR tool comparison.
- Brainstorming session on tools and technologies used in VR.
- Demonstration of the created VR applications.

UNIT IV AUGMENTED AND MIXED REALITY 9

Taxonomy, technology and features of augmented reality, difference between AR and VR, Challenges with AR, AR systems and functionality, Augmented reality methods, visualization techniques for augmented reality, wireless displays in educational augmented reality applications, mobile projection interfaces, marker-less tracking for augmented reality, enhancing interactivity in AR environments, evaluating AR systems

Suggested Activities:

- External learning - AR Systems

Suggested Evaluation Methods:

- Brainstorming session different AR systems and environments.

UNIT V I/O INTERFACE IN VR & APPLICATION OF VR 9

Human factors: Introduction, the eye, the ear, the somatic senses. VR Hardware: Introduction, sensor hardware, Head-coupled displays, Acoustic hardware, Integrated VR systems. VR Software: Introduction, Modeling virtual world, Physical simulation, VR toolkits, Introduction to

VRML, Input -- Tracker, Sensor, Digitalglobe, Movement Capture, Video-based Input, 3D Menus & 3DScanner etc. Output -- Visual /Auditory / Haptic Devices. VR Technology in Film & TV Production. VR Technology in Physical Exercises and Games. Demonstration of Digital Entertainment by VR.

Suggested Activities:

- External learning – Different types of sensing and tracking devices for creating mixed reality environments.
- Practical – Create MR scenes using any toolkit and develop applications.

Suggested Evaluation Methods:

- Tutorial – Mobile Interface Design.
- Brainstorming session on wearable computing devices and games design.
- Demonstration and evaluation of the developed MR application.

TOTAL: 45 PERIODS

PRACTICALS:

1. Study of tools like Unity, Maya, 3DS MAX, AR toolkit, Vuforia and Blender.
2. Use the primitive objects and apply various projection methods by handling the camera.
3. Download objects from asset stores and apply various lighting and shading effects.
4. Model three dimensional objects using various modeling techniques and apply textures over them.
5. Create three dimensional realistic scenes and develop simple virtual reality enabled mobile applications which have limited interactivity.
6. Add audio and text special effects to the developed application.
7. Develop VR enabled applications using motion trackers and sensors incorporating full haptic interactivity.
8. Develop AR enabled applications with interactivity like E learning environment, Virtual walkthroughs and visualization of historic places.
9. Develop MR enabled simple applications like human anatomy visualization, DNA/RNA structure visualization and surgery simulation.
10. Develop simple MR enabled gaming applications.

TOTAL: 30 PERIODS

COURSE OUTCOMES:

CO1: Understand the Fundamental Concept and Components of Virtual Reality

CO2: Able to know the Interactive Techniques in Virtual Reality

CO3: Can know about Visual Computation in Virtual Reality

CO4: Able to know the concepts of Augmented and Mixed Reality and Its Applications

CO5: Know about I/O Interfaces and its functions.

TOTAL:45+30=75 PERIODS

REFERENCES

1. Burdea, G. C. and P. Coffet. Virtual Reality Technology, Second Edition. Wiley-IEEE Press, 2003/2006.
2. Alan B. Craig, Understanding Augmented Reality, Concepts and Applications, Morgan Kaufmann, First Edition 2013.
3. Alan Craig, William Sherman and Jeffrey Will, Developing Virtual Reality Applications, Foundations of Effective Design, Morgan Kaufmann, 2009.
4. John Vince, "Virtual Reality Systems ", Pearson Education Asia, 2007.
5. Adams, "Visualizations of Virtual Reality", Tata McGraw Hill, 2000.
6. Grigore C. Burdea, Philippe Coiffet , "Virtual Reality Technology", Wiley Inter Science, 2nd

Edition, 2006.

7. William R. Sherman, Alan B. Craig, "Understanding Virtual Reality: Interface, Application and Design", Morgan Kaufmann, 2008

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	3	1	3	1	-	-
2	3	-	3	-	1	-
3	3	1	-	-	1	-
4	-	-	-	-	1	-
5	-	1	3	-	-	2
Avg	3	1	3	1	1	2

AUDIT COURSES

AX4091

ENGLISH FOR RESEARCH PAPER WRITING

L T P C
2 0 0 0

COURSE OBJECTIVES:

- Teach how to improve writing skills and level of readability
- Tell about what to write in each section
- Summarize the skills needed when writing a Title
- Infer the skills needed when writing the Conclusion
- Ensure the quality of paper at very first-time submission

UNIT I INTRODUCTION TO RESEARCH PAPER WRITING

6

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

UNIT II PRESENTATION SKILLS

6

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction

UNIT III TITLE WRITING SKILLS

6

Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check

UNIT IV RESULT WRITING SKILLS

6

Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions

UNIT V VERIFICATION SKILLS**6**

Useful phrases, checking Plagiarism, how to ensure paper is as good as it could possibly be the first- time submission

TOTAL: 30 PERIODS**COURSE OUTCOMES:**

- CO1 –Understand that how to improve your writing skills and level of readability
- CO2 – Learn about what to write in each section
- CO3 – Understand the skills needed when writing a Title
- CO4 – Understand the skills needed when writing the Conclusion
- CO5 – Ensure the good quality of paper at very first-time submission

REFERENCES:

1. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011
2. Day R How to Write and Publish a Scientific Paper, Cambridge University Press 2006
3. Goldbort R Writing for Science, Yale University Press (available on Google Books) 2006
4. Highman N, Handbook of Writing for the Mathematical Sciences, SIAM. Highman's
5. book 1998.

AX4092**DISASTER MANAGEMENT****L T P C
2 0 0 0****COURSE OBJECTIVES:**

- Summarize basics of disaster
- Explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- Illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- Describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
- Develop the strengths and weaknesses of disaster management approaches

UNIT I INTRODUCTION**6**

Disaster: Definition, Factors and Significance; Difference between Hazard And Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

UNIT II REPERCUSSIONS OF DISASTERS AND HAZARDS**6**

Economic Damage, Loss of Human and Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

UNIT III DISASTER PRONE AREAS IN INDIA**6**

Study of Seismic Zones; Areas Prone To Floods and Droughts, Landslides And Avalanches; Areas Prone To Cyclonic and Coastal Hazards with Special Reference To Tsunami; Post-Disaster Diseases and Epidemics

UNIT IV DISASTER PREPAREDNESS AND MANAGEMENT 6

Preparedness: Monitoring Of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological And Other Agencies, Media Reports: Governmental and Community Preparedness.

UNIT V RISK ASSESSMENT 6

Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival

TOTAL : 30 PERIODS

COURSE OUTCOMES:

CO1: Ability to summarize basics of disaster

CO2: Ability to explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.

CO3: Ability to illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.

CO4: Ability to describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.

CO5: Ability to develop the strengths and weaknesses of disaster management approaches

REFERENCES:

1. Goel S. L., Disaster Administration And Management Text And Case Studies", Deep & Deep Publication Pvt. Ltd., New Delhi,2009.
2. NishithaRai, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "New Royal book Company,2007.
3. Sahni, Pradeep Et.Al. ," Disaster Mitigation Experiences And Reflections", Prentice Hall OfIndia, New Delhi,2001.

AX4093

CONSTITUTION OF INDIA

L T P C

2 0 0 0

COURSE OBJECTIVES:

Students will be able to:

- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional
- Role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.
- To address the role of socialism in India after the commencement of the Bolshevik Revolution 1917 And its impact on the initial drafting of the Indian Constitution.

UNIT I HISTORY OF MAKING OF THE INDIAN CONSTITUTION

History, Drafting Committee, (Composition & Working)

UNIT II PHILOSOPHY OF THE INDIAN CONSTITUTION

Preamble, Salient Features

UNIT III CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES

Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

UNIT IV ORGANS OF GOVERNANCE

Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.

UNIT V LOCAL ADMINISTRATION

District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO, Municipal Corporation. Pachayati raj: Introduction, PRI: Zila Panchayat. Elected officials and their roles, CEO Zila Pachayat: Position and role. Block level: Organizational Hierarchy(Different departments), Village level:Role of Elected and Appointed officials, Importance of grass root democracy.

UNIT VI ELECTION COMMISSION

Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners - Institute and Bodies for the welfare of SC/ST/OBC and women.

TOTAL: 30 PERIODS

COURSE OUTCOMES:

Students will be able to:

- Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
- Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
- Discuss the circumstances surrounding the foundation of the Congress Socialist Party[CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
- Discuss the passage of the Hindu Code Bill of 1956.

SUGGESTED READING

1. The Constitution of India,1950(Bare Act),Government Publication.
2. Dr.S.N.Busi, Dr.B. R.Ambedkar framing of Indian Constitution,1st Edition, 2015.
3. M.P. Jain, Indian Constitution Law, 7th Edn., LexisNexis,2014.
4. D.D. Basu, Introduction to the Constitution of India, LexisNexis, 2015.

AX4094

நற்றமிழ் இலக்கியம்

**L T P C
2 0 0 0**

UNIT I

சங்க இலக்கியம்

6

1. தமிழின் துவக்க நூல் தொல்காப்பியம்
- எழுத்து, சொல், பொருள்
2. அகநானூறு (82)

- இயற்கை இன்னிசை அரங்கம்
- 3. குறிஞ்சிப் பாட்டின் மலர்க்காட்சி
- 4. புறநானூறு (95,195)
 - போரை நிறுத்திய ஔவையார்

UNIT II அறநெறித் தமிழ் 6

- 1. அறநெறி வகுத்த திருவள்ளுவர்
 - அறம் வலியுறுத்தல், அன்புடைமை, ஒப்புறவு அறிதல், ஈகை, புகழ்
- 2. பிற அறநூல்கள் - இலக்கிய மருந்து
 - ஏலாதி, சிறுபஞ்சமூலம், திரிகடுகம், ஆசாரக்கோவை (தூய்மையை வலியுறுத்தும் நூல்)

UNIT III இரட்டைக் காப்பியங்கள் 6

- 1. கண்ணகியின் புரட்சி
 - சிலப்பதிகார வழக்குரை காதை
- 2. சமூகசேவை இலக்கியம் மணிமேகலை
 - சிறைக்கோட்டம் அறக்கோட்டமாகிய காதை

UNIT IV அருள்நெறித் தமிழ் 6

- 1. சிறுபாணாற்றுப்படை
 - பாரி முல்லைக்குத் தேர் கொடுத்தது, பேகன் மயிலுக்குப் போர்வை கொடுத்தது, அதியமான் ஔவைக்கு நெல்லிக்கனி கொடுத்தது, அரசர் பண்புகள்
- 2. நற்றிணை
 - அன்னைக்குரிய புன்னை சிறப்பு
- 3. திருமந்திரம் (617, 618)
 - இயமம் நியமம் விதிகள்
- 4. தர்மச்சாலையை நிறுவிய வள்ளலார்
- 5. புறநானூறு
 - சிறுவனே வள்ளலானான்
- 6. அகநானூறு (4) - வண்டு
 நற்றிணை (11) - நண்டு
 கலித்தொகை (11) - யானை, புறா
 ஐந்திணை 50 (27) - மான்
 ஆகியவை பற்றிய செய்திகள்

UNIT V நவீன தமிழ் இலக்கியம் 6

- 1. உரைநடைத் தமிழ்,
 - தமிழின் முதல் புதினம்,
 - தமிழின் முதல் சிறுகதை,
 - கட்டுரை இலக்கியம்,
 - பயண இலக்கியம்,

- நாடகம்,
- 2. நாட்டு விடுதலை போராட்டமும் தமிழ் இலக்கியமும்,
- 3. சமுதாய விடுதலையும் தமிழ் இலக்கியமும்,
- 4. பெண் விடுதலையும் விளிம்பு நிலையினரின் மேம்பாட்டில் தமிழ் இலக்கியமும்,
- 5. அறிவியல் தமிழ்,
- 6. இணையத்தில் தமிழ்,
- 7. சுற்றுச்சூழல் மேம்பாட்டில் தமிழ் இலக்கியம்.

TOTAL: 30 PERIODS

தமிழ் இலக்கிய வெளியீடுகள் / புத்தகங்கள்

1. தமிழ் இணைய கல்விக்கழகம் (Tamil Virtual University)
- www.tamilvu.org
2. தமிழ் விக்கிப்பீடியா (Tamil Wikipedia)
-https://ta.wikipedia.org
3. தர்மபுர ஆதீன வெளியீடு
4. வாழ்வியல் களஞ்சியம்
- தமிழ்ப் பல்கலைக்கழகம், தஞ்சாவூர்
5. தமிழ்கலைக் களஞ்சியம்
- தமிழ் வளர்ச்சித் துறை (thamilvalarchithurai.com)
6. அறிவியல் களஞ்சியம்
- தமிழ்ப் பல்கலைக்கழகம், தஞ்சாவூர்

OCE431

INTEGRATED WATER RESOURCES MANAGEMENT

**LT P C
3 0 0 3**

OBJECTIVE

- Students will be introduced to the concepts and principles of IWRM, which is inclusive of the economics, public-private partnership, water & health, water & food security and legal & regulatory settings.

UNIT I

CONTEXT FOR IWRM

9

Water as a global issue: key challenges – Definition of IWRM within the broader context of development – Key elements of IWRM - Principles – Paradigm shift in water management - Complexity of the IWRM process – UN World Water Assessment - SDGs.

UNIT II

WATER ECONOMICS

9

Economic view of water issues: economic characteristics of water good and services – Non-market monetary valuation methods – Water economic instruments – Private sector involvement in water resources management: PPP objectives, PPP models, PPP processes, PPP experiences through case studies.

UNIT III

LEGAL AND REGULATORY SETTINGS

9

Basic notion of law and governance: principles of international and national law in the area of water management - Understanding UN law on non-navigable uses of international water courses –

International law for groundwater management – World Water Forums – Global Water Partnerships - Development of IWRM in line with legal and regulatory framework.

UNIT IV WATER AND HEALTH WITHIN THE IWRM CONTEXT 9

Links between water and health: options to include water management interventions for health – Health protection and promotion in the context of IWRM – Global burden of Diseases - Health impact assessment of water resources development projects – Case studies.

UNIT V AGRICULTURE IN THE CONCEPT OF IWRM 9

Water for food production: ‘blue’ versus ‘green’ water debate – Water foot print - Virtual water trade for achieving global water and food security -- Irrigation efficiencies, irrigation methods - current water pricing policy– scope to relook pricing.

TOTAL: 45 PERIODS

OUTCOMES

- On completion of the course, the student is expected to be able to

CO1 Describe the context and principles of IWRM; Compare the conventional and integrated ways of water management.

CO2 Select the best economic option among the alternatives; illustrate the pros and cons of PPP through case studies.

CO3 Apply law and governance in the context of IWRM.

CO4 Discuss the linkages between water-health; develop a HIA framework.

CO5 Analyse how the virtual water concept pave way to alternate policy options.

REFERENCES:

1. Cech Thomas V., Principles of water resources: history, development, management and policy. John Wiley and Sons Inc., New York. 2003.
2. Mollinga .P. etal “ Integrated Water Resources Management”, Water in South Asia Volume I, Sage Publications, 2006.
3. Technical Advisory Committee, Integrated Water Resources management, Technical Advisory Committee Background Paper No: 4. Global water partnership, Stockholm, Sweden. 2002.
4. Technical Advisory Committee, Dublin principles for water as reflected in comparative assessment of institutional and legal arrangements for Integrated Water Resources Management, Technical Advisory Committee Background paper No: 3. Global water partnership, Stockholm, Sweden. 1999.
5. Technical Advisory Committee, Effective Water Governance”. Technical Advisory Committee Background paper No: 7. Global water partnership, Stockholm, Sweden, 2003.

OCE432

WATER, SANITATION AND HEALTH

L T P C

3 0 0 3

OBJECTIVES:

- Understand the accelerating health impacts due to the present managerial aspects and initiatives in water and sanitation and health sectors in the developing scenario

4. Sen, Amartya 1997. On Economic Inequality. Enlarged edition, with annex by James Foster and Amartya Sen, Oxford: Clarendon Press, 1997.
5. Intersectoral Water Allocation Planning and Management, 2000, World Bank Publishers www. Amazon.com
6. Third World Network.org (www.twn.org).

OCE433

PRINCIPLES OF SUSTAINABLE DEVELOPMENT

**L T P C
3 0 0 3**

OBJECTIVES:

- To impart knowledge on environmental, social and economic dimensions of sustainability and the principles evolved through landmark events so as to develop an action mindset for sustainable development.

UNIT I SUSTAINABILITY AND DEVELOPMENT CHALLENGES 9

Definition of sustainability – environmental, economical and social dimensions of sustainability - sustainable development models – strong and weak sustainability – defining development-millennium development goals – mindsets for sustainability: earthly, analytical, precautionary, action and collaborative– syndromes of global change: utilisation syndromes, development syndromes, and sink syndromes – core problems and cross cutting Issues of the 21 century - global, regional and local environmental issues – social insecurity - resource degradation –climate change – desertification.

UNIT II PRINCIPLES AND FRAME WORK 9

History and emergence of the concept of sustainable development - our common future - Stockholm to Rio plus 20– Rio Principles of sustainable development – Agenda 21 natural step-peoples earth charter – business charter for sustainable development –UN Global Compact - Role of civil society, business and government – United Nations’ 2030 Agenda for sustainable development – 17 sustainable development goals and targets, indicators and intervention areas

UNIT III SUSTAINABLE DEVELOPMENT AND WELLBEING 9

The Unjust World and inequities - Quality of Life - Poverty, Population and Pollution - Combating Poverty - - Demographic dynamics of sustainability - Strategies to end Rural and Urban Poverty and Hunger – Sustainable Livelihood Framework- Health, Education and Empowerment of Women, Children, Youth, Indigenous People, Non-Governmental Organizations, Local Authorities and Industry for Prevention, Precaution , Preservation and Public participation.

UNIT IV SUSTAINABLE SOCIO-ECONOMIC SYSTEMS 10

Sustainable Development Goals and Linkage to Sustainable Consumption and Production – Investing in Natural Capital- Agriculture, Forests, Fisheries - Food security and nutrition and sustainable agriculture- Water and sanitation - Biodiversity conservation and Ecosystem integrity – Ecotourism - Sustainable Cities – Sustainable Habitats- Green Buildings - Sustainable Transportation — Sustainable Mining - Sustainable Energy– Climate Change –Mitigation and Adaptation - Safeguarding Marine Resources - Financial Resources and Mechanisms

UNIT V ASSESSING PROGRESS AND WAY FORWARD

8

Nature of sustainable development strategies and current practice- Sustainability in global, regional and national context –Approaches to measuring and analysing sustainability– limitations of GDP- Ecological Footprint- Human Development Index- Human Development Report – National initiatives for Sustainable Development - Hurdles to Sustainability - Science and Technology for sustainable development –Performance indicators of sustainability and Assessment mechanism – Inclusive Green Growth and Green Economy – National Sustainable Development Strategy Planning and National Status of Sustainable Development Goals

TOTAL: 45 PERIODS

OUTCOMES:

- On completion of the course, the student is expected to be able to
 - CO1 Explain and evaluate current challenges to sustainability, including modern world social, environmental, and economic structures and crises.
 - CO2 Identify and critically analyze the social environmental, and economic dimensions of sustainability in terms of UN Sustainable development goals
 - CO3 Develop a fair understanding of the social, economic and ecological linkage of Human well being, production and consumption
 - CO4 Evaluate sustainability issues and solutions using a holistic approach that focuses on connections between complex human and natural systems.
 - CO5 Integrate knowledge from multiple sources and perspectives to understand environmental limits governing human societies and economies and social justice dimensions of sustainability.

REFERENCES:

1. Tom Theis and Jonathan Tomkin, Sustainability: A Comprehensive Foundation, Rice University, Houston, Texas, 2012
2. A guide to SDG interactions:from science to implementation, International Council for Science, Paris,2017
3. Karel Mulder, Sustainable Development for Engineers - A Handbook and Resource Guide, Rouledge Taylor and Francis, 2017.
4. The New Global Frontier - Urbanization, Poverty and Environmentin the 21st Century - *George Martine,Gordon McGranahan,Mark Montgomery and Rogelio Fernández-Castilla*, IIED and UNFPA, Earthscan, UK, 2008
5. Nolberto Munier, Introduction to Sustainability: Road to a Better Future, Springer, 2006
6. Barry Dalal Clayton and Stephen Bass, Sustainable Development Strategies- a resource book”, Earthscan Publications Ltd, London, 2002.

OCE434

ENVIRONMENTAL IMPACT ASSESSMENT

L T P C

3 0 0 3

OBJECTIVES:

- To make the students to understand environmental clearance, its legal requirements and to provide knowledge on overall methodology of EIA, prediction tools and models, environmental management plan and case studies.

UNIT I INTRODUCTION

9

Historical development of Environmental Impact Assessment (EIA). Environmental Clearance- EIA in project cycle. legal and regulatory aspects in India – types and limitations of EIA –EIA process- screening – scoping - terms of reference in EIA- setting – analysis – mitigation. Cross sectoral

issues –public hearing in EIA- EIA consultant accreditation.

UNIT II IMPACT IDENTIFICATION AND PREDICTION 10

Matrices – networks – checklists – cost benefit analysis – analysis of alternatives – expert systems in EIA. prediction tools for EIA – mathematical modeling for impact prediction – assessment of impacts – air – water – soil – noise – biological — cumulative impact assessment

UNIT III SOCIO-ECONOMIC IMPACT ASSESSMENT 8

Socio-economic impact assessment - relationship between social impacts and change in community and institutional arrangements. factors and methodologies- individual and family level impacts. communities in transition-rehabilitation

UNIT IV EIA DOCUMENTATION AND ENVIRONMENTAL MANAGEMENT PLAN 9

Environmental management plan - preparation, implementation and review – mitigation and rehabilitation plans – policy and guidelines for planning and monitoring programmes – post project audit – documentation of EIA findings – ethical and quality aspects of environmental impact assessment

UNIT V CASE STUDIES 9

Mining, power plants, cement plants, highways, petroleum refining industry, storage & handling of hazardous chemicals, common hazardous waste facilities, CETPs, CMSWMF, building and construction projects

TOTAL: 45 PERIODS

OUTCOMES:

- On completion of the course, the student is expected to be able to

CO1	Understand need for environmental clearance, its legal procedure, need of EIA, its types, stakeholders and their roles
CO2	Understand various impact identification methodologies, prediction techniques and model of impacts on various environments
CO3	Understand relationship between social impacts and change in community due to development activities and rehabilitation methods
CO4	Document the EIA findings and prepare environmental management and monitoring plan
CO5	Identify, predict and assess impacts of similar projects based on case studies

REFERENCES:

1. EIA Notification 2006 including recent amendments, by Ministry of Environment, Forest and Climate Change, Government of India
2. Sectoral Guidelines under EIA Notification by Ministry of Environment, Forest and Climate Change, Government of India
3. Canter, L.W., Environmental Impact Assessment, McGraw Hill, New York. 1996
4. Lawrence, D.P., Environmental Impact Assessment – Practical solutions to recurrent problems, Wiley-Interscience, New Jersey. 2003
5. Lee N. and George C. 2000. Environmental Assessment in Developing and Transitional Countries. Chichester: Willey

6. World Bank –Source book on EIA ,1999
7. Sam Mannan, Lees' Loss Prevention in the Process Industries, Hazard Identification Assessment and Control, 4th Edition, Butterworth Heineman, 2012.

OME431 VIBRATION AND NOISE CONTROL STRATEGIES L T P C
3 0 0 3

OBJECTIVES

- To appreciate the basic concepts of vibration in damped and undamped systems
- To appreciate the basic concepts of noise, its effect on hearing and related terminology
- To use the instruments for measuring and analyzing the vibration levels in a body
- To use the instruments for measuring and analyzing the noise levels in a system
- To learn the standards of vibration and noise levels and their control techniques

UNIT- I BASICS OF VIBRATION 9

Introduction – Sources and causes of Vibration-Mathematical Models - Displacement, velocity and Acceleration - Classification of vibration: free and forced vibration, undamped and damped vibration, linear and non-linear vibration - Single Degree Freedom Systems - Vibration isolation - Determination of natural frequencies

UNIT- II BASICS OF NOISE 9

Introduction - Anatomy of human ear - Mechanism of hearing - Amplitude, frequency, wavelength and sound pressure level - Relationship between sound power, sound intensity and sound pressure level - Addition, subtraction and averaging decibel levels - sound spectra -Types of sound fields - Octave band analysis - Loudness.

UNIT- III INSTRUMENTATION FOR VIBRATION MEASUREMENT 9

Experimental Methods in Vibration Analysis.- Vibration Measuring Instruments - Selection of Sensors - Accelerometer Mountings - Vibration Exciters - Mechanical, Hydraulic, Electromagnetic and Electrodynamics – Frequency Measuring Instruments -. System Identification from Frequency Response -Testing for resonance and mode shapes

UNIT- IV INSTRUMENTATION FOR NOISE MEASUREMENT AND ANALYSIS 9

Microphones - Weighting networks - Sound Level meters, its classes and calibration - Noise measurements using sound level meters - Data Loggers - Sound exposure meters - Recording of noise - Spectrum analyser - Intensity meters - Energy density sensors - Sound source localization.

UNIT- V METHODS OF VIBRATION CONTROL, SOURCES OF NOISE AND ITS CONTROL 9

Specification of Vibration Limits – Vibration severity standards - Vibration as condition Monitoring Tool – Case Studies - Vibration Isolation methods - Dynamic Vibration Absorber – Need for Balancing - Static and Dynamic Balancing machines – Field balancing - Major sources of noise - Noise survey techniques – Measurement technique for vehicular noise - Road vehicles Noise standard – Noise due to construction equipment and domestic appliances – Industrial noise sources and its strategies – Noise control at the source – Noise control along the path – Acoustic Barriers – Noise control at the receiver -- Sound transmission through barriers – Noise reduction Vs Transmission loss - Enclosures

OUTCOMES:

On Completion of the course the student will be able to

1. apply the basic concepts of vibration in damped and undamped systems
2. apply the basic concepts of noise and to understand its effects on systems
3. select the instruments required for vibration measurement and its analysis
4. select the instruments required for noise measurement and its analysis.
5. recognize the noise sources and to control the vibration levels in a body and to control noise under different strategies.

REFERENCES:

1. Singiresu S. Rao, “Mechanical Vibrations”, Pearson Education Incorporated, 2017.
2. Graham Kelly. Sand Shashidhar K. Kudari, “Mechanical Vibrations”, Tata McGraw –Hill Publishing Com. Ltd., 2007.
3. Ramamurti. V, “Mechanical Vibration Practice with Basic Theory”, Narosa Publishing House, 2000.
4. William T. Thomson, “Theory of Vibration with Applications”, Taylor & Francis, 2003.
5. G.K. Grover, “Mechanical Vibrations”, Nem Chand and Bros.,Roorkee, 2014.
6. A.G. Ambekar, “Mechanical Vibrations and Noise Engineering”, PHI Learning Pvt. Ltd., 2014.
7. David A. Bies and Colin H. Hansen, “Engineering Noise Control – Theory and Practice”, Spon Press, London and New York, 2009.

OME432 ENERGY CONSERVATION AND MANAGEMENT IN DOMESTIC SECTORS

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To learn the present energy scenario and the need for energy conservation.
- To understand the different measures for energy conservation in utilities.
- Acquaint students with principle theories, materials, and construction techniques to create energy efficient buildings.
- To identify the energy demand and bridge the gap with suitable technology for sustainable habitat
- To get familiar with the energy technology, current status of research and find the ways to optimize a system as per the user requirement

UNIT I ENERGY SCENARIO 9

Primary energy resources - Sectorial energy consumption (domestic, industrial and other sectors), Energy pricing, Energy conservation and its importance, Energy Conservation Act-2001 and its features – Energy star rating.

UNIT II HEATING, VENTILLATION & AIR CONDITIONING 9

Basics of Refrigeration and Air Conditioning – COP / EER / SEC Evaluation – SPV system design & optimization for Solar Refrigeration.

UNIT III LIGHTING, COMPUTER, TV 9
Specification of Luminaries – Types – Efficacy – Selection & Application – Time Sensors – Occupancy Sensors – Energy conservation measures in computer – Television – Electronic devices.

UNIT IV ENERGY EFFICIENT BUILDINGS 9
Conventional versus Energy efficient buildings – Landscape design – Envelope heat loss and heat gain – Passive cooling and heating – Renewable sources integration.

UNIT V ENERGY STORAGE TECHNOLOGIES 9
Necessity & types of energy storage – Thermal energy storage – Battery energy storage, charging and discharging– Hydrogen energy storage & Super capacitors – energy density and safety issues – Applications.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

1. Understand technical aspects of energy conservation scenario.
2. Energy audit in any type for domestic buildings and suggest the conservation measures.
3. Perform building load estimates and design the energy efficient landscape system.
4. Gain knowledge to utilize an appliance/device sustainably.
5. Understand the status and current technological advancement in energy storage field.

REFERENCES:

1. Yogi Goswami, Frank Kreith, Energy Efficiency and Renewable energy Handbook, CRC Press, 2016
2. ASHRAE Handbook 2020 – HVAC Systems & Equipment
3. Paolo Bertoldi, Andrea Ricci, Anibal de Almeida, Energy Efficiency in Household Appliances and Lighting, Conference proceedings, Springer, 2001
4. David A. Bainbridge, Ken Haggard, Kenneth L. Haggard, Passive Solar Architecture: Heating, Cooling, Ventilation, Daylighting, and More Using Natural Flows, Chelsea Green Publishing, 2011.
5. Guide book for National Certification Examination for Energy Managers and Energy Auditors (Could be downloaded from www.energymanagertraining.com)
6. Ibrahim Dincer and Mark A. Rosen, Thermal Energy Storage Systems and Applications, John Wiley & Sons 2002.
7. Robert Huggins, Energy Storage: Fundamentals, Materials and Applications, 2nd edition, Springer, 2015
8. Ru-shiliu, Leizhang, Xueliang sun, Electrochemical technologies for energy storage and conversion, Wiley publications, 2012.

OME433 ADDITIVE MANUFACTURING L T P C
3 0 0 3

UNIT I INTRODUCTION 9
Need - Development - Rapid Prototyping Rapid Tooling – Rapid Manufacturing – Additive Manufacturing. AM Process Chain- Classification – Benefits.

UNIT II DESIGN FOR ADDITIVE MANUFACTURING 9
CAD Model Preparation - Part Orientation and Support Structure Generation -Model Slicing - Tool Path Generation Customized Design and Fabrication - Case Studies.

UNIT III VAT POLYMERIZATION 9
Stereolithography Apparatus (SLA)- Materials -Process -Advantages Limitations- Applications. Digital Light Processing (DLP) - Materials – Process - Advantages - Applications. Multi Jet Modelling (MJM) - Principles - Process - Materials - Advantages and Limitations.

UNIT IV MATERIAL EXTRUSION AND SHEET LAMINATION 9
Fused Deposition Modeling (FDM)- Process-Materials - Applications and Limitations. Sheet Lamination Process: Laminated Object Manufacturing (LOM)- Basic Principle- Mechanism: Gluing or Adhesive Bonding – Thermal Bonding- Materials- Application and Limitation - Bio-Additive Manufacturing Computer Aided Tissue Engineering (CATE) – Case studies

POWDER BASED PROCESS

Selective Laser Sintering (SLS): Process –Mechanism– Typical Materials and Application- Multi Jet Fusion - Basic Principle-- Materials- Application and Limitation - Three Dimensional Printing - Materials -Process - Benefits and Limitations. Selective Laser Melting (SLM) and Electron Beam Melting (EBM): Materials – Process - Advantages and Applications. Beam Deposition Process: Laser Engineered Net Shaping (LENS)- Process -Material Delivery - Process Parameters - Materials -Benefits -Applications.

UNIT V CASE STUDIES AND OPPORTUNITIES ADDITIVE MANUFACTURING PROCESSES 9
Education and training - Automobile- pattern and mould - tooling - Building Printing-Bio Printing - medical implants -development of surgical tools Food Printing -Printing Electronics. Business Opportunities and Future Directions - Intellectual Property.

TOTAL: 45 PERIODS

REFERENCES:

1. Andreas Gebhardt and Jan-Steffen Hötter “Additive Manufacturing: 3D Printing for Prototyping and Manufacturing”, Hanser publications, United States, 2015, ISBN: 978-1- 56990-582-1.
2. Ian Gibson, David W. Rosen and Brent Stucker “Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing”, 2nd edition, Springer., United States, 2015, ISBN13: 978-1493921126.
3. Amit Bandyopadhyay and Susmita Bose, “Additive Manufacturing”, 1st Edition, CRC Press., United States, 2015, ISBN-13: 978-1482223590
4. Andreas Gebhardt, “Understanding Additive Manufacturing: Rapid Prototyping, Rapid Manufacturing”, Hanser Gardner Publication, Cincinnati., Ohio, 2011, ISBN :9783446425521.
5. Chua C.K., Leong K.F., and Lim C.S., “Rapid prototyping: Principles and applications”, Third edition, World Scientific Publishers, 2010.

UNIT I NEED FOR ELECTRIC VEHICLES 9

History and need for electric and hybrid vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies, comparison of diesel, petrol, electric and hybrid vehicles, limitations, technical challenges

UNIT II ELECTRIC VEHICLE ARCHITECTURE 9

Electric vehicle types, layout and power delivery, performance – traction motor characteristics, tractive effort, transmission requirements, vehicle performance, energy consumption, Concepts of hybrid electric drive train, architecture of series and parallel hybrid electric drive train, merits and demerits, mild and full hybrids, plug-in hybrid electric vehicles and range extended hybrid electric vehicles, Fuel cell vehicles.

UNIT III ENERGY STORAGE 9

Batteries – types – lead acid batteries, nickel based batteries, and lithium based batteries, electrochemical reactions, thermodynamic voltage, specific energy, specific power, energy efficiency, Battery modeling and equivalent circuit, battery charging and types, battery cooling, Ultra-capacitors, Flywheel technology, Hydrogen fuel cell, Thermal Management of the PEM fuel cell

UNIT IV ELECTRIC DRIVES AND CONTROL 9

Types of electric motors – working principle of AC and DC motors, advantages and limitations, DC motor drives and control, Induction motor drives and control, PMSM and brushless DC motor - drives and control , AC and Switch reluctance motor drives and control – Drive system efficiency – Inverters – DC and AC motor speed controllers

UNIT V DESIGN OF ELECTRIC VEHICLES 9

Materials and types of production, Chassis skate board design, motor sizing, power pack sizing, component matching, Ideal gear box – Gear ratio, torque–speed characteristics, Dynamic equation of vehicle motion, Maximum tractive effort – Power train tractive effort Acceleration performance, rated vehicle velocity – maximum gradability, Brake performance, Electronic control system, safety and challenges in electric vehicles. Case study of Nissan leaf, Toyota Prius, tesla model 3, and Renault Zoe cars.

TOTAL: 45 PERIODS**REFERENCES:**

1. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, 2nd edition CRC Press, 2011.
2. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
3. James Larminie, John Lowry, Electric Vehicle Technology Explained - Wiley, 2003.
4. Ehsani, M, "Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design", CRC Press, 2005

COURSE OBJECTIVES:

The main learning objective of this course is to prepare the students for:

- Applying the principles of generic development process; and understanding the organization structure for new product design and development.
- Identifying opportunity and planning for new product design and development.
- Conducting customer need analysis; and setting product specification for new product design and development.
- Generating, selecting, and testing the concepts for new product design and development.
- Applying the principles of Industrial design and prototype for new product design and development.

UNIT I INTRODUCTION TO PRODUCT DESIGN & DEVELOPMENT 9

Introduction – Characteristics of Successful Product Development – People involved in Product Design and Development – Duration and Cost of Product Development – The Challenges of Product Development – The Product Development Process – Concept Development: The Front-End Process – Adapting the Generic Product Development Process – Product Development Process Flows – Product Development Organizations.

UNIT II OPPORTUNITY IDENTIFICATION & PRODUCT PLANNING 9

Opportunity Identification: Definition – Types of Opportunities – Tournament Structure of Opportunity Identification – Effective Opportunity Tournaments – Opportunity Identification Process – Product Planning: Four types of Product Development Projects – The Process of Product Planning.

UNIT III IDENTIFYING CUSTOMER NEEDS & PRODUCT SPECIFICATIONS 9

Identifying Customer Needs: The Importance of Latent Needs – The Process of Identifying Customer Needs. Product Specifications: Definition – Time of Specifications Establishment – Establishing Target Specifications – Setting the Final Specifications

UNIT IV CONCEPT GENERATION, SELECTION & TESTING 9

Concept Generation: Activity of Concept Generation – Structured Approach – Five step method of Concept Generation. Concept Selection: Methodology – Concept Screening and Concepts Scoring. Concept testing: Seven Step activities of concept testing.

UNIT V INDUSTRIAL DESIGN & PROTOTYPING 9

Industrial Design: Need and Impact–Industrial Design Process. Prototyping – Principles of Prototyping – Prototyping Technologies – Planning for Prototypes.

TOTAL: 45 PERIODS**COURSE OUTCOMES:**

Upon completion of this course, the students will be able to:

- Apply the principles of generic development process; and understand the organization structure for new product design and development.
- Identify opportunity and plan for new product design and development.

- Conduct customer need analysis; and set product specification for new product design and development.
- Generate, select, and test the concepts for new product design and development.
- Apply the principles of Industrial design and prototype for design and develop new products.

TEXT BOOK:

1. Ulrich K.T., Eppinger S. D. and Anita Goyal, “Product Design and Development “McGraw-Hill Education; 7 edition, 2020.

REFERENCES:

1. Belz A., 36-Hour Course: “Product Development” McGraw-Hill, 2010.
2. Rosenthal S., “Effective Product Design and Development”, Business One Orwin, Homewood, 1992, ISBN1-55623-603-4.
3. Pugh.S, “Total Design Integrated Methods for Successful Product Engineering”, Addison Wesley Publishing, 1991, ISBN0-202-41639-5.
4. Chitale, A. K. and Gupta, R. C., Product Design and Manufacturing, PHI Learning, 2013.
5. Jamnia, A., Introduction to Product Design and Development for Engineers, CRC Press, 2018.

OBA431

SUSTAINABLE MANAGEMENT

**LT P C
3 0 0 3**

COURSE OBJECTIVES:

- To provide students with fundamental knowledge of the notion of corporate sustainability.
- To determine how organizations impacts on the environment and socio-technical systems, the relationship between social and environmental performance and competitiveness, the approaches and methods.

UNIT I MANAGEMENT OF SUSTAINABILITY 9

Management of sustainability -rationale and political trends: An introduction to sustainability management, International and European policies on sustainable development, theoretical pillars in sustainability management studies.

UNIT II CORPORATE SUSTAINABILITY AND RESPONSIBILITY 9

Corporate sustainability parameter, corporate sustainability institutional framework, integration of sustainability into strategic planning and regular business practices, fundamentals of stakeholder engagement.

UNIT III SUSTAINABILITY MANAGEMENT: STRATEGIES AND APPROACHES 9

Corporate sustainability management and competitiveness: Sustainability-oriented corporate strategies, markets and competitiveness, Green Management between theory and practice, Sustainable Consumption and Green Marketing strategies, Environmental regulation and strategic

postures; Green Management approaches and tools; Green engineering: clean technologies and innovation processes; Sustainable Supply Chain Management and Procurement.

UNIT IV SUSTAINABILITY AND INNOVATION 9

Socio-technical transitions and sustainability, Sustainable entrepreneurship, Sustainable pioneers in green market niches, Smart communities and smart specializations.

UNIT V SUSTAINABLE MANAGEMENT OF RESOURCES, COMMODITIES AND COMMONS 9

Energy management, Water management, Waste management, Wild Life Conservation, Emerging trends in sustainable management, Case Studies.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- CO1: An understanding of sustainability management as an approach to aid in evaluating and minimizing environmental impacts while achieving the expected social impact.
CO2: An understanding of corporate sustainability and responsible Business Practices
CO3: Knowledge and skills to understand, to measure and interpret sustainability performances.
CO4: Knowledge of innovative practices in sustainable business and community management
CO5: Deep understanding of sustainable management of resources and commodities

REFERENCES:

1. Daddi, T., Iraldo, F., Testa, Environmental Certification for Organizations and Products: Management, 2015
2. Christian N. Madu, Handbook of Sustainability Management 2012
3. Petra Molthan-Hill, The Business Student's Guide to Sustainable Management: Principles and Practice, 2014
4. Margaret Robertson, Sustainability Principles and Practice, 2014
5. Peter Rogers, An Introduction to Sustainable Development, 2006

**OBA432 MICRO AND SMALL BUSINESS MANAGEMENT L T P C
3 0 0 3**

COURSE OBJECTIVES

- To familiarize students with the theory and practice of small business management.
- To learn the legal issues faced by small business and how they impact operations.

UNIT I INTRODUCTION TO SMALL BUSINESS 9

Creation, Innovation, entrepreneurship and small business - Defining Small Business –Role of Owner – Manager – government policy towards small business sector –elements of entrepreneurship –evolution of entrepreneurship –Types of Entrepreneurship – social, civic, corporate - Business life cycle - barriers and triggers to new venture creation – process to assist start ups – small business and family business.

UNIT II SCREENING THE BUSINESS OPPORTUNITY AND FORMULATING THE BUSINESS PLAN 9

Concepts of opportunity recognition; Key factors leading to new venture failure; New venture screening process; Applying new venture screening process to the early stage small firm Role

planning in small business – importance of strategy formulation – management skills for small business creation and development.

UNIT III BUILDING THE RIGHT TEAM AND MARKETING STRATEGY 9

Management and Leadership – employee assessments – Tuckman’s stages of group development - The entrepreneurial process model - Delegation and team building - Comparison of HR management in small and large firms - Importance of coaching and how to apply a coaching model.

Marketing within the small business - success strategies for small business marketing - customer delight and business generating systems, - market research, - assessing market performance- sales management and strategy - the marketing mix and marketing strategy.

UNIT IV FINANCING SMALL BUSINESS 9

Main sources of entrepreneurial capital; Nature of ‘bootstrap’ financing - Difference between cash and profit - Nature of bank financing and equity financing - Funding-equity gap for small firms. Importance of working capital cycle - Calculation of break-even point - Power of gross profit margin- Pricing for profit - Credit policy issues and relating these to cash flow management and profitability.

UNIT V VALUING SMALL BUSINESS AND CRISIS MANAGEMENT 9

Causes of small business failure - Danger signals of impending trouble - Characteristics of poorly performing firms - Turnaround strategies - Concept of business valuation - Different valuation measurements - Nature of goodwill and how to measure it - Advantages and disadvantages of buying an established small firm - Process of preparing a business for sale.

TOTAL: 45 PERIODS

COURSE OUTCOMES

- CO1. Familiarise the students with the concept of small business
- CO2. In depth knowledge on small business opportunities and challenges
- CO3. Ability to devise plans for small business by building the right skills and marketing strategies
- CO4. Identify the funding source for small start ups
- CO5. Business evaluation for buying and selling of small firms

REFERENCES

1. Hankinson,A.(2000). “The key factors in the profile of small firm owner-managers that influence business performance. The South Coast Small Firms Survey, 1997-2000.” Industrial and Commercial Training 32(3):94-98.
2. Parker,R.(2000). “Small is not necessarily beautiful: An evaluation of policy support for small and medium-sized enterprise in Australia.” Australian Journal of Political Science 35(2):239-253.
3. Journal articles on SME’s.

COURSE OBJECTIVE

- To understand intellectual property rights and its valuation.

UNIT I INTRODUCTION**9**

Intellectual property rights - Introduction, Basic concepts, Patents, Copyrights, Trademarks, Trade Secrets, Geographic Indicators; Nature of Intellectual Property, Technological Research, Inventions and Innovations, History - the way from WTO to WIPO, TRIPS.

UNIT II PROCESS**9**

New Developments in IPR, Procedure for grant of Patents, TM, GIs, Patenting under Patent Cooperation Treaty, Administration of Patent system in India, Patenting in foreign countries.

UNIT III STATUTES**9**

International Treaties and conventions on IPRs, The TRIPs Agreement, PCT Agreement, The Patent Act of India, Patent Amendment Act (2005), Design Act, Trademark Act, Geographical Indication Act, Bayh- Dole Act and Issues of Academic Entrepreneurship.

UNIT IV STRATEGIES IN INTELLECTUAL PROPERTY**9**

Strategies for investing in R&D, Patent Information and databases, IPR strength in India, Traditional Knowledge, Case studies.

UNIT V MODELS**9**

The technologies Know-how, concept of ownership, Significance of IP in Value Creation, IP Valuation and IP Valuation Models, Application of Real Option Model in Strategic Decision Making, Transfer and Licensing.

TOTAL: 45 PERIODS**COURSE OUTCOMES**

- CO1: Understanding of intellectual property and appreciation of the need to protect it
 CO2: Awareness about the process of patenting
 CO3: Understanding of the statutes related to IPR
 CO4: Ability to apply strategies to protect intellectual property
 CO5: Ability to apply models for making strategic decisions related to IPR

REFERENCES

1. Sople Vinod, Managing Intellectual Property by (Prentice hall of India Pvt.Ltd), 2006.
2. Intellectual Property rights and copyrights, EssEss Publications.
3. Primer, R. Anita Rao and Bhanoji Rao, Intellectual Property Rights, Lastain Book company. Edited by Derek Bosworth and Elizabeth Webster, The Management of Intellectual Property, Edward Elgar Publishing Ltd., 2006.
4. WIPO Intellectual Property Hand book.

COURSE OBJECTIVE

➤ To help students develop knowledge and competence in ethical management and decision making in organizational contexts.

UNIT I ETHICS AND SOCIETY**9**

Ethical Management- Definition, Motivation, Advantages-Practical implications of ethical management. Managerial ethics, professional ethics, and social Responsibility-Role of culture and society's expectations- Individual and organizational responsibility to society and the community.

UNIT II ETHICAL DECISION MAKING AND MANAGEMENT IN A CRISIS**9**

Managing in an ethical crisis, the nature of a crisis, ethics in crisis management, discuss case studies, analyze real-world scenarios, develop ethical management skills, knowledge, and competencies. Proactive crisis management.

UNIT III STAKEHOLDERS IN ETHICAL MANAGEMENT**9**

Stakeholders in ethical management, identifying internal and external stakeholders, nature of stakeholders, ethical management of various kinds of stakeholders: customers (product and service issues), employees (leadership, fairness, justice, diversity) suppliers, collaborators, business, community, the natural environment (the sustainability imperative, green management, Contemporary issues).

UNIT IV INDIVIDUAL VARIABLES IN ETHICAL MANAGEMENT**9**

Understanding individual variables in ethics, managerial ethics, concepts in ethical psychology-ethical awareness, ethical courage, ethical judgment, ethical foundations, ethical emotions/intuitions/intensity. Utilization of these concepts and competencies for ethical decision-making and management.

UNIT V PRACTICAL FIELD-GUIDE, TECHNIQUES AND SKILLS**9**

Ethical management in practice, development of techniques and skills, navigating challenges and dilemmas, resolving issues and preventing unethical management proactively. Role modelling and creating a culture of ethical management and human flourishing.

TOTAL: 45 PERIODS**COURSE OUTCOMES**

- CO1: Role modelling and influencing the ethical and cultural context.
- CO2: Respond to ethical crises and proactively address potential crises situations.
- CO3: Understand and implement stakeholder management decisions.
- CO4: Develop the ability, knowledge, and skills for ethical management.
- CO5: Develop practical skills to navigate, resolve and thrive in management situations

REFERENCES

1. Brad Agle, Aaron Miller, Bill O' Rourke, The Business Ethics Field Guide: the essential companion to leading your career and your company, 2016.
2. Steiner & Steiner, Business, Government & Society: A managerial Perspective, 2011.
3. Lawrence & Weber, Business and Society: Stakeholders, Ethics, Public Policy, 2020.

COURSE OBJECTIVES:

- To study about **Internet of Things** technologies and its role in real time applications.
- To introduce the infrastructure required for IoT
- To familiarize the accessories and communication techniques for IoT.
- To provide insight about the embedded processor and sensors required for IoT
- To familiarize the different platforms and Attributes for IoT

UNIT I INTRODUCTION TO INTERNET OF THINGS**9**

Overview, Hardware and software requirements for IOT, Sensor and actuators, Technology drivers, Business drivers, Typical IoT applications, Trends and implications.

UNIT II IOT ARCHITECTURE**9**

IoT reference model and architecture -Node Structure - Sensing, Processing, Communication, Powering, Networking - Topologies, Layer/Stack architecture, IoT standards, Cloud computing for IoT, Bluetooth, Bluetooth Low Energy beacons.

UNIT III PROTOCOLS AND WIRELESS TECHNOLOGIES FOR IOT**9****PROTOCOLS:**

NFC, SCADA and RFID, Zigbee MIPI, M-PHY, UniPro, SPMI, SPI, M-PCIe GSM, CDMA, LTE, GPRS, small cell.

Wireless technologies for IoT: WiFi (IEEE 802.11), Bluetooth/Bluetooth Smart, ZigBee/ZigBee Smart, UWB (IEEE 802.15.4), 6LoWPAN, Proprietary systems-Recent trends.

UNIT IV IOT PROCESSORS**9**

Services/Attributes: Big-Data Analytics for IOT, Dependability, Interoperability, Security, Maintainability.

Embedded processors for IOT :Introduction to Python programming -Building IOT with RASPBERRY PI and Arduino.

UNIT V CASE STUDIES**9**

Industrial IoT, Home Automation, smart cities, Smart Grid, connected vehicles, electric vehicle charging, Environment, Agriculture, Productivity Applications, IOT Defense

TOTAL: 45 PERIODS**COURSE OUTCOMES:**

At the end of this course, the students will have the ability to

CO1: Analyze the concepts of IoT and its present developments.

CO2: Compare and contrast different platforms and infrastructures available for IoT

CO3: Explain different protocols and communication technologies used in IoT

CO4: Analyze the big data analytic and programming of IoT

CO5: Implement IoT solutions for smart applications

REFERENCES:

1. ArshdeepBahga and VijaiMadiseti : A Hands-on Approach "Internet of Things",Universities Press 2015.
2. Oliver Hersent , David Boswarthick and Omar Elloumi " The Internet of Things", Wiley,2016.

3. Samuel Greengard, "The Internet of Things", The MIT press, 2015.
4. Adrian McEwen and Hakim Cassimally "Designing the Internet of Things" Wiley, 2014.
5. Jean- Philippe Vasseur, Adam Dunkels, "Interconnecting Smart Objects with IP: The Next Internet" Morgan Kuffmann Publishers, 2010.
6. Adrian McEwen and Hakim Cassimally, "Designing the Internet of Things", John Wiley and sons, 2014.
7. Lingyang Song/DusitNiyato/ Zhu Han/ Ekram Hossain," Wireless Device-to-Device Communications and Networks, CAMBRIDGE UNIVERSITY PRESS, 2015.
8. OvidiuVermesan and Peter Friess (Editors), "Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems", River Publishers Series in Communication, 2013.
9. Vijay Madiseti , ArshdeepBahga, "Internet of Things (A Hands on-Approach)", 2014.
10. Zach Shelby, Carsten Bormann, "6LoWPAN: The Wireless Embedded Internet", John Wiley and sons, 2009.
11. Lars T.Berger and Krzysztof Iniewski, "Smart Grid applications, communications and security", Wiley, 2015.
12. JanakaEkanayake, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama and Nick Jenkins, " Smart Grid Technology and Applications", Wiley, 2015.
13. UpenaDalal,"Wireless Communications & Networks,Oxford,2015.

ET4072

MACHINE LEARNING AND DEEP LEARNING

L T P C

3 0 0 3

COURSE OBJECTIVES:

The course is aimed at

- Understanding about the learning problem and algorithms
- Providing insight about neural networks
- Introducing the machine learning fundamentals and significance
- Enabling the students to acquire knowledge about pattern recognition.
- Motivating the students to apply deep learning algorithms for solving real life problems.

UNIT I LEARNING PROBLEMS AND ALGORITHMS

9

Various paradigms of learning problems, Supervised, Semi-supervised and Unsupervised algorithms

UNIT II NEURAL NETWORKS

9

Differences between Biological and Artificial Neural Networks - Typical Architecture, Common Activation Functions, Multi-layer neural network, Linear Separability, Hebb Net, Perceptron, Adaline, Standard Back propagation Training Algorithms for Pattern Association - Hebb rule and Delta rule, Hetero associative, Auto associative, Kohonen Self Organising Maps, Examples of Feature Maps, Learning Vector Quantization, Gradient descent, Boltzmann Machine Learning.

UNIT III MACHINE LEARNING – FUNDAMENTALS & FEATURE SELECTIONS & CLASSIFICATIONS

9

Classifying Samples: The confusion matrix, Accuracy, Precision, Recall, F1- Score, the curse of dimensionality, training, testing, validation, cross validation, overfitting, under-fitting the data, early stopping, regularization, bias and variance. Feature Selection, normalization, dimensionality

reduction, Classifiers: KNN, SVM, Decision trees, Naïve Bayes, Binary classification, multi class classification, clustering.

UNIT IV DEEP LEARNING: CONVOLUTIONAL NEURAL NETWORKS 9

Feed forward networks, Activation functions, back propagation in CNN, optimizers, batch normalization, convolution layers, pooling layers, fully connected layers, dropout, Examples of CNNs.

UNIT V DEEP LEARNING: RNNs, AUTOENCODERS AND GANS 9

State, Structure of RNN Cell, LSTM and GRU, Time distributed layers, Generating Text, Autoencoders: Convolutional Autoencoders, Denoising autoencoders, Variational autoencoders, GANs: The discriminator, generator, DCGANs

TOTAL : 45 PERIODS

COURSE OUTCOMES (CO):

At the end of the course the student will be able to

CO1 : Illustrate the categorization of machine learning algorithms.

CO2: Compare and contrast the types of neural network architectures, activation functions

CO3: Acquaint with the pattern association using neural networks

CO4: Elaborate various terminologies related with pattern recognition and architectures of convolutional neural networks

CO5: Construct different feature selection and classification techniques and advanced neural network architectures such as RNN, Autoencoders, and GANs.

REFERENCES:

1. J. S. R. Jang, C. T. Sun, E. Mizutani, Neuro Fuzzy and Soft Computing - A Computational Approach to Learning and Machine Intelligence, 2012, PHI learning
2. Deep Learning, Ian Good fellow, YoshuaBengio and Aaron Courville, MIT Press, ISBN: 9780262035613, 2016.
3. The Elements of Statistical Learning. Trevor Hastie, Robert Tibshirani and Jerome Friedman. Second Edition. 2009.
4. Pattern Recognition and Machine Learning. Christopher Bishop. Springer. 2006.
5. Understanding Machine Learning. Shai Shalev-Shwartz and Shai Ben-David. Cambridge University Press. 2017.

PROGRESS THROUGH KNOWLEDGE

PX4012

RENEWABLE ENERGY TECHNOLOGY

L T P C

3 0 0 3

OBJECTIVES:

To impart knowledge on

- Different types of renewable energy technologies
- Standalone operation, grid connected operation of renewable energy systems

UNIT I INTRODUCTION 9

Classification of energy sources – Co2 Emission - Features of Renewable energy - Renewable energy scenario in India -Environmental aspects of electric energy conversion: impacts of renewable energy generation on environment Per Capital Consumption - CO₂ Emission - importance of renewable energy sources, Potentials – Achievements– Applications.

UNIT II SOLAR PHOTOVOLTAICS 9

Solar Energy: Sun and Earth-Basic Characteristics of solar radiation- angle of sunrays on solar collector-Estimating Solar Radiation Empirically - Equivalent circuit of PV Cell- Photovoltaic cell-characteristics: P-V and I-V curve of cell-Impact of Temperature and Insolation on I-V characteristics-Shading Impacts on I-V characteristics-Bypass diode -Blocking diode.

UNIT III PHOTOVOLTAIC SYSTEM DESIGN 9

Block diagram of solar photo voltaic system : Line commutated converters (inversion mode) - Boost and buck-boost converters - selection of inverter, battery sizing, array sizing - PV systems classification- standalone PV systems - Grid tied and grid interactive inverters- grid connection issues.

UNIT IV WIND ENERGY CONVERSION SYSTEMS 9

Origin of Winds: Global and Local Winds- Aerodynamics of Wind turbine-Derivation of Betz's limit-Power available in wind-Classification of wind turbine: Horizontal Axis wind turbine and Vertical axis wind turbine- Aerodynamic Efficiency-Tip Speed-Tip Speed Ratio-Solidity-Blade Count-Power curve of wind turbine - Configurations of wind energy conversion systems: Type A, Type B, Type C and Type D Configurations- Grid connection Issues - Grid integrated SCIG and PMSG based WECS.

UNIT V OTHER RENEWABLE ENERGY SOURCES 9

Qualitative study of different renewable energy resources: ocean, Biomass, Hydrogen energy systems, Fuel cells, Ocean Thermal Energy Conversion (OTEC), Tidal and wave energy, Geothermal Energy Resources.

TOTAL : 45 PERIODS

OUTCOMES:

After completion of this course, the student will be able to:

- CO1: Demonstrate the need for renewable energy sources.
- CO2: Develop a stand-alone photo voltaic system and implement a maximum power point tracking in the PV system.
- CO3: Design a stand-alone and Grid connected PV system.
- CO4: Analyze the different configurations of the wind energy conversion systems.
- CO5: Realize the basic of various available renewable energy sources

REFERENCES:

1. S.N.Bhadra, D. Kastha, & S. Banerjee "Wind Electrical Systems", Oxford University Press, 2009.
2. Rai. G.D, "Non conventional energy sources", Khanna publishes, 1993.
3. Rai. G.D," Solar energy utilization", Khanna publishes, 1993.
4. Chetan Singh Solanki, "Solar Photovoltaics: Fundamentals, Technologies and Applications", PHI Learning Private Limited, 2012.
5. John Twideu and Tony Weir, "Renewal Energy Resources" BSP Publications, 2006
6. Gray, L. Johnson, "Wind energy system", prentice hall of India, 1995.
7. B.H.Khan, " Non-conventional Energy sources", , McGraw-hill, 2nd Edition, 2009.
8. Fang Lin Luo Hong Ye, " Renewable Energy systems", Taylor & Francis Group,2013.

COURSE OBJECTIVES

- To Study about Smart Grid technologies, different smart meters and advanced metering infrastructure.
- To know about the function of smart grid.
- To familiarize the power quality management issues in Smart Grid.
- To familiarize the high performance computing for Smart Grid applications
- To get familiarized with the communication networks for Smart Grid applications

UNIT I INTRODUCTION TO SMART GRID 9

Evolution of Electric Grid, Concept, Definitions and Need for Smart Grid, Smart grid drivers, functions, opportunities, challenges and benefits, Difference between conventional & Smart Grid, Comparison of Micro grid and Smart grid, Present development & International policies in Smart Grid, Smart Grid Initiative for Power Distribution Utility in India – Case Study.

UNIT II SMART GRID TECHNOLOGIES 9

Technology Drivers, Smart Integration of energy resources, Smart substations, Substation Automation, Feeder Automation, Transmission systems: EMS, FACTS and HVDC, Wide area monitoring, Protection and control, Distribution systems: DMS, Volt/Var control, Fault Detection, Isolation and service restoration, Outage management, High-Efficiency Distribution Transformers, Phase Shifting Transformers, Plug in Hybrid Electric Vehicles (PHEV) – Grid to Vehicle and Vehicle to Grid charging concepts.

UNIT III SMART METERS AND ADVANCED METERING INFRASTRUCTURE 9

Introduction to Smart Meters, Advanced Metering infrastructure (AMI) drivers and benefits, AMI protocols, standards and initiatives, AMI needs in the smart grid, Phasor Measurement Unit (PMU) & their application for monitoring & protection. Demand side management and demand response programs, Demand pricing and Time of Use, Real Time Pricing, Peak Time Pricing.

UNIT IV POWER QUALITY MANAGEMENT IN SMART GRID 9

Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring, Power Quality Audit.

Unit V HIGH PERFORMANCE COMPUTING FOR SMART GRID APPLICATIONS 9

Architecture and Standards -Local Area Network (LAN), House Area Network (HAN), Wide Area Network (WAN), Broadband over Power line (BPL), PLC, Zigbee, GSM, IP based Protocols, Basics of Web Service and CLOUD Computing, Cyber Security for Smart Grid.

TOTAL : 45 PERIODS**COURSE OUTCOME:**

Students able to

CO1: Relate with the smart resources, smart meters and other smart devices.

CO2: Explain the function of Smart Grid.

CO3: Experiment the issues of Power Quality in Smart Grid.

CO4: Analyze the performance of Smart Grid.

CO5: Recommend suitable communication networks for smart grid applications

REFERENCES

1. Stuart Borlase 'Smart Grid: Infrastructure, Technology and Solutions', CRC Press 2012.
2. JanakaEkanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama, 'Smart Grid: Technology and Applications', Wiley, 2012.
3. Mini S. Thomas, John D McDonald, 'Power System SCADA and Smart Grids', CRC Press, 2015
4. Kenneth C.Budka, Jayant G. Deshpande, Marina Thottan, 'Communication Networks for Smart Grids', Springer, 2014
5. SMART GRID Fundamentals of Design and Analysis, James Momoh, IEEE press, A John Wiley & Sons, Inc., Publication.

DS4015

BIG DATA ANALYTICS

L T P C
3 0 0 3

COURSE OBJECTIVES:

- To understand the basics of big data analytics
- To understand the search methods and visualization
- To learn mining data streams
- To learn frameworks
- To gain knowledge on R language

UNIT I INTRODUCTION TO BIG DATA

9

Introduction to Big Data Platform – Challenges of Conventional Systems - Intelligent data analysis –Nature of Data - Analytic Processes and Tools - Analysis Vs Reporting - Modern Data Analytic Tools- Statistical Concepts: Sampling Distributions - Re-Sampling - Statistical Inference - Prediction Error.

UNIT II SEARCH METHODS AND VISUALIZATION

9

Search by simulated Annealing – Stochastic, Adaptive search by Evaluation – Evaluation Strategies –Genetic Algorithm – Genetic Programming – Visualization – Classification of Visual Data Analysis Techniques – Data Types – Visualization Techniques – Interaction techniques – Specific Visual data analysis Techniques

UNIT III MINING DATA STREAMS

9

Introduction To Streams Concepts – Stream Data Model and Architecture - Stream Computing - Sampling Data in a Stream – Filtering Streams – Counting Distinct Elements in a Stream – Estimating Moments – Counting Oneness in a Window – Decaying Window - Real time Analytics Platform(RTAP) Applications - Case Studies - Real Time Sentiment Analysis, Stock Market Predictions

UNIT IV FRAMEWORKS

9

MapReduce – Hadoop, Hive, MapR – Sharding – NoSQL Databases - S3 - Hadoop Distributed File Systems – Case Study- Preventing Private Information Inference Attacks on Social Networks- Grand Challenge: Applying Regulatory Science and Big Data to Improve Medical Device Innovation

UNIT V R LANGUAGE**9**

Overview, Programming structures: Control statements -Operators -Functions -Environment and scope issues -Recursion -Replacement functions, R data structures: Vectors -Matrices and arrays - Lists -Data frames -Classes, Input/output, String manipulations

COURSE OUTCOMES:

CO1:understand the basics of big data analytics

CO2: Ability to use Hadoop, Map Reduce Framework.

CO3: Ability to identify the areas for applying big data analytics for increasing the business outcome.

CO4:gain knowledge on R language

CO5: Contextually integrate and correlate large amounts of information to gain faster insights.

TOTAL:45 PERIODS**REFERENCE:**

1. Michael Berthold, David J. Hand, Intelligent Data Analysis, Springer, 2007.
2. Anand Rajaraman and Jeffrey David Ullman, Mining of Massive Datasets, Cambridge University Press, 3rd edition 2020.
3. Norman Matloff, The Art of R Programming: A Tour of Statistical Software Design, No Starch Press, USA, 2011.
4. Bill Franks, Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics, John Wiley & sons, 2012.
5. Glenn J. Myatt, Making Sense of Data, John Wiley & Sons, 2007.

NC4201 INTERNET OF THINGS AND CLOUD**L T P C
3 0 0 3****COURSE OBJECTIVES:**

- To understand Smart Objects and IoT Architectures
- To learn about various IOT-related protocols
- To build simple IoT Systems using Arduino and Raspberry Pi.
- To understand data analytics and cloud in the context of IoT
- To develop IoT infrastructure for popular applications

UNIT I FUNDAMENTALS OF IoT**9**

Introduction to IoT – IoT definition – Characteristics – IoT Complete Architectural Stack – IoT enabling Technologies – IoT Challenges. Sensors and Hardware for IoT – Hardware Platforms – Arduino, Raspberry Pi, Node MCU. A Case study with any one of the boards and data acquisition from sensors.

UNIT II PROTOCOLS FOR IoT**9**

Infrastructure protocol (IPV4/V6/RPL), Identification (URIs), Transport (Wifi, Lifi, BLE), Discovery, Data Protocols, Device Management Protocols. – A Case Study with MQTT/CoAP usage-IoT privacy, security and vulnerability solutions.

UNIT III CASE STUDIES/INDUSTRIAL APPLICATIONS**9**

Case studies with architectural analysis: IoT applications – Smart City – Smart Water – Smart Agriculture – Smart Energy – Smart Healthcare – Smart Transportation – Smart Retail – Smart waste management.

UNIT IV CLOUD COMPUTING INTRODUCTION**9**

Introduction to Cloud Computing - Service Model – Deployment Model- Virtualization Concepts – Cloud Platforms – Amazon AWS – Microsoft Azure – Google APIs.

UNIT V IoT AND CLOUD**9**

IoT and the Cloud - Role of Cloud Computing in IoT - AWS Components - S3 – Lambda - AWS IoT Core -Connecting a web application to AWS IoT using MQTT- AWS IoT Examples. Security Concerns, Risk Issues, and Legal Aspects of Cloud Computing- Cloud Data Security

TOTAL:45 PERIODS**COURSE OUTCOMES:**

At the end of the course, the student will be able to:

CO1: Understand the various concept of the IoT and their technologies..

CO2: Develop IoT application using different hardware platforms

CO3: Implement the various IoT Protocols

CO4: Understand the basic principles of cloud computing.

CO5: Develop and deploy the IoT application into cloud environment

REFERENCES

1. "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", by Pethuru Raj and Anupama C. Raman ,CRC Press, 2017
2. Adrian McEwen, Designing the Internet of Things, Wiley,2013.
3. EMC Education Services, "Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data", Wiley publishers, 2015.
4. Simon Walkowiak, "Big Data Analytics with R" PackT Publishers, 2016
5. Bart Baesens, "Analytics in a Big Data World: The Essential Guide to Data Science and its Applications", Wiley Publishers, 2015.

MX4073**MEDICAL ROBOTICS****L T P C****3 0 0 3****COURSE OBJECTIVES:**

- To explain the basic concepts of robots and types of robots
- To discuss the designing procedure of manipulators, actuators and grippers
- To impart knowledge on various types of sensors and power sources
- To explore various applications of Robots in Medicine
- To impart knowledge on wearable robots

UNIT I INTRODUCTION TO ROBOTICS**9**

Introduction to Robotics, Overview of robot subsystems, Degrees of freedom, configurations and concept of workspace, Dynamic Stabilization

Sensors and Actuators

Sensors and controllers, Internal and external sensors, position, velocity and acceleration sensors, Proximity sensors, force sensors Pneumatic and hydraulic actuators, Stepper motor control circuits, End effectors, Various types of Grippers, PD and PID feedback actuator models

UNIT II MANIPULATORS & BASIC KINEMATICS**9**

Construction of Manipulators, Manipulator Dynamic and Force Control, Electronic and pneumatic manipulator, Forward Kinematic Problems, Inverse Kinematic Problems, Solutions of Inverse

Kinematic problems

Navigation and Treatment Planning

Variable speed arrangements, Path determination – Machinery vision, Ranging – Laser – Acoustic, Magnetic, fiber optic and Tactile sensor

UNIT III SURGICAL ROBOTS 9

Da Vinci Surgical System, Image guided robotic systems for focal ultrasound based surgical applications, System concept for robotic Tele-surgical system for off-pump, CABG surgery, Urologic applications, Cardiac surgery, Neuro-surgery, Pediatric and General Surgery, Gynecologic Surgery, General Surgery and Nanorobotics. Case Study

UNIT IV REHABILITATION AND ASSISTIVE ROBOTS 9

Pediatric Rehabilitation, Robotic Therapy for the Upper Extremity and Walking, Clinical-Based Gait Rehabilitation Robots, Motion Correlation and Tracking, Motion Prediction, Motion Replication. Portable Robot for Tele rehabilitation, Robotic Exoskeletons – Design considerations, Hybrid assistive limb. Case Study

UNIT V WEARABLE ROBOTS 9

Augmented Reality, Kinematics and Dynamics for Wearable Robots, Wearable Robot technology, Sensors, Actuators, Portable Energy Storage, Human–robot cognitive interaction (cHRI), Human–robot physical interaction (pHRI), Wearable Robotic Communication - case study

TOTAL:45 PERIODS

COURSE OUTCOMES:

CO1: Describe the configuration, applications of robots and the concept of grippers and actuators

CO2: Explain the functions of manipulators and basic kinematics

CO3: Describe the application of robots in various surgeries

CO4: Design and analyze the robotic systems for rehabilitation

CO5: Design the wearable robots

REFERENCES

1. Nagrath and Mittal, "Robotics and Control", Tata McGraw Hill, First edition, 2003
2. Spong and Vidhyasagar, "Robot Dynamics and Control", John Wiley and Sons, First edition, 2008
3. Fu.K.S, Gonzalez. R.C., Lee, C.S.G, "Robotics, control", sensing, Vision and Intelligence, Tata McGraw Hill International, First edition, 2008
4. Bruno Siciliano, Oussama Khatib, Springer Handbook of Robotics, 1st Edition, Springer, 2008
5. Shane (S.Q.) Xie, Advanced Robotics for Medical Rehabilitation - Current State of the Art and Recent Advances, Springer, 2016
6. Sashi S Kommu, Rehabilitation Robotics, I-Tech Education and Publishing, 2007
7. Jose L. Pons, Wearable Robots: Biomechatronic Exoskeletons, John Wiley & Sons Ltd, England, 2008
8. Howie Choset, Kevin Lynch, Seth Hutchinson, "Principles of Robot Motion: Theory, Algorithms, and Implementations", Prentice Hall of India, First edition, 2005
9. Philippe Coiffet, Michel Chirouze, "An Introduction to Robot Technology", Tata McGraw Hill, First Edition, 1983
10. Jacob Rosen, Blake Hannaford & Richard M Satava, "Surgical Robotics: System Applications & Visions", Springer 2011

11. Jocelyn Troccaz, Medical Robotics, Wiley, 2012
12. Achim Schweikard, Floris Ernst, Medical Robotics, Springer, 2015

VE4202

EMBEDDED AUTOMATION

L T P C
3 0 0 3

COURSE OBJECTIVES:

- To learn about the process involved in the design and development of real-time embedded system
- To develop the embedded C programming skills on 8-bit microcontroller
- To study about the interfacing mechanism of peripheral devices with 8-bit microcontrollers
- To learn about the tools, firmware related to microcontroller programming
- To build a home automation system

UNIT - I INTRODUCTION TO EMBEDDED C PROGRAMMING 9

C Overview and Program Structure - C Types, Operators and Expressions - C Control Flow - C Functions and Program Structures - C Pointers And Arrays - FIFO and LIFO - C Structures - Development Tools

UNIT - II AVR MICROCONTROLLER 9

ATMEGA 16 Architecture - Nonvolatile and Data Memories - Port System - Peripheral Features : Time Base, Timing Subsystem, Pulse Width Modulation, USART, SPI, Two Wire Serial Interface, ADC, Interrupts - Physical and Operating Parameters

UNIT – III HARDWARE AND SOFTWARE INTERFACING WITH 8-BIT SERIES CONTROLLERS 9

Lights and Switches - Stack Operation - Implementing Combinational Logic - Expanding I/O - Interfacing Analog To Digital Convertors - Interfacing Digital To Analog Convertors - LED Displays : Seven Segment Displays, Dot Matrix Displays - LCD Displays - Driving Relays - Stepper Motor Interface - Serial EEPROM - Real Time Clock - Accessing Constants Table - Arbitrary Waveform Generation - Communication Links - System Development Tools

UNIT – IV VISION SYSTEM 9

Fundamentals of Image Processing - Filtering - Morphological Operations - Feature Detection and Matching - Blurring and Sharpening - Segmentation - Thresholding - Contours - Advanced Contour Properties - Gradient - Canny Edge Detector - Object Detection - Background Subtraction

UNIT – V HOME AUTOMATION 9

Home Automation - Requirements - Water Level Notifier - Electric Guard Dog - Tweeting Bird Feeder - Package Delivery Detector - Web Enabled Light Switch - Curtain Automation - Android Door Lock - Voice Controlled Home Automation - Smart Lighting - Smart Mailbox - Electricity Usage Monitor - Proximity Garage Door Opener - Vision Based Authentic Entry System

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of this course, students will be able to

CO1: analyze the 8-bit series microcontroller architecture, features and pin details

- CO2:** write embedded C programs for embedded system application
CO3: design and develop real time systems using AVR microcontrollers
CO4: design and develop the systems based on vision mechanism
CO5: design and develop a real time home automation system

REFERENCES:

1. Dhananjay V. Gadre, "Programming and Customizing the AVR Microcontroller", McGraw-Hill, 2001.
2. Joe Pardue, "C Programming for Microcontrollers ", Smiley Micros, 2005.
3. Steven F. Barrett, Daniel J. Pack, "ATMEL AVR Microcontroller Primer : Programming and Interfacing", Morgan & Claypool Publishers, 2012
4. Mike Riley, "Programming Your Home - Automate With Arduino, Android and Your Computer", the Pragmatic Programmers, Llc, 2012.
5. Richard Szeliski, "Computer Vision: Algorithms and Applications", Springer, 2011.
6. Kevin P. Murphy, "Machine Learning - a Probabilistic Perspective", the MIT Press Cambridge, Massachusetts, London, 2012.

CX4016	ENVIRONMENTAL SUSTAINABILITY	L	T	P	C
		3	0	0	3
UNIT I	INTRODUCTION				9
Valuing the Environment: Concepts, Valuing the Environment: Methods, Property Rights, Externalities, and Environmental Problems					
UNIT II	CONCEPT OF SUSTAINABILITY				9
Sustainable Development: Defining the Concept, the Population Problem, Natural Resource Economics: An Overview, Energy, Water, Agriculture					
UNIT III	SIGNIFICANCE OF BIODIVERSITY				9
Biodiversity, Forest Habitat, Commercially Valuable Species, Stationary - Source Local Air Pollution, Acid Rain and Atmospheric Modification, Transportation					
UNIT IV	POLLUTION IMPACTS				9
Water Pollution, Solid Waste and Recycling, Toxic Substances and Hazardous Wastes, Global Warming.					
UNIT V	ENVIRONMENTAL ECONOMICS				9
Development, Poverty, and the Environment, Visions of the Future, Environmental economics and policy by Tom Tietenberg, Environmental Economics					
					TOTAL : 45 PERIODS

REFERENCES

1. Andrew Hoffman, Competitive Environmental Strategy - A Guide for the Changing Business Landscape, Island Press.
2. Stephen Doven, Environment and Sustainability Policy: Creation, Implementation, Evaluation, the Federation Press, 2005
3. Robert Brinkmann., Introduction to Sustainability, Wiley-Blackwell., 2016
4. Niko Roorda., Fundamentals of Sustainable Development, 3rd Edn, Routledge, 2020
5. Bhavik R Bakshi., Sustainable Engineering: Principles and Practice, Cambridge University Press, 2019

TX4092

TEXTILE REINFORCED COMPOSITES

**L T P C
3 0 0 3**

UNIT I REINFORCEMENTS 9

Introduction – composites –classification and application; reinforcements- fibres and its properties; preparation of reinforced materials and quality evaluation; preforms for various composites

UNIT II MATRICES 9

Preparation, chemistry, properties and applications of thermoplastic and thermoset resins; mechanism of interaction of matrices and reinforcements; optimization of matrices

UNIT III COMPOSITE MANUFACTURING 9

Classification; methods of composites manufacturing for both thermoplastics and thermosets- Hand layup, Filament Winding, Resin transfer moulding, prepregs and autoclave moulding, pultrusion, vacuum impregnation methods, compression moulding; post processing of composites and composite design requirements

UNIT IV TESTING 9

Fibre volume and weight fraction, specific gravity of composites, tensile, flexural, impact, compression, inter laminar shear stress and fatigue properties of thermoset and thermoplastic composites.

UNIT V MECHANICS 9

Micro mechanics, macro mechanics of single layer, macro mechanics of laminate, classical lamination theory, failure theories and prediction of inter laminar stresses using at ware

TOTAL: 45 PERIODS

REFERENCES

1. BorZ.Jang, "Advanced Polymer composites", ASM International, USA, 1994.
2. Carlsson L.A. and Pipes R.B., "Experimental Characterization of advanced composite Materials", Second Edition, CRC Press, New Jersey, 1996.
3. George Lubin and Stanley T. Peters, "Handbook of Composites", Springer Publications, 1998.
4. Mel. M. Schwartz, "Composite Materials", Vol. 1 & 2, Prentice Hall PTR, New Jersey, 1997.
5. Richard M. Christensen, "Mechanics of composite materials", Dover Publications, 2005.
6. Sanjay K. Mazumdar, "Composites Manufacturing: Materials, Product, and Process Engineering", CRC Press, 2001

NT4002

NANOCOMPOSITE MATERIALS

**L T P C
3 0 0 3**

UNIT I BASICS OF NANOCOMPOSITES 9

Nomenclature, Properties, features and processing of nanocomposites. Sample Preparation and Characterization of Structure and Physical properties. Designing, stability and mechanical properties and applications of super hard nanocomposites.

UNIT II METAL BASED NANOCOMPOSITES 9

Metal-metal nanocomposites, some simple preparation techniques and their properties. Metal-

Oxide or Metal-Ceramic composites, Different aspects of their preparation techniques and their final properties and functionality. Fractal based glass-metal nanocomposites, its designing and fractal dimension analysis. Core-Shell structured nanocomposites

UNIT III POLYMER BASED NANOCOMPOSITES 9

Preparation and characterization of diblock Copolymer based nanocomposites; Polymer Carbon nanotubes based composites, their mechanical properties, and industrial possibilities.

UNIT IV NANOCOMPOSITE FROM BIOMATERIALS 9

Natural nanocomposite systems - spider silk, bones, shells; organic-inorganic nanocomposite formation through self-assembly. Biomimetic synthesis of nanocomposites material; Use of synthetic nanocomposites for bone, teeth replacement.

UNIT V NANOCOMPOSITE TECHNOLOGY 9

Nanocomposite membrane structures- Preparation and applications. Nanotechnology in Textiles and Cosmetics-Nano-fillers embedded polypropylene fibers – Soil repellence, Lotus effect - Nano finishing in textiles (UV resistant, anti-bacterial, hydrophilic, self-cleaning, flame retardant finishes), Sun-screen dispersions for UV protection using titanium oxide – Colour cosmetics. Nanotechnology in Food Technology - Nanopackaging for enhanced shelf life - Smart/Intelligent packaging.

TOTAL : 45 PERIODS

REFERENCES:

1. Introduction to Nanocomposite Materials. Properties, Processing, Characterization- Thomas E. Twardowski. 2007. DEStech Publications. USA.
2. Nanocomposites Science and Technology - P. M. Ajayan, L.S. Schadler, P. V.Braun 2006.
3. Physical Properties of Carbon Nanotubes- R. Saito 1998.
4. Carbon Nanotubes (Carbon , Vol 33) - M. Endo, S. Iijima, M.S. Dresselhaus 1997.
5. The search for novel, superhard materials- Stan Vepřek (Review Article) JVST A, 1999
6. Nanometer versus micrometer-sized particles-Christian Brosseau, Jamal BeN Youssef, Philippe Talbot, Anne-Marie Konn, (Review Article) J. Appl. Phys, Vol 93, 2003
7. Diblock Copolymer, - Aviram (Review Article), Nature, 2002
8. Bikramjit Basu, Kantesh Balani Advanced Structural Ceramics, A John Wiley & Sons, Inc.,
9. P. Brown and K. Stevens, Nanofibers and Nanotechnology in Textiles, Woodhead publication, London, 2006

PROGRESS THROUGH KNOWLEDGE

BY4016

IPR, BIOSAFETY AND ENTREPRENEURSHIP

**L T P C
3 0 0 3**

UNIT I IPR 9

Intellectual property rights – Origin of the patent regime – Early patents act & Indian pharmaceutical industry – Types of patents – Patent Requirements – Application preparation filing and prosecution – Patentable subject matter – Industrial design, Protection of GMO's IP as a factor in R&D, IP's of relevance to biotechnology and few case studies.

UNIT II AGREEMENTS, TREATIES AND PATENT FILING PROCEDURES 9

History of GATT Agreement – Madrid Agreement – Hague Agreement – WIPO Treaties – Budapest Treaty – PCT – Ordinary – PCT – Conventional – Divisional and Patent of Addition – Specifications – Provisional and complete – Forms and fees Invention in context of "prior art" –

Patent databases – Searching International Databases – Country-wise patent searches (USPTO, espacenet(EPO) – PATENT Scope (WIPO) – IPO, etc National & PCT filing procedure – Time frame and cost – Status of the patent applications filed – Precautions while patenting – disclosure/non-disclosure – Financial assistance for patenting – Introduction to existing schemes Patent licensing and agreement Patent infringement – Meaning, scope, litigation, case studies

UNIT III BIOSAFETY

9

Introduction – Historical Background – Introduction to Biological Safety Cabinets – Primary Containment for Biohazards – Biosafety Levels – Biosafety Levels of Specific Microorganisms – Recommended Biosafety Levels for Infectious Agents and Infected Animals – Biosafety guidelines – Government of India.

UNIT IV GENETICALLY MODIFIED ORGANISMS

9

Definition of GMOs & LMOs – Roles of Institutional Biosafety Committee – RCGM – GEAC etc. for GMO applications in food and agriculture – Environmental release of GMOs – Risk Analysis – Risk Assessment – Risk management and communication – Overview of National Regulations and relevant International Agreements including Cartagena Protocol.

UNIT V ENTREPRENEURSHIP DEVELOPMENT

9

Introduction – Entrepreneurship Concept – Entrepreneurship as a career – Entrepreneurial personality – Characteristics of successful Entrepreneur – Factors affecting entrepreneurial growth – Entrepreneurial Motivation – Competencies – Mobility – Entrepreneurship Development Programmes (EDP) - Launching Of Small Enterprise - Definition, Characteristics – Relationship between small and large units – Opportunities for an Entrepreneurial career – Role of small enterprise in economic development – Problems of small scale industries – Institutional finance to entrepreneurs - Institutional support to entrepreneurs.

TOTAL : 45 PERIODS

REFERENCES

1. Bouchoux, D.E., “Intellectual Property: The Law of Trademarks, Copyrights, Patents, and Trade Secrets for the Paralegal”, 3rd Edition, Delmar Cengage Learning, 2008.
2. Fleming, D.O. and Hunt, D.L., “Biological Safety: Principles and Practices”, 4th Edition, American Society for Microbiology, 2006.
3. Irish, V., “Intellectual Property Rights for Engineers”, 2nd Edition, The Institution of Engineering and Technology, 2005.
4. Mueller, M.J., “Patent Law”, 3rd Edition, Wolters Kluwer Law & Business, 2009.
5. Young, T., “Genetically Modified Organisms and Biosafety: A Background Paper for Decision- Makers and Others to Assist in Consideration of GMO Issues” 1st Edition, World Conservation Union, 2004.
6. S.S Khanka, “Entrepreneurial Development”, S.Chand & Company LTD, New Delhi, 2007.

ANNA UNIVERSITY: CHENNAI 600 025
NON AUTONOMOUS COLLEGES AFFILIATED TO ANNA UNIVERSITY
REGULATIONS – 2021
CHOICE BASED CREDIT SYSTEM
M.E. POWER ELECTRONICS AND DRIVES (FULL TIME)

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs) :

- i. To prepare the students for successful career in power electronic industry, research and teaching institutions.
- ii. To analyze, design and develop the power electronic converter/drive systems.
- iii. To develop the ability to analyze the dynamics in power electronic converters/drives systems and design various controllers to meet the performance criteria.
- iv. To design power electronic systems and special electrical machines for efficient extraction and utilization of various renewable energy sources.
- v. To promote student awareness for the lifelong learning and to introduce them to professional ethics.

PO#	Programme Outcomes
1	An ability to independently carry out research/investigation and development work to solve practical problems
2	An ability to write and present a substantial technical report/document.
3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.
4	Apply knowledge of basic science and engineering in design and testing of power electronic systems and drives.
5	Interact with Industry in a professional and ethical manner to meet the requirements of societal needs and to contribute sustainable development of the society.
6	Implement cost effective and cutting edge technologies in power electronics and drives system.

PEO/PO Mapping:

PEO	PO					
	1	2	3	4	5	6
I.	3	3	3	2	2	1
II.	2	2	2	3	1	2
III.	3	1	1	2	2	3
IV.	3	1	2	3	3	2
V.	2	1	1	1	3	1

1,2,3,-, scale against the correlation PO's with PEO's

PROGRAM ARTICULATION MATRIX OF PG - POWER ELECTRONICS AND DRIVES ENGINEERING

		COURSE NAME	PO1	PO2	PO3	PO4	PO5	PO6
YEAR I	SEMESTER I	Applied Mathematics For Power Electronics Engineers						
		Analysis of Electrical Machines	3	3	3	3	3	3
		Analysis of Power Converters	3	0	3	3	2	2
		Modeling and Design of SMPS	2	0	2	2.2	1.8	1.8
		Research Methodology and IPR						
		Professional Elective – I						
		Audit Course I*						
	Power Converters Laboratory	2	1	3	1	2	3	
	Analog and Digital Controllers for PE Converters Laboratory	2	1	1.4	1	1.8	2	
	SEMESTER II	Analysis of Electrical Drives	1.6	1	2	3	1	1.6
		Special Electrical Machines	3	1	3	2	2	2
		Electric Vehicles and Power Management	3	3	3	2	3	2
		Professional Elective – II						
		Professional Elective – III						
Audit Course II*								
Power Electronics and Drives Laboratory		3	0	3	3	3	2	
Design Laboratory for Power Electronics Systems	3	0	3	3	3	3		
YEAR II	SEMESTER III	Professional Elective – IV						
		Professional Elective – V						
		Open Elective						
		Project Work – I						
	SEMESTER IV	Project Work – II						

ANNA UNIVERSITY: CHENNAI 600 025
NON AUTONOMOUS COLLEGES AFFILIATED TO ANNA UNIVERSITY
REGULATIONS – 2021
CHOICE BASED CREDIT SYSTEM
M.E. POWER ELECTRONICS AND DRIVES (FULL TIME)
I TO IV SEMESTERS CURRICULUM AND SYLLABUS

SEMESTER I

S.NO	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	MA4106	Applied Mathematics for Power Electronics Engineers	FC	3	1	0	4	4
2.	PX4101	Analysis of Electrical Machines	PCC	3	1	0	4	4
3.	PX4151	Analysis of Power Converters	PCC	3	1	0	4	4
4.	PX4102	Modeling and Design of SMPS	PCC	3	0	0	3	3
5.	RM4151	Research Methodology and IPR	RMC	2	0	0	2	2
6.		Professional Elective I	PEC	3	0	0	3	3
7.		Audit Course I*	AC	2	0	0	2	0
PRACTICALS								
8.	PX4161	Power Converters Laboratory	PCC	0	0	3	3	1.5
9.	PX4111	Analog and Digital Controllers for PE Converters Laboratory	PCC	1	0	3	4	2.5
TOTAL				20	3	6	29	24

* Audit Course is optional

SEMESTER II

S.NO	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	PX4201	Analysis of Electrical Drives	PCC	3	1	0	4	4
2.	PX4202	Special Electrical Machines	PCC	3	0	0	3	3
3.	PX4291	Electric Vehicles and Power Management	PCC	3	1	0	4	4
4.		Professional Elective II	PEC	3	0	0	3	3
5.		Professional Elective III	PEC	3	0	0	3	3
6.		Audit course II*	AC	2	0	0	2	0
PRACTICALS								
7.	PX4211	Power Electronics and Drives Laboratory	PCC	0	0	3	3	1.5
8.	PX4212	Design Laboratory for Power Electronics Systems	PCC	0	0	3	3	1.5
TOTAL				17	2	6	25	20

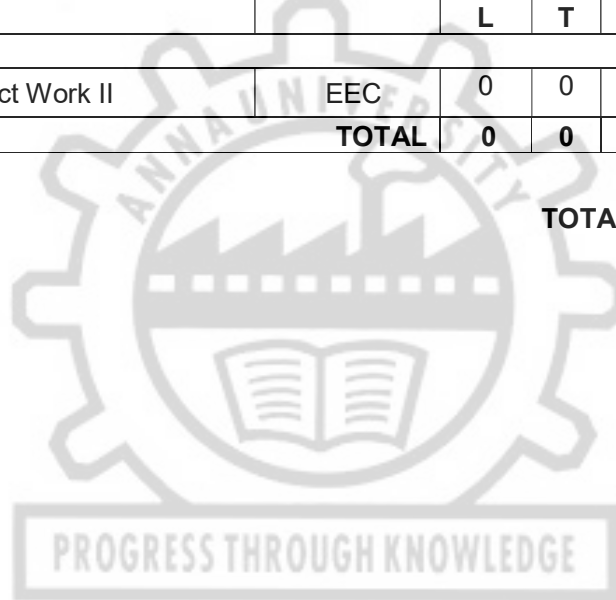
* Audit Course is optional

SEMESTER III

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.		Professional Elective IV	PEC	3	0	0	3	3
2.		Professional Elective V	PEC	3	0	0	3	3
3.		Open Elective	OEC	3	0	0	3	3
PRACTICALS								
4.	PX4311	Project Work I	EEC	0	0	12	12	6
TOTAL				9	0	12	21	15

SEMESTER IV

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
PRACTICALS								
1.	PX4411	Project Work II	EEC	0	0	24	24	12
TOTAL				0	0	24	24	12

TOTAL NO. OF CREDITS: 71

FOUNDATION COURSES (FC)

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			LECTURE	TUTORIAL	PRACTICAL		
1.	MA4106	Applied Mathematics for Power Electronics Engineers	3	1	0	4	I

PROFESSIONAL CORE COURSES (PCC)

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			LECTURE	TUTORIAL	PRACTICAL		
1	PX4101	Analysis of Electrical Machines	3	1	0	4	I
2	PX4151	Analysis of Power Converters	3	1	0	4	I
3	PX4102	Modeling and Design of SMPS	3	0	0	3	I
4	PX4161	Power Converters Laboratory	0	0	3	1.5	I
5	PX4111	Analog and Digital Controllers for PE Converters Laboratory	1	0	3	2.5	I
6	PX4201	Analysis of Electrical Drives	3	1	0	4	II
7	PX4202	Special Electrical Machines	3	0	0	3	II
8	PX4291	Electric Vehicles and Power Management	3	1	0	4	II
9	PX4211	Power Electronics and Drives Laboratory	0	0	3	1.5	II
10	PX4212	Design Laboratory for Power Electronics Systems	1	0	3	1.5	II
TOTAL CREDITS						29	

RESEARCH METHODOLOGY AND IPR COURSES (RMC)

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			LECTURE	TUTORIAL	PRACTICAL		
1.	RM4151	Research Methodology and IPR	2	0	0	2	I

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

S.NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			LECTURE	TUTORIAL	PRACTICAL		
1.	PX4311	Project Work I	0	0	12	6	III
2.	PX4411	Project Work II	0	0	24	12	IV
TOTAL CREDITS						18	

PROFESSIONAL ELECTIVES

SEMESTER I ELECTIVE I

S. NO.	COURS ECODE	COURSE TITLE	CATE- GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1	PX4001	Power Semiconductor Devices	PEC	3	0	0	3	3
2	PX4002	System Design Using Microcontroller	PEC	3	0	0	3	3
3	PX4003	Electromagnetic Field Computation and Modelling	PEC	3	0	0	3	3
4	PX4004	Soft Computing Techniques	PEC	3	0	0	3	3
5	PS4151	System Theory	PEC	3	0	0	3	3

SEMESTER II ELECTIVE II & III

S. NO.	COURS ECODE	COURSE TITLE	CATE- GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1	PX4005	Power Electronics for Renewable Energy Systems	PEC	3	0	0	3	3
2	PX4006	Modern Rectifiers and Resonant Converters	PEC	3	0	0	3	3
3	PX4007	Advanced Power Converters	PEC	3	0	0	3	3
4	PX4009	Control of Power Electronic Circuits	PEC	3	0	0	3	3
5	PS4072	Energy Storage Technologies	PEC	3	0	0	3	3
6	PX4071	Power Quality	PEC	3	0	0	3	3
7	ET4071	DSP Based System Design	PEC	3	0	0	3	3
8	ET4072	Machine Learning and Deep Learning	PEC	3	0	0	3	3
9	ET4251	IoT for Smart Systems	PEC	3	0	0	3	3
10	ET4018	MEMS Design: Sensors and Actuators	PEC	3	0	0	3	3

**SEMESTER III
ELECTIVE IV & V**

S. NO.	COURS ECODE	COURSE TITLE	CATE- GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1	PX4010	Nonlinear Dynamics for Power Electronics Circuits	PEC	3	0	0	3	3
2	PX4011	Grid Integration of Renewable Energy Sources	PEC	3	0	0	3	3
3	PX4012	Renewable Energy Technology	PEC	3	0	0	3	3
4	PX4013	Wind Energy Conversion System	PEC	3	0	0	3	3
5	PX4014	Optimization Techniques	PEC	3	0	0	3	3
6	PS4091	Distributed Generation and Micro Grid	PEC	3	0	0	3	3
7	PS4071	Energy Management and Auditing	PEC	3	0	0	3	3
8	PS4093	Smart Grid	PEC	3	0	0	3	3
9	PS4351	HVDC and FACTS	PEC	3	0	0	3	3
10	ET4073	Python Programming for Machine Learning	PEC	3	0	0	3	3

AUDIT COURSES - I

REGISTRATION FOR ANY OF THESE COURSES IS OPTIONAL TO STUDENTS

SL. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS
			L	T	P	
1.	AX4091	English for Research Paper Writing	2	0	0	0
2.	AX4092	Disaster Management	2	0	0	0
3.	AX4093	Constitution of India	2	0	0	0
4.	AX4094	நற்றமிழ்இலக்கியம்	2	0	0	0

LIST OF OPEN ELECTIVES FOR PG PROGRAMMES

SL. NO.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS
			L	T	P	
1.	OCE431	Integrated Water Resources Management	3	0	0	3
2.	OCE432	Water, Sanitation and Health	3	0	0	3
3.	OCE433	Principles of Sustainable Development	3	0	0	3
4.	OCE434	Environmental Impact Assessment	3	0	0	3
5.	OIC431	Blockchain Technologies	3	0	0	3
6.	OIC432	Deep Learning	3	0	0	3
7.	OME431	Vibration and Noise Control Strategies	3	0	0	3
8.	OME432	Energy Conservation and Management in Domestic Sectors	3	0	0	3
9.	OME433	Additive Manufacturing	3	0	0	3
10.	OME434	Electric Vehicle Technology	3	0	0	3
11.	OME435	New Product Development	3	0	0	3
12.	OBA431	Sustainable Management	3	0	0	3
13.	OBA432	Micro and Small Business Management	3	0	0	3
14.	OBA433	Intellectual Property Rights	3	0	0	3
15.	OBA434	Ethical Management	3	0	0	3
16.	CP4391	Security Practices	3	0	0	3
17.	MP4251	Cloud Computing Technologies	3	0	0	3
18.	IF4072	Design Thinking	3	0	0	3
19.	MU4153	Principles of Multimedia	3	0	0	3
20.	DS4015	Big Data Analytics	3	0	0	3
21.	NC4201	Internet of Things and Cloud	3	0	0	3
22.	MX4073	Medical Robotics	3	0	0	3
23.	VE4202	Embedded Automation	3	0	0	3
24.	CX4016	Environmental Sustainability	3	0	0	3
25.	TX4092	Textile Reinforced Composites	3	0	0	3
26.	NT4002	Nanocomposite Materials	3	0	0	3
27.	BY4016	IPR, Biosafety and Entrepreneurship	3	0	0	3

SUMMARY

Name of the Programme: M.E POWER ELECTRONICS AND DRIVES						
	SUBJECT AREA	CREDITS PER SEMESTER				CREDITS TOTAL
		I	II	III	IV	
1.	FC	4	0	0	0	4
2.	PCC	15	14	0	0	29
3.	PEC	3	6	6	0	15
4.	OEC	0	0	3	0	3
5.	EEC	0	0	6	12	18
6.	RMC	2	0	0	0	2
7.	Non Credit/Audit Course	√	√	0	0	0
	TOTAL	24	20	15	12	71



OBJECTIVES :

- To develop the ability to apply the concepts of matrix theory in Electrical Engineering problems.
- To familiarize the students in the field of differential equations to solve boundary value problems associated with engineering applications.
- To develop the ability among the students to solve problems using Laplace transform associated with engineering applications.
- To introduce the effective mathematical tools for the solutions of partial differential equations that model several physical processes and to develop Z transform techniques for discrete time systems.
- To develop the ability among the students to solve problems using Fourier series associated with engineering applications.

UNIT I MATRIX THEORY 12

The Cholesky decomposition - Generalized Eigenvectors - Canonical basis - QR factorization - Singular value decomposition - Pseudo inverses - Least square approximation.

UNIT II CALCULUS OF VARIATIONS 12

Concept of variations and its properties - Euler's theorem - Functional dependent on first and higher order of derivatives - Functionals dependent on functions of several independent variables - Variational problems with moving boundaries - Isoperimetric problems - Direct methods : Rayleigh Ritz method and Kantorovich problems .

UNIT III LAPLACE TRANSFORM TECHNIQUES FOR PARTIAL DIFFERENTIAL EQUATIONS 12

Definitions - Properties - Transform error function - Bessel's function - Dirac Delta function - Unit step function - Convolution theorem - Inverse Laplace transform - Complex inversion formula - Solutions to partial differential equations : Heat and Wave equations.

UNIT IV Z - TRANSFORM TECHNIQUES FOR PARTIAL DIFFERENTIAL EQUATIONS 12

Z-transforms - Elementary properties – Convergence of Z-transforms - Initial and final value theorems - Inverse Z - transform (using partial fraction and residues) - Convolution theorem - Formation of difference equations – Solution of difference equations using Z - transforms.

UNIT V FOURIER SERIES 12

Fourier Trigonometric series : Periodic function as power signals - Convergence of series - Even and odd functions : Cosine and sine series - Non periodic function - Extension to other intervals - Power signals : Exponential Fourier series - Parseval's theorem and power spectrum - Eigenvalue problems and orthogonal functions - Regular Sturm –Liouville systems - Generalized Fourier series.

TOTAL : 60 PERIODS

OUTCOMES :

- Able to apply the concepts of matrix theory in Electrical Engineering problems.
- Able to solve boundary value problems associated with engineering applications.
- Able to solve problems using Laplace transform associated with engineering applications.
- Use the effective mathematical tools for the solutions of partial differential equations by using Z transform techniques for discrete time systems.
- Able to solve problems using Fourier series associated with engineering applications.

MAPPING OF CO'S WITH PO'S

CO	PO					
	1	2	3	4	5	6
1	3	2	2	3	1	1
2	3	2	2	3	1	1
3	3	2	2	3	1	1
4	3	2	2	3	1	1
5	3	2	2	3	1	1
AVG	3	2	2	3	1	1

REFERENCES:

1. Richard Bronson, MATRIX OPERATION , Schaum's outline series, Second Edition, McGraw Hill, New Delhi , 2011.
2. Elsgolc. L.D., " CALCULUS OF VARIATIONS " , Dover Publications Inc., New York, 2007.
3. SankaraRao. K , INTRODUCTION TO PARTIAL DIFFERENTIAL EQUATIONS , Prentice Hall of India Pvt . Ltd, New Delhi , 1997.
4. Grewal.B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 44th Edition , 2018.
5. Andrews .L.C, and Phillips. R.L., MATHEMATICAL TECHNIQUES FOR ENGINEERS AND SCIENTISTS , Prentice Hall , New Delhi , 2005.

PX4101

ANALYSIS OF ELECTRICAL MACHINES

**LT P C
3 1 0 4**

OBJECTIVES:

- To understand the principles of electromechanical energy conversion in electrical machines and to know the dynamic characteristics of DC motors
- To study the concepts related with AC machines, magnetic noise and harmonics in rotating electrical machines.
- To interpret the principles of reference frame theory
- To study the principles of three phase, doubly fed and 'n' phase induction machine in machine variables and reference variables.
- To understand the principles of three phase, synchronous machine in machine variables and reference variables.

UNIT I ELECTROMECHANICAL ENERGY CONVERSION and DC MACHINES 12

Magnetic circuits, permanent magnet, Energy conservation - stored magnetic energy, co-energy - force and torque in singly and doubly excited systems – Elementary DC machine and analysis of steady state operation - Voltage and torque equations – dynamic characteristics - DC motors – Time domain block diagrams - solution of dynamic characteristic by Laplace transformation

UNIT II AC MACHINES -CONCEPTS 12

Distributed Windings - Winding Functions - Air-Gap Magnetomotive Force -Rotating MMF - Flux Linkage and Inductance -Resistance -Voltage and Flux Linkage Equations for Distributed Winding Machines--magnetic noise and harmonics in rotating electrical machines. Modeling of 'n' phase machine.

UNIT III REFERENCE FRAME THEORY 12

Historical background – phase transformation and commutator transformation – transformation of variables from stationary to arbitrary reference frame – transformation of balanced set-variables observed from several frames of reference.

UNIT IV INDUCTION MACHINES 12

Three phase induction machine and doubly fed induction machine- equivalent circuit and analysis of steady state operation – free acceleration characteristics – voltage and torque equations in machine variables and arbitrary reference frame variables – analysis of dynamic performance for load torque variations- Transformation theory for ‘n’ phase induction machine.

UNIT V SYNCHRONOUS MACHINES 12

Three phase synchronous machine and analysis of steady state operation - voltage and torque equations in machine variables and rotor reference frame variables (Park’s equations) – analysis of dynamic performance for load torque variations –Krons primitive machine

TOTAL : 60 PERIODS**OUTCOMES:**

After completion of this course, student will be able to

- CO1: Understand the principles of electromechanical energy conversion and characteristics of DC motors
- CO2: Know the concepts related with AC machines and modeling of ‘n’ phase machines
- CO3: Interpret the concepts of reference frame theory.
- CO4: Apply procedures to develop induction machine model in both machine variable form and reference variable forms
- CO5: Follow the procedures to develop synchronous machine model in machine variables form and reference variable form.

REFERENCES:

- 1 Stephen D. Umans, “Fitzgerald & Kingsley’s Electric Machinery”, Tata McGraw Hill, 7th Edition, 2020.
- 2 Bogdan M. Wilamowski, J. David Irwin, The Industrial Electronics Handbook, Second Edition, Power Electronics and Motor Drives, CRC Press, 2011
- 3 Paul C. Krause, Oleg Wasynczuk, Scott D. Sudhoff, Steven D. Pekarek, “Analysis of Electric Machinery and Drive Systems”, 3rd Edition, Wiley-IEEE Press, 2013.
- 4 R. Krishnan, Electric Motor & Drives: Modeling, Analysis and Control, Pearson Education, 1st Imprint, 2015.
- 5 R.Ramanujam, Modeling and Analysis of Electrical Machines, I.k. International Publishing House Pvt.Ltd, 2018

CO-PO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	3	2
CO2	3	3	3	3	3	2
CO3	3	3	3	3	3	2
CO4	3	3	3	3	3	2
CO5	3	3	3	3	3	2
AVG	3	3	3	3	3	2

OBJECTIVES:

- To provide the mathematical fundamentals necessary for deep understanding of power converter operating modes.
- To introduce the electrical circuit concepts behind the different working modes of power converters so as to enable deep understanding of their operation.
- To impart required skills to formulate and design inverters for generic load and for machine loads.
- To equip with required skills to derive the criteria for the design of power converters starting from basic fundamentals.
- To inculcate knowledge to perform analysis and comprehend the various operating modes of different configurations of power converters

UNIT I SINGLE PHASE AC-DC CONVERTER 12

Static Characteristics of power diode, SCR and GTO, half controlled and fully controlled converters with R-L, R-L-E loads and freewheeling diodes – continuous and discontinuous modes of operation - inverter operation and its limit –Sequence control of converters – performance parameters – effect of source impedance and overlap-reactive power and power balance in converter circuit.

UNIT II THREE PHASE AC-DC CONVERTER 12

Half controlled and fully controlled converters with R, R-L, R-L-E loads and freewheeling diodes – inverter operation and its limit – performance parameters – effect of source impedance and overlap - 12 pulse converter –Applications - Excitation system, DC drive system.

UNIT III SINGLE PHASE INVERTERS 12

Introduction to self-commutated switches : MOSFET and IGBT - Principle of operation of half and full bridge inverters – Performance parameters – Voltage control of single phase inverters using various PWM techniques – various harmonic elimination techniques – Design of UPS - VSR operation

UNIT IV THREE PHASE INVERTERS 12

180 degree and 120 degree conduction mode inverters with star and delta connected loads – voltage control of three phase inverters: single, multi pulse, sinusoidal, space vector modulation techniques – VSR operation-Application – Induction heating, AC drive system – Current source inverters.

UNIT V MODERN INVERTERS 12

Multilevel concept – diode clamped – flying capacitor – cascaded type multilevel inverters - Comparison of multilevel inverters - application of multilevel inverters – PWM techniques for MLI – Single phase & Three phase Impedance source inverters – Filters.

TOTAL : 60 PERIODS**OUTCOMES:**

After completing the above course, students will be able to

CO1 : Acquire and apply knowledge of mathematics in power converter analysis

CO2: Model, analyze and understand power electronic systems and equipments.

CO3 :Formulate, design and simulate phase controlled rectifiers for generic load and for machine loads

CO4 : Design and simulate switched mode inverters for generic load and for machine loads

CO5 : Select device and calculate performance parameters of power converters under various operating modes

REFERENCES:

1. Rashid M.H., "Power Electronics Circuits, Devices and Applications ", Pearson, fourth Edition, 10th Impression 2021.
2. Jai P. Agrawal, "Power Electronics System Theory and Design", Pearson Education, First Edition, 2015
3. Bimal.K.Bose "Modern Power Electronics and AC Drives", Pearson Education, Second Edition, 2003
4. Ned Mohan, T.M.Undeland and W.P.Robbins, "Power Electronics: converters, Application and design", 3rd edition Wiley, 2007.
5. Philip T. Krein, "Elements of Power Electronics" Indian edition Oxford University Press-2017
6. P.C.Sen, "Modern Power Electronics", S.Chand Publishing 2005.
7. P.S.Bimbira, "Power Electronics", Khanna Publishers, Eleventh Edition, 2003
8. Bin Wu, Mehdi Narimani, "High-Power Converters and AC Drives", Wiley, 2nd Edition, 2017

CO-PO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	3	3	2	2
CO2	3	-	3	3	2	2
CO3	3	-	3	3	2	2
CO4	3	-	3	3	2	2
CO5	3	-	3	3	2	2
AVG	3	-	3	3	2	2

PX4102**MODELING AND DESIGN OF SMPS****LT P C
3 0 0 3****OBJECTIVES:**

1. To inculcate knowledge on steady state analysis of Non-Isolated DC-DC converter
2. To perform steady state analysis of Isolated DC-DC converter
3. To educate on different converter dynamics
4. To impart knowledge on the design of controllers for DC-DC converters
5. To familiarize the design magnetics for SMPS applications

UNIT I ANALYSIS OF NON-ISOLATED DC-DC CONVERTERS**9**

Buck, Boost, Buck- Boost and Cuk converters: Principles of operation – Continuous conduction mode– Concepts of volt-sec balance and charge balance – Analysis and design based on steady-state relationships – Introduction to discontinuous conduction mode - SEPIC topology - design examples - Applications to Battery operated vehicle, PV system.

UNIT II ANALYSIS OF ISOLATED DC-DC CONVERTERS**9**

Introduction - classification- forward- flyback- pushpull – half bridge – full bridge topologies- design of SMPS - Applications to Battery operated vehicle

UNIT III CONVERTER DYNAMICS**9**

AC equivalent circuit analysis – State space averaging – Circuit averaging – Averaged switch modeling – Transfer function model for buck, boost, buck-boost and cuk converters – Input filters.

UNIT IV CONTROLLER DESIGN**9**

Review of P, PI, and PID control concepts – gain margin and phase margin – Bode plot based analysis – Design of controller for buck, boost, buck-boost and cuk converters

UNIT V DESIGN OF MAGNETICS**9**

Basic magnetic theory revision – Inductor design – Design of mutual inductance – Design of transformer for isolated topologies – Ferrite core table and selection of area product – wire table – selection of wire gauge

TOTAL : 45 PERIODS**OUTCOMES:**

After completing the above course, students will be able to

CO1 : Analyse and design Non-Isolated DC-DC converter

CO2: Analyse and design Isolated DC-DC converter

CO3: Derive transfer function of different converters

CO4 : Design controllers for DC-DC converters

CO5 : Design magnetics for SMPS application

TEXT BOOKS:

1. Robert W. Erickson & Dragon Maksimovic, "Fundamentals of Power Electronics", Third Edition, 2020.

REFERENCES:

1. John G. Kassakian, Martin F. Schlecht, George C. Verghese, "Principles of Power Electronics", Pearson, India, New Delhi, 2010
2. Simon Ang and Alejandra Oliva, "Power-Switching Converters", CRC press, 3rd edition, 2011.
3. Philip T Krein, "Elements of Power Electronics", Oxford University Press, 2017.
4. Ned Mohan, "Power Electronics: A first course", Wiley, 2011, 1st edition.
5. Issa Batarseh, Ahmad Harb, "Power Electronics- Circuit Analysis and Design, Second edition, 2018
- 6 V.Ramanarayanan, "Course material on Switched mode power conversion", 2007
7. Alex Van den Bossche and Vencislav Cekov Valchev, "Inductors and Transformers for Power Electronics", CRC Press, 1st edition, 2005.
8. W. G. Hurley and W. H. Wolfe, "Transformers and Inductors for Power Electronics Theory, Design and Applications", 2013 Wiley, 1st Edition.

CO-PO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	1	-	3	3	2	2
CO2	1	-	2	2	3	2
CO3	2	-	2	3	2	1
CO4	3	-	2	1	1	2
CO5	3	-	1	2	1	2
AVG	2	-	2	2.2	1.8	1.8

RM4151**RESEARCH METHODOLOGY AND IPR****L T P C****2 0 0 2****UNIT I RESEARCH DESIGN****6**

Overview of research process and design, Use of Secondary and exploratory data to answer the research question, Qualitative research, Observation studies, Experiments and Surveys.

UNIT II DATA COLLECTION AND SOURCES 6

Measurements, Measurement Scales, Questionnaires and Instruments, Sampling and methods.
Data - Preparing, Exploring, examining and displaying.

UNIT III DATA ANALYSIS AND REPORTING 6

Overview of Multivariate analysis, Hypotheses testing and Measures of Association. Presenting Insights and findings using written reports and oral presentation.

UNIT IV INTELLECTUAL PROPERTY RIGHTS 6

Intellectual Property – The concept of IPR, Evolution and development of concept of IPR, IPR development process, Trade secrets, utility Models, IPR & Bio diversity, Role of WIPO and WTO in IPR establishments, Right of Property, Common rules of IPR practices, Types and Features of IPR Agreement, Trademark, Functions of UNESCO in IPR maintenance.

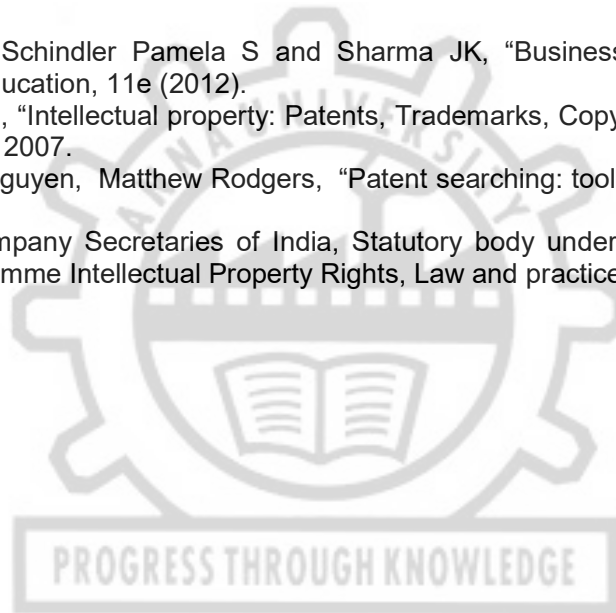
UNIT V PATENTS 6

Patents – objectives and benefits of patent, Concept, features of patent, Inventive step, Specification, Types of patent application, process E-filing, Examination of patent, Grant of patent, Revocation, Equitable Assignments, Licences, Licensing of related patents, patent agents, Registration of patent agents.

TOTAL : 30 PERIODS

REFERENCES

1. Cooper Donald R, Schindler Pamela S and Sharma JK, "Business Research Methods", Tata McGraw Hill Education, 11e (2012).
2. Catherine J. Holland, "Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets", Entrepreneur Press, 2007.
3. David Hunt, Long Nguyen, Matthew Rodgers, "Patent searching: tools & techniques", Wiley, 2007.
4. The Institute of Company Secretaries of India, Statutory body under an Act of parliament, "Professional Programme Intellectual Property Rights, Law and practice", September 2013.



OBJECTIVES:

- To provide the basic understanding of the dynamic behavior of the power electronic switches
- To make the students familiar with the digital processors used in generation of gate pulses for the power electronic switches
- To make the students acquire knowledge on the design of power electronic circuits and implementing the same using simulation tools
- To facilitate the students to design gate drive circuits for power converters
- To provide the fundamentals of DC-AC power converter topologies and analyze the harmonics.

LIST OF EXPERIMENTS:

1. Study of switching characteristics of Power MOSFET & IGBT.
2. Circuit Simulation of Three-phase semi-converter with R, RL & RLE load.
3. Circuit Simulation of Three-phase fully controlled converter with R, RL & RLE load.
4. Circuit Simulation of Three-phase Voltage Source Inverter in 180 and 120 degree mode of conduction
5. Circuit simulation of Three-phase PWM inverter and study of spectrum analysis for various modulation indices.
6. Simulation of Four quadrant operation of DC Chopper.
7. Generation of Gating pulse using Arduino/Micro Controller/PIC microcontroller for a DC-DC converter and single-phase voltage source inverter.
8. Simulation of a single-phase Z-source inverter with R load.
9. Simulation of three-phase AC voltage Controller with R load.
10. Simulation of a five-level cascaded multilevel inverter with R load.
11. Simulation of a Flyback DC-DC converter

TOTAL : 45 PERIODS**OUTCOMES:**

- CO1: Comprehensive understanding on the switching behaviour of Power Electronic Switches
- CO2: Comprehensive understanding on mathematical modeling of power electronic system and ability to implement the same using simulation tools
- CO3: Ability of the student to use arduino/microcontroller for power electronic applications
- CO4: Ability of the student to design and simulate various topologies of inverters and analyze their harmonic spectrum
- CO5: Ability to design and fabricate the gate drive power converter circuits.
Analyze the three-phase controlled rectifiers and isolated DC-DC converters for designing the power supplies

CO-PO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	3	1	2	
CO2	2		3	1	2	3
CO3	2		3			
CO4	2		3		2	
CO5	2		3			3
Avg.	2	1	3	1	2	3

OBJECTIVES:

- To understand the concepts related with analog and digital controllers.
- To design and understand the op-amp circuits and microcontroller circuits for power electronics.
- To study and design the driving circuits, sensing circuits, protection circuits for power converters.
- To design and select the appropriate digital controller for power converters along with control strategy

LIST OF EXPERIMENTS:

1. Amplifiers and buffer design and verification by using Opamp
2. Filter design and verification by using Opamp
3. ON/OFF controller design and verification by using analog circuits
4. Design of Driver Circuit using IR2110
5. Waveform generation by using look up table
6. Generation of PWM gate pulses with duty cycle control using PWM peripheral of microcontroller (TI-C2000 family/ PIC18)
7. Duty cycle control from IDE
8. Duty Cycle control using a POT connected to ADC peripheral in a standalone mode
9. Generation of Sine-PWM pulses for a single and three phase Voltage Source Inverter with control of modulation index using PWM peripheral of microcontroller (TI C2000 family/PIC 18)
10. Design and testing of signal conditioning circuit to interface voltage/current sensor with microcontroller (TI-C2000 family/ PIC18)
11. Interface Hall effect voltage and current sensor with microcontroller and display the current waveform in the IDE and validate with actual waveform in DSO
12. Design of closed loop P, I and PI controllers using OP-AMP
13. Design of closed loop P, I and PI controllers using TI-C2000 family/ PIC18

TOTAL : 60 PERIODS**OUTCOMES:**

After completing the above course, students will be able to

- CO1: Identification of suitable analog and digital controller for the converter design.
- CO2: Know the advantages of gate driver, sensing and protection circuits in power converters.
- CO3: Hands on with different controller with strategies for design.
- CO4: Design and testing the proper driving circuits and protection circuits.
- CO5: Fabrication of analog and digital controllers for various real time applications.

CO-PO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2		1	1	1	2
CO2	2		1	1	2	2
CO3	2		2	1	2	2
CO4	2		1	1	2	2
CO5	2	1	2	1	2	2
AVG.	2	1	1.4	1	1.8	2

OBJECTIVES:

To understand steady state operation and transient dynamics of a motor load system

- To study and analyse the operation of the converter / chopper fed DC drive, both qualitatively and quantitatively
- To analyse and design the current and speed controllers for a closed loop solid state DC motor drive.
- To understand the drive characteristics for different load torque profiles and quadrants of operation
- To understand the speed control of induction motor drive from stator and rotor sides.
- To study and analyse the operation of VSI & CSI fed induction motor control and pulse width modulation techniques

UNIT I DC MOTORS FUNDAMENTALS AND MECHANICAL SYSTEMS 12

DC motor- Types, induced emf, speed-torque relations; Speed control – Armature and field speed control; Ward Leonard control – Constant torque and constant horse power operation- Introduction to high speed drives and modern drives. Characteristics of mechanical system– dynamic equations, components of torque, types of load; Requirements of drives characteristics – stability of drives–multi-quadrant operation; Drive elements, types of motor duty and selection of motor rating.

UNIT II CONVERTER AND CHOPPER CONTROL 12

Principle of phase control – Fundamental relations; Analysis of series and separately excited DC motor with single-phase and three-phase converters –performance parameters, performance characteristics. Introduction to time ratio control and frequency modulation; chopper controlled DC motor – performance analysis, multi-quadrant control – Chopper based implementation of braking schemes; Related problems

UNIT III CLOSED LOOP CONTROL 12

Modeling of drive elements – Equivalent circuit, transfer function of self, separately excited DC motors; Linear Transfer function model of power converters; Sensing and feeds back elements – Closed loop speed control – current and speed loops, P, PI and PID controllers – response comparison. Simulation of converter and chopper fed DC drive

UNIT IV VSI AND CSI FED STATOR CONTROLLED INDUCTION MOTOR CONTROL 12

AC voltage controller – six step inverter voltage control-closed loop variable frequency PWM inverter fed induction motor (IM) with braking-CSI fed IM variable frequency motor drives – pulse width modulation techniques – simulation of closed loop operation of stator controlled induction motor drives

UNIT V ROTOR CONTROLLED INDUCTION MOTOR DRIVES 12

Static rotor resistance control – injection of voltage in the rotor circuit – static scherbius drives – static and modified Kramer drives – sub-synchronous and super-synchronous speed operation of induction machines – simulation of closed loop operation of rotor controlled induction motor drives

TOTAL : 60 PERIODS

OUTCOMES:

- CO1: Ability to acquire and apply knowledge of mathematics and converter/machine dynamics in Electrical engineering.
- CO2: Ability to formulate, design, simulate power supplies for generic load and for machine loads.
- CO3: Ability to analyze, comprehend, design and simulate direct current motor based adjustable speed drives.
- CO4: Ability to analyze, comprehend, design and simulate induction motor based adjustable speed drives.
- CO5: Ability to design a closed loop motor drive system with controllers for the current and speed control operations.

TEXTBOOKS:

1. Gopal K Dubey, "Power Semiconductor controlled Drives", Prentice Hall Inc., NewYersy, 1989
2. R. Krishnan, "Electric Motor Drives – Modeling, Analysis and Control", Prentice-Hall of India Pvt. Ltd., New Delhi, 2010
3. Bimal K Bose, "Modern Power Electronics and AC Drives", Pearson Education Asia 2002

REFERENCES:

1. Gopal K. Dubey, "Fundamentals of Electrical Drives", Narosal Publishing House, New Delhi, Second Edition, 2009.
2. Vedam Subramanyam, "Electric Drives – Concepts and Applications", Tata McGraw- Hill publishing company Ltd., New Delhi, 2002.
3. P.C Sen "Thyristor DC Drives", John Wiley and sons, New York, 1981.
4. W. Leonhard, "Control of Electrical Drives", Narosa Publishing House, 1992.
5. Murphy J.M.D and Turnbull, "Thyristor Control of AC Motors", Pergamon Press, Oxford, 1988.

CO-PO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	2	3	1	1
CO2	2	2	2	3	1	1
CO3	2	1	2	3	1	2
CO4	1	1	2	3	1	2
CO5	1	1	2	3	1	2
AVG.	1.6	1	2	3	1	1.6

OBJECTIVES:

- To understand the working, characteristics and speed control principles of stepper motor.
- To study the construction, working, characteristics and speed control methods of switched reluctance motors. .
- To know the principle of operation, construction, characteristics and speed control methods for the permanent magnet brushless DC motors.
- To understand the concepts related with permanent magnet synchronous motors and synchronous reluctance motors.
- To know the features of axial flux machines and its working principles

UNIT I STEPPER MOTORS 9

Constructional features –Principle of operation –Types – Torque predictions – Linear and Non-linear analysis – Characteristics – Drive circuits – Closed loop control –Applications

UNIT II SWITCHED RELUCTANCE MOTORS 9

Constructional features –Principle of operation- Torque prediction–Characteristics-Power controllers – Control of SRM drive- Speed control-current control-design procedures- Sensorless operation of SRM – Current sensing- rotor position measurement and estimation methods-sensorless rotor position estimation-inductance based estimation –applications

UNIT III PERMANENT MAGNET BRUSHLESS DC MOTORS 9

Fundamentals of Permanent Magnets- Types- Principle of operation- Magnetic circuit analysis EMF and Torque equations- Characteristics- Controller design-Transfer function –Machine, Load and Inverter-Current and Speed Controller

UNIT IV PERMANENT MAGNET SYNCHRONOUS MOTORS 9

Permanent Magnet ac Machines, Machine Configurations, PMSM - Principle of operation – EMF and Torque equations - Phasor diagram - Torque speed characteristics – Modeling and small signal equations- evaluation of control characteristics- design of current and speed controllers- Constructional features, operating principle and characteristics of synchronous reluctance motor

UNIT V AXIAL FLUX MACHINES 9

Axial Flux Permanent Magnet Machines- Comparison with Radial Flux Machines- Development- Geometries, Principle of Operation-Torque production - Applications.
Axial flux switched reluctance machine- Topologies and Structures -Operating Principles -Output Equation- Applications

TOTAL : 45 PERIODS**OUTCOMES:**

After the completion of this course, student will be able to

- CO1: Know the concepts related with stepper motor.
- CO2: Understand the working and various characteristics of switched reluctance machines.
- CO3: Study the working principle and characteristics of permanent magnet brushless DC motors.
- CO4: Know the construction, working principles and characteristics of permanent magnet synchronous motor and synchronous reluctance motor.
- CO5: Understand the features of axial flux machines in comparison with radial flux machines and to know the principles of axial flux machines.

REFERENCES:

1. Jacek F. Gieras, Dr. Rong-Jie Wang, Professor Maarten J. Kamper - Axial Flux Permanent Magnet Brushless Machines-Springer Netherlands (2008)
2. Bilgin, Berker, Emadi, Ali, Jiang, James Weisheng - Switched reluctance motor drives: fundamentals to applications-CRC (2019)
3. Ramu Krishnan - Permanent Magnet Synchronous and Brushless DC Motor Drives -CRC Press, Marcel Applications -CRC Press (2001)
4. T. Kenjo, 'Stepping motors and their microprocessor controls', Oxford University press, New Delhi, 2000 Dekker (2009)
4. T.J.E. Miller, 'Brushless magnet and Reluctance motor drives', Clarendon press, London, 1989
5. R. Krishnan - Switched Reluctance Motor Drives_ Modeling, Simulation, Analysis, Design, and Applications -CRC Press (2001)

CO-PO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	3	2	2	2
CO2	3	1	3	2	2	2
CO3	3	1	3	2	2	2
CO4	3	1	3	2	2	2
CO5	3	1	3	2	2	2
AVG.	3	1	3	2	2	2

PX4291**ELECTRIC VEHICLES AND POWER MANAGEMENT****LT P C
3 1 0 4****OBJECTIVES:**

- To understand the concept of electric vehicles and its operations
- To present an overview of Electric Vehicle (EV), Hybrid Electric vehicle (HEV) and their architecture
- To understand the need for energy storage in hybrid vehicles
- To provide knowledge about various possible energy storage technologies that can be used in electric vehicles

UNIT I ELECTRIC VEHICLES AND VEHICLE MECHANICS 12

Electric Vehicles (EV), Hybrid Electric Vehicles (HEV), Engine ratings- Comparisons of EV with internal combustion Engine vehicles- Fundamentals of vehicle mechanics.

UNIT II ARCHITECTURE OF EV's AND POWER TRAIN COMPONENTS 12

Architecture of EV's and HEV's – Plug-n Hybrid Electric Vehicles (PHEV)- Power train components and sizing, Gears, Clutches, Transmission and Brakes.

UNIT III POWER ELECTRONICS AND MOTOR DRIVES 12

Electric drive components – Power electronic switches- four quadrant operation of DC drives – Induction motor and permanent magnet synchronous motor-based vector control operation – Switched reluctance motor (SRM) drives- EV motor sizing.

UNIT IV BATTERY ENERGY STORAGE SYSTEM 12

Battery Basics- Different types- Battery Parameters-Battery life & safety impacts -Battery modeling-Design of battery for large vehicles.

UNIT V ALTERNATIVE ENERGY STORAGE SYSTEMS 12

Introduction to fuel cell – Types, Operation and characteristics- proton exchange membrane (PEM) fuel cell for E-mobility– hydrogen storage systems –Super capacitors for transportation applications.

TOTAL : 60 PERIODS

OUTCOMES:

After the completion of this course, students will be able to

- CO1: Understand the concept of electric vehicle and energy storage systems.
- CO2: Describe the working and components of Electric Vehicle and Hybrid Electric Vehicle
- CO3: Know the principles of power converters and electrical drives
- CO4: Illustrate the operation of storage systems such as battery and super capacitors
- CO5: Analyze the various energy storage systems based on fuel cells and hydrogen storage

REFERENCES:

1. Iqbal Hussain, "Electric and Hybrid Vehicles: Design Fundamentals, Second Edition" CRC Press, Taylor & Francis Group, Second Edition (2011).
2. Ali Emadi, Mehrdad Ehsani, John M. Miller, "Vehicular Electric Power Systems", Special Indian Edition, Marcel Dekker, Inc 2010.
3. Mehrdad Ehsani, Yimin Gao, Sebastian E. Gay, Ali Emadi, 'Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design', CRC Press, 2004.
4. C.C. Chan and K.T. Chau, 'Modern Electric Vehicle Technology', OXFORD University Press, 2001.
5. Wie Liu, "Hybrid Electric Vehicle System Modeling and Control", Second Edition, John Wiley & Sons, 2017.

CO-PO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	2	3	2
CO2	3	3	3	2	3	2
CO3	3	3	3	2	3	2
CO4	3	3	3	2	3	2
CO5	3	3	3	2	3	2
AVG.	3	3	3	2	3	2

OBJECTIVES:

- To control the speed of DC motor-based drive system.
- To conduct load tests in an electrical drive system.
- To conduct experiments to enhance the understanding of different power electronic controller for motor drive applications.
- To control the speed of Stepper motor and BLDC motor-based drive systems.
- To control the speed of an Induction motor and SRM motor-based drive systems.

LIST OF EXPERIMENTS:

1. Simulation of closed loop control of Converter fed DC drive.
2. Speed control of Converter fed DC motor.
3. Speed control of Chopper fed DC motor.
4. Simulation of VSI fed three phase Induction motor drive.
5. V/f control of Three-Phase Induction motor.
6. Micro controller based speed control of Stepper motor.
7. Speed control of BLDC motor.
8. DSP based speed control of SRM motor.
9. Simulation of Four quadrant operation of three-phase induction motor.
10. Voltage Regulation of three-phase Synchronous Generator.
11. AC voltage Controller based speed control of induction motor.

TOTAL : 45 PERIODS**OUTCOMES:**

CO1: Ability to construct the simulation circuit for the closed loop control of drive systems

CO2: Ability to formulate, design the speed controller for DC motor-based drive system.

CO3: Ability to conduct load tests in an electrical drive system.

CO4: Ability to formulate, design the speed controller for AC motor-based drive system.

CO5: Ability to design the control algorithm for the control of an electrical drive using Microcontroller and Digital signal processor.

REFERENCES:

- 1.Ned Mohan, T.M. Undeland and W.P Robbin, "Power Electronics: converters, Application and design" John Wiley and sons. Wiley India edition, 2006
- 2.Rashid M.H., "Power Electronics Circuits, Devices and Applications ", Prentice Hal India, New Delhi, 1995.
- 3.Bimal K Bose "Modern Power Electronics and AC Drives" Pearson Education, Second Edition,2003.
- 4.Bin Wu, Mehdi Narimani, "High Power Converters and AC Drives, Wiley Publishers, Second Edition,2017.

CO-PO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	3	3	3	2
CO2	3	-	3	3	3	2
CO3	3	-	3	3	3	2
CO4	3	-	3	3	3	2
CO5	3	-	3	3	3	2
AVG.	3	-	3	3	3	2

OBJECTIVES:

- To design power converter after selecting the suitable component for typical applications
- To design non-isolated and isolated switching mode regulators
- To simulate analyse and test different switching mode regulators

LIST OF EXPERIMENTS:

1. Selection and Design of components (Inductor, Capacitor, transformers and devices) for power converters
2. Design and testing of Isolated converter design and verification (100 W)
3. Design and testing of Non-isolated converter design and verification (100 W)
4. Mini Project Demonstration with applications

TOTAL : 45 PERIODS**OUTCOMES:**

- CO1: Ability to independently carryout research and development work in power converters
 CO2: Ability to demonstrate a degree of mastery over the design and fabrication of switching regulators.
 CO3: Ability to apply conceotual basis required for design and testing of various
 CO4: Ability to interact with industry to take up problem of societal importance as miniproject designed.
 CO5: Ability to compare different possible solution to the same practical problem.

CO-PO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3					
CO2			3			
CO3				3		
CO4					3	
CO5						3
AVG.	3	-	3	3	3	3

OBJECTIVES:

- To understand the concepts related with power switches and its requirements.
- To know about the developments and characteristics of Silicon Carbide (SiC) and Gallium Nitride (GaN) devices..
- To understand the working, steady state and switching characteristics of current controlled and voltage controlled silicon devices.
- To study the working of driving circuits, protection circuits for power devices.
- To understand the thermal characteristics of power devices and the ability to design heat sink for the power devices.

UNIT I INTRODUCTION 9

Power switching devices overview – Attributes of an ideal switch, application requirements, circuit symbols; Power handling capability – (SOA); Power diodes – Types, forward and reverse characteristics, switching characteristics – rating. Features and Brief History of Silicon Carbide-Promise and Demonstration of SiC Power Devices- Physical Properties of Silicon Carbide devices –Unipolar and Bipolar Diodes- GaN Technology Overview

UNIT II CURRENT CONTROLLED DEVICES 9

BJT's – Construction, static characteristics, switching characteristics; Negative temperature coefficient and second breakdown; - Thyristors – Construction, working, static and transient characteristics, types, series and parallel operation; comparison of BJT and Thyristor – steady state and dynamic models of BJT & Thyristor- Basics of GTO, SiC based Bipolar devices- Applications- Building a GaN Transistor –GaN Transistor Electrical Characteristics

UNIT III VOLTAGE CONTROLLED DEVICES 9

Power MOSFETs and IGBTs – Principle of voltage controlled devices, construction, types, static and switching characteristics, steady state and dynamic models of MOSFET and IGBTs – and IGCT. New semiconductor materials for devices – Intelligent power modules- study of modules like APTGT100TL170G, MSCSM70TAM05TPAG. Integrated gate commutated thyristor (IGCT) - SiC based unipolar devices-applications

UNIT IV DEVICE SELECTION , DRIVING and PROTECTING CIRCUITS 9

Device selection strategy – On-state and switching losses – EMI due to switching. Necessity of isolation, pulse transformer, optocoupler – Gate drive integrated circuit: Study of Driver IC – IRS2110/2113. SCR, MOSFET, IGBTs and base driving for power BJT. – Over voltage, over current and gate protections; Design of snubbers

UNIT V THERMAL PROTECTION 9

Heat transfer – conduction, convection and radiation; Cooling – liquid cooling, vapour – phase cooling; Guidance for heat sink selection – Thermal resistance and impedance –Electrical analogy of thermal components, heat sink types and design – Mounting types- switching loss calculation for power device

TOTAL : 45 PERIODS**OUTCOMES:**

After completing the above course, students will be able to

- CO1: Identification of suitable device for the application.
- CO2: Know the advantages of Silicon Carbide devices and Gallium Nitride devices.
- CO3: Understand the principles and characteristics of Silicon devices, Silicon Carbide devices and Gallium Nitride devices.

CO4: Design proper driving circuits and protection circuits.

CO5: Construct a proper thermal protective devices for power semiconductor devices.

REFERENCES:

- 1.Rashid M.H., “ Power Electronics Circuits, Devices and Applications “, Pearson, 4th Edition, 10th Impression 2021.
- 2.Mohan, Undeland and Robins, “Power Electronics: Converters Applications and Design, Media Enhanced 3rd Edition, Wiley, 2007
- 3.Tsunenobu Kimoto and James A. Cooper , Fundamentals of Silicon Carbide Technology: Growth, Characterization, Devices, and Applications, First Edition., 2014 John Wiley & Sons Singapore Pte Ltd
- 4.Alex Lidow, Johan Strydom, Michael de Rooij, David Reusch, GaN Transistors for efficient power conversion, Second Edition, Wiley, 2015
- 5.Biswanath Paul, Power Electronics, Universities Press 2019

CO-PO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	3	2	2	2
CO2	1		2	1	3	3
CO3	1		2	1	3	3
CO4	2	1	3	2	2	1
CO5	2	2	3	2	2	1
Avg.	1.6	1.3	2.6	1.6	2.4	2

PX4002

SYSTEM DESIGN USING MICROCONTROLLER

L T P C
3 0 0 3

OBJECTIVES:

- To get introduce the fundamentals of microcontroller based system design.
- To learn I/O and other built in features available in microcontroller.
- To know Microcontroller based system design, applications.
- To learn I/O interface in system Design
- To involve Discussions/ Practice/Exercise onto revising & familiarizing the concepts acquired for improved employability skills

UNIT I

8051 ARCHITECTURE

9

Architecture – memory organization – addressing modes – instruction set – Timers – Interrupts – I/O ports, Interfacing I/O Devices – Serial Communication.

UNIT II

8051 PROGRAMMING

9

Assembly language programming – Arithmetic Instructions – Logical Instructions –Single bit Instructions – Timer Counter Programming – Serial Communication Programming Interrupt Programming – LCD digital clock/thermometer. Introduction to IDE based assembler programming.

UNIT III

PIC 16 MICROCONTROLLER

9

Architecture – memory organization – addressing modes – instruction set – PIC programming in Assembly & C –I/O port, Data Conversion, RAM & ROM Allocation, Timer programming, practice in MP-LAB.

UNIT IV PERIPHERAL OF PIC 16 MICROCONTROLLER 9

Timers – Interrupts, I/O ports- I2C bus-A/D converter-UART- CCP modules –ADC, DAC and Sensor Interfacing –Flash and EEPROM Memories

UNIT V SYSTEM DESIGN –CASE STUDY 9

Interfacing LCD Display – Keypad Interfacing – Generation of Gate signals for converters and Inverters – Motor Control – Controlling DC/ AC appliances – Measurement of frequency- Stand alone Data Acquisition System

TOTAL :45 PERIODS

OUTCOMES:

- CO1: Ability to understand the features of microcontroller 8051
- CO2: Ability to write programs using 8051 assemble language, utilizing its build in features
- CO3: Ability to understand the features of PIC microcontroller.
- CO4: Ability to use the peripherals built in the PIC microcontroller through programming
- CO5: Ability to grasp the interfacing concepts involving in the design of microcontroller based systems.

TEXTBOOKS:

- 1. Kenneth J Ayala, “The 8051 Microcontroller”, Thomson press, 2007
- 2. Muhammad Ali Mazidi, RolinD.Mckinlay, Danny Causey ‘ PIC Microcontroller and Embedded Systems using Assembly and C for PIC18’, Pearson Education 2008

REFERENCES:

- 1. Rajkamal, ”Microcontrollers Architecture, Programming, Interfacing & System Design, Pearson, 2012.
- 2. MykePredko, “Programming and customizing the 8051 microcontroller”, Tata McGraw Hill 2001
- 3. Muhammad Ali Mazidi, SarmadNaimi, SepehrNaimi,” The AVR Microcontroller and Embedded Systems’ Using Assembly & C, PearsonEducation,2014
- 4. Muhammad Ali Mazidi, Janice G. Mazidi and Rolin D. McKinlay, ‘The 8051 Microcontroller and Embedded Systems’ Prentice Hall,2005.
- 5. John Iovine, ‘PIC Microcontroller Project Book ’, McGraw Hill2000

CO-PO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	2	3	1	1	2
CO2	2		2	2	1	3
CO3	1	2	3	1	1	3
CO4	2		2	2	1	1
CO5	3	2	2	3	2	1
AVG.	1.8	2	2.4	1.8	1.2	2

OBJECTIVES:

- To refresh the fundamentals of Electromagnetic Field Theory
- To provide foundation in formulation and computation of electromagnetic field equations using analytical methods
- To impart knowledge in the concept of problem formulation and computation of electromagnetic field equations using numerical methods.
- To compute and analyze the field quantities using FEM.
- To formulate, solve, analyze and optimize the design of electrical components

UNIT I INTRODUCTION 9

Review of basic field theory – Maxwell's equations – Constitutive relationships and Continuity equations – Laplace, Poisson and Helmholtz equation – principle of energy conversion – force/torque calculation

UNIT II BASIC SOLUTION METHODS FOR FIELD EQUATIONS 9

Limitations of the conventional design procedure need for the field analysis based design, problem definition, boundary conditions, solution by analytical methods - direct integration method – variable separable method – method of images

UNIT III SOLUTION BY NUMERICAL METHODS 9

Finite Difference Method - Finite Element method – Boundary Elimination method - Variational Formulation – Energy minimization – Discretisation – Shape functions –Stiffness matrix –1D and 2D planar and axial symmetry problems

UNIT IV COMPUTATION OF BASIC QUANTITIES USING FEM PACKAGES 9

Basic quantities – Energy stored in Electric Field – Capacitance – Magnetic Field – Linked Flux – Inductance – Force – Torque – Skin effect – Resistance

UNIT V DESIGN APPLICATIONS 9

Design of Insulators –Magnetic actuators – Transformers – Rotating machines.

TOTAL :45 PERIODS

OUTCOMES:

At the end of the course, the students will be able to

- CO1: Explain and interpret the concept of Electromagnetic Field Theory.
- CO2: Formulate the field problem and apply analytical and numerical method for solving Electromagnetic field problems.
- CO3: Formulate Finite Element Methodology for solving Electro Magnetic field problem
- CO4: Estimate the basic Electromagnetic field quantities using FEM.
- CO5: Design electrical apparatus using FEM

REFERENCES:

1. Matthew. N.O. Sadiku, "Elements of Electromagnetics", Seventh Edition, Oxford University Press, First Indian Edition 2018.
2. K.J.Binns, P.J.Lawrenson, C.W Trowbridge, "The analytical and numerical solution of Electric and magnetic fields", John Wiley & Sons, 1995.
3. Nicola Biyanchi, "Electrical Machine analysis using Finite Elements", Taylor and Francis Group, CRC Publishers, 2005.
4. Nathan Ida, Joao P.A.Bastos, "Electromagnetics and calculation of fields", Springer-Verlage, 1997.
5. S.J Salon, "Finite Element Analysis of Electrical Machines" Kluwer Academic Publishers, London, Second Edition, 2011, distributed by TBH Publishers & Distributors, Chennai, India.

6. Silvester and Ferrari, "Finite Elements for Electrical Engineers" Cambridge University press, Third Edition 1996.

CO-PO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2		2	2		
CO2	2		2	1		
CO3	2		3	1		
CO4	2		3	2	2	2
CO5	3	3	3	3	3	2
Avg.	2.2	3	2.6	1.8	2.5	2

PX4004

SOFT COMPUTING TECHNIQUES

L T P C
3 0 0 3

OBJECTIVES

To educate the students on

- Design of ANN and fuzzy set theory.
- Analysis and implementation of ANN and Fuzzy logic for modeling and control of Non-linear system and to get familiarized with the Matlab toolbox.
- Impart the knowledge of various optimization techniques and hybrid schemes with the ANFIS tool box.

UNIT I INTRODUCTION AND ARTIFICIAL NEURAL NETWORKS 9

Introduction to intelligent systems- Soft computing techniques- Conventional Computing versus Swarm Computing - Classification of meta-heuristic techniques - Properties of Swarm intelligent Systems - Application domain - Discrete and continuous problems - Single objective and multi-objective problems -Neuron- Nerve structure and synapse- Artificial Neuron and its model- activation functions- Neural network architecture- single layer and multilayer feed forward networks- Mc Culloch Pitts neuron model- perceptron model- Adaline and Madaline- multilayer perception model- back propagation learning methods- effect of learning rule coefficient -back propagation algorithm- factors affecting back propagation training- applications.

UNIT II ARTIFICIAL NEURAL NETWORKS AND ASSOCIATIVE MEMORY 9

Counter propagation network- architecture- functioning & characteristics of counter Propagation network- Hopfield/ Recurrent network configuration - stability constraints associative memory and characteristics- limitations and applications- Hopfield v/s Boltzman machine- Adaptive Resonance Theory- Architecture- classifications- Implementation and training - Associative Memory.

UNIT III FUZZY LOGIC SYSTEM 9

Introduction to crisp sets and fuzzy sets- basic fuzzy set operation and approximate reasoning. Introduction to fuzzy logic modeling and control- Fuzzification inferencing and defuzzification-Fuzzy knowledge and rule bases-Fuzzy modeling and control schemes for nonlinear systems. Self organizing fuzzy logic control- Fuzzy logic control for nonlinear time delay system.

UNIT IV GENETIC ALGORITHM 9

Evolutionary programs – Genetic algorithms, genetic programming and evolutionary

programming - Genetic Algorithm versus Conventional Optimization Techniques - Genetic representations and selection mechanisms; Genetic operators- different types of crossover and mutation operators - Optimization problems using GA-discrete and continuous - Single objective and multi-objective problems - Procedures in evolutionary programming.

UNIT V HYBRID CONTROL SCHEMES

9

Fuzzification and rule base using ANN–Neuro fuzzy systems-ANFIS – Fuzzy Neuron - Optimization of membership function and rule base using Genetic Algorithm –Introduction to Support Vector Machine- Evolutionary Programming-Particle Swarm Optimization - Case study – Familiarization of NN, FLC and ANFIS Tool Box.

TOTAL : 45 PERIODS

OUTCOMES:

Ability to

- CO1: Understand the basic architectures of NN and Fuzzy sets
- CO2: Design and implement ANN architectures, algorithms and know their limitations
- CO3: Identify and work with different operations on the fuzzy sets.
- CO4: Develop ANN and fuzzy logic based models and control schemes for non-linear systems.
- CO5: Understand and explore hybrid control schemes and PSO

TEXT BOOKS:

1. Laurene V. Fausett, “Fundamentals of Neural Networks: Architectures, Algorithms And Applications”, Pearson Education.
2. Timothy J. Ross, “Fuzzy Logic with Engineering Applications” Wiley India, 2008.
3. Zimmermann H.J. "Fuzzy set theory and its Applications" Springer international edition, 2011.
4. David E.Goldberg, “Genetic Algorithms in Search, Optimization, and Machine Learning”, Pearson Education, 2009.
5. W.T.Miller, R.S.Sutton and P.J.Webrose, “Neural Networks for Control” MIT Press”, 1996.
6. T. Ross, “Fuzzy Logic with Engineering Applications”, Tata McGraw Hill, New Delhi, 1995.
7. EthemAlpaydin, “Introduction to Machine Learning (Adaptive Computation and Machine Learning Series)”, MIT Press, 2004.
8. Corinna Cortes and V. Vapnik, " Support - Vector Networks, Machine Learning " 1995.

CO-PO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	2	2	1	1
CO2	3	-	2	2	1	1
CO3	3	-	2	2	1	1
CO4	3	-	2	2	1	1
CO5	2	-	2	2	1	1
Avg.	2.8	-	2	2	1	1

OBJECTIVES:

1. To educate on modeling and representing systems in state variable form.
2. To train on solving linear and non-linear state equations.
3. To illustrate the properties of control system.
4. To classify non-linearities and examine stability of systems in the sense of Lyapunov's theory.
5. To educate on modal concepts, design of state, output feedback controllers and estimators.

UNIT I STATE VARIABLE REPRESENTATION 9

Introduction-Concept of State-Space equations for Dynamic Systems –Time invariance and linearity- Non uniqueness of state model- Physical Systems and State Assignment – free and forced responses- State Diagrams.

UNIT II SOLUTION OF STATE EQUATIONS 9

Existence and uniqueness of solutions to Continuous-time state equations – Solution of Nonlinear and Linear Time Varying State equations – State transition matrix and its properties – Evaluation of matrix exponential- System modes- Role of Eigen values and Eigen vectors.

UNIT III PROPERTIES OF THE CONTROL SYSTEM 9

Controllability and Observability-Stabilizability and Detectability-Test for Continuous time Systems-Time varying and Time invariant case-Output Controllability-Reducibility-System Realizations.

UNIT IV NON-LINEARITIES AND STABILITY ANALYSIS 9

Equilibrium Points-Stability in the sense of Lyapunov-BIBO Stability-Stability of LTI Systems-Types of nonlinearity – Phase plane analysis – Singular points – Limit cycles – Construction of phase trajectories – Describing function method – Derivation of describing functions. Equilibrium Stability of Nonlinear Continuous Time Autonomous Systems – Direct Method of Lyapunov and the Linear Continuous-Time Autonomous Systems- Lyapunov Functions for Nonlinear Continuous Time Autonomous Systems-Krasovskii and Variable-Gradient Method

UNIT IV MODAL ANALYSIS 9

Controllable and Observable Companion Forms – SISO and MIMO Systems – Effect of State Feedback on Controllability and Observability-Pole Placement by State Feedback for both SISO and MIMO Systems-Full Order and Reduced Order Observers.

TOTAL: 45 PERIODS**OUTCOMES:**

Students able to

- CO1 Understand the concept of State-State representation for Dynamic Systems
- CO2 Explain the solution techniques of state equations
- CO3 Realize the properties of control systems in state space form
- CO4 Identify non-linearities and evaluate the stability of the system using Lyapunov notion
- CO5 Perform Modal analysis and design controller and observer in state space form

REFERENCES:

1. M. Gopal, "Modern Control System Theory", New Age International, 2005.
2. Z. Bubnicki, "Modern Control Theory", Springer, 2005
3. K. Ogatta, "Modern Control Engineering", PHI, 2002
4. John S. Bay, "Fundamentals of Linear State Space Systems", McGraw-Hill, 1999
5. D. Roy Choudhury, "Modern Control Systems", New Age International, 2005
6. John J. D'Azzo, C. H. Houpis and S. N. Sheldon, "Linear Control System Analysis and Design with MATLAB", Taylor Francis, 2003
7. M. Vidyasagar, "Nonlinear Systems Analysis", 2nd edition, Prentice Hall, Englewood Cliffs, New Jersey, 2002

MAPPING OF CO'S WITH PO'S

CO	PO					
	1	2	3	4	5	6
1	3	-	2	2	3	-
2	2	2	3	-	2	3
3	3	-	3	-	-	-
4	3	-	3	2	2	-
5	3	-	3	2	3	2
AVG	2.8	2	2.8	3	2.5	2.5

PX4005

POWER ELECTRONICS FOR RENEWABLE ENERGY SYSTEMS

LT P C
3 0 0 3

OBJECTIVES:

- To provide knowledge about different types of renewable energy systems.
- To analyze the various electrical Generators used for the Wind Energy Conversion Systems.
- To design a power converter used in renewable energy systems such as AC-DC, DC-DC, and AC-AC converters.
- To understand the importance of standalone, grid-connected, and hybrid operation in renewable energy systems.
- To analyse various maximum power point tracking algorithms

UNIT I INTRODUCTION TO RENEWABLE ENERGY SYSTEMS 9

Classification of Energy Sources – Importance of Non-conventional energy sources – Advantages and disadvantages of conventional energy sources – Environmental aspects of energy – Impacts of renewable energy generation on the environment – Qualitative study of renewable energy resources: Ocean energy, Biomass energy, Hydrogen energy, - Solar Photovoltaic (PV), Fuel cells: Operating principles and characteristics, Wind Energy: Nature of wind, Types, control strategy, operating area

UNIT II ELECTRICAL MACHINES FOR WIND ENERGY CONVERSION SYSTEMS (WECS) 9

Review of reference theory fundamentals –Construction, Principle of operation and analysis: Squirrel Cage Induction Generator (SCIG), Doubly Fed Induction Generator (DFIG) – Permanent Magnet Synchronous Generator (PMSG).

UNIT III POWER CONVERTERS AND ANALYSIS OF SOLAR PV SYSTEMS 9

Power Converters: Line commutated converters (inversion-mode) – Boost and buck-boost converters- selection of inverter, battery sizing, array sizing.

Analysis:Block diagram of the solar PV systems – Types of Solar PV systems: Stand-alone PV systems, Grid integrated solar PV Systems – Grid connection Issues

UNIT IV POWER CONVERTERS AND ANALYSIS OF WIND SYSTEMS 9

Power Converters: Three-phase AC voltage controllers- AC-DC-AC converters: uncontrolled rectifiers, PWM Inverters, Grid-Interactive Inverters – Matrix converter.

Analysis:Stand-alone operation of fixed and variable speed WECS-Grid integrated SCIG and PMSG based WECS.

UNIT V HYBRID RENEWABLE ENERGY SYSTEMS**9**

Need for Hybrid Systems- Range and type of Hybrid systems- Case studies of Diesel-PV, Wind-PV, Microhydel-PV, Biomass-Diesel systems – Maximum Power Point Tracking (MPPT).

TOTAL : 45 PERIODS**OUTCOMES:**

Upon completion of the course, students will be able to:

- CO1: Analyze the impacts of renewable energy technologies on the environment and demonstrate them to harness electrical power.
- CO2: Select a suitable Electrical machine for Wind Energy Conversion Systems.
- CO3: Design the power converters such as AC-DC, DC-DC, and AC-AC converters for Solar energy systems.
- CO4: Design the power converters such as AC-DC, DC-DC, and AC-AC converters for Wind energy systems.
- CO5: Interpret the stand-alone, grid-connected, and hybrid renewable energy systems with MPPT.

REFERENCES:

1. S.N.Bhadra, D. Kastha, & S. Banerjee “Wind Electrical Systems”, Oxford University Press, 2009
2. Rashid .M. H “Power electronics Hand book”, Academic press, 2nd Edition, 2006.
3. Rai. G.D, “Non-conventional energy sources”, Khanna publishers, 2010.
4. Rai. G.D,” Solar energy utilization”, Khanna publishers, 5th Edition, 2008.
5. Gray, L. Johnson, “Wind energy system”, prentice hall of india, 1995.
6. B.H.Khan “Non-conventional Energy sources “,Tata McGraw-hill Publishing Company, New Delhi, 2017.

CO-PO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	3	2	3	2
CO2	2	1	3	2	2	2
CO3	2	1	3	2	2	2
CO4	1	1	3	2	2	2
CO5	1	1	3	2	2	2
Avg.	1.4	1	3	2	2.2	2

OBJECTIVES:

- To inculcate knowledge on harmonics standards.
- To impart knowledge on the design power factor correction rectifiers for UPS applications.
- To familiarize the design resonant converters for SMPS applications.
- To provide knowledge on dynamic analysis of DC to DC Converters.
- To introduce the control techniques for control of resonant converters.

UNIT I POWER SYSTEM HARMONICS & LINE COMMUTATED RECTIFIERS 9

Average power-RMS value of an AC waveform-Power factor-AC line current harmonic standards IEC 1000-IEEE 519- The Single phase full wave rectifier-Continuous Conduction Mode-Discontinuous Conduction Mode-Single phase Rectifier's behavior for large value of Capacitance – Minimizing THD for small value of Capacitance- Three phase rectifiers- Continuous Conduction Mode-Discontinuous Conduction Mode- Introduction to Harmonic trap filters.

UNIT II PULSE WIDTH MODULATED RECTIFIERS 9

Properties of Ideal rectifiers-Realization of non-ideal rectifier-Single phase converter system incorporating ideal rectifiers-Modeling losses and efficiency in CCM – high quality rectifiers-Boost rectifier-expression for controller duty cycle-expression for DC load current-solution for converter Efficiency.

UNIT III RESONANT CONVERTERS 9

Review on Parallel and Series Resonant Switches-Soft Switching- Zero Current Switching – Zero Voltage Switching –Classification of Quasi resonant switches-Zero Current and Zero Voltage Switching of Quasi Resonant Buck converter- Zero Current and Zero Voltage Switching of Quasi Resonant Boost converter: Steady State analysis.

UNIT IV DYNAMIC ANALYSIS OF SWITCHING CONVERTERS 9

Review of linear system analysis-State Space Averaging-Basic State Space Average Model- State Space Averaged model for Buck Converter, Boost Converter, Buck Boost Converter and Cuk Converter.

UNIT V CONTROL OF PWM RECTIFIERS 9

Pulse Width Modulation-Voltage Mode PWM Scheme-Current Mode PWM Scheme- Average current control-Current programmed Control- Hysteresis control- Nonlinear carrier control –Design of Controllers: PI Controller, Variable Structure Controller for source current shaping of PWM rectifiers.

TOTAL : 45 PERIODS**OUTCOMES:**

- CO1: To understand the standards for supply current harmonics and its significance.
CO2: To design power factor correction rectifiers for UPS applications.
CO3: To analyse and design the resonant converters.
CO4: To derive the state space model of basic and derived DC-DC converters.
CO5: To design an appropriate controller for PWM rectifiers.

REFERENCES:

1. John G. Kassakian, Martin F. Schlecht, George C. Verghese, "Principles of Power Electronics", Pearson, India, New Delhi, 2010
2. Philip T Krein, " Elements of Power Electronics", Oxford University Press,1998
3. Ned Mohan, "Power Electronics: A first course", John Wiley,2011
4. Issa Batarseh, Ahmad Harb, "Power Electronics- Circuit Analysis and Design, Second edition,2018

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	-	2	2	3	1
CO2	2	-	2	1	2	2
CO3	3	-	3	1	2	2
CO4	3	-	2	1	1	1
CO5	3	-	2	2	1	2
Avg.	2.6	-	2.2	1.4	1.8	1.6

PX4007**ADVANCED POWER CONVERTERS****L T P C
3 0 0 3****OBJECTIVES:**

- To study the operation of voltage lift circuits
- To impart knowledge on the working of super lift circuits
- To learn the operation of ultra lift converters and multiple quadrant converters.
- To provide knowledge on the principle of bidirectional dual active bridge converters
- To educate on the working principle of Impedance source converter

UNIT I VOLTAGE-LIFT CONVERTERS 9

Introduction- Self-lift and reverse self-lift circuits- Cuk converter, Luo converter and SEPIC converter- continuous and discontinuous conduction mode.-Applications

UNIT II POSITIVE OUTPUT & NEGATIVE OUTPUT SUPER-LIFT LUO-CONVERTERS 9

Main series, -Elementary Circuit, Re-Lift Circuit, Triple-Lift Circuit, Higher-Order Lift Circuit- Continuous and discontinuous conduction modes- Applications

UNIT III ULTRA LIFT CONVERTERS AND MULTIPLE-QUADRANT OPERATING LUO-CONVERTERS 9

Ultra-Lift Luo- Converter- Operation – Continuous and discontinuous conduction Modes of Ultra-Lift Luo-Converter-Instantaneous Values- Multiple quadrant operating Luo Converters- Circuit explanations-Modes of operation- Applications

UNIT IV BIDIRECTIONAL DUAL ACTIVE BRIDGE DC-DC CONVERTERS 9

Application of Bidirectional DC-DC Converter-Classification of Bidirectional DC-DC Converter – Working Principle of Hybrid-Bridge-Based Dual active bridge (DAB) converter- Performance-Voltage mode control- Principle of Dual-Transformer based DAB converter- Three-Level bidirectional DC-DC converter- Applications

UNIT V IMPEDANCE SOURCE CONVERTER 9

Voltage-Fed Z-source inverters –Topologies –Steady state and dynamic model- Current fed Z-source inverter –Topology –Modification and operational principles. Modulation Methods- Sine PWM- SVPWM and Pulse width Amplitude Modulation- Applications

TOTAL :45 PERIODS**OUTCOMES:**

After completing the above course, students will be able to

CO1 : Understand the working of voltage lift circuits

CO2: Design the super lift converters

- CO3 : Understand the working and applications of ultra-lift converters
 CO4 : Acquire knowledge on working and design of bi-directional DC-DC converters
 CO5 : Understand the concepts related with impedance source converter

TEXT BOOKS

- 1.Fang Lin Luo, Hong Ye “Advanced DC/DC Converters”, Second Edition, CRC press, 2018
2. Yushan Liu , Haitham Abu- Rub , BaomingGe , Dr. FredeBlaabjerg , Omar Ellabban , Poh Chiang Loh, “Impedance source power electronic converters”, Wiley IEEE Press, 2016
3. DeshangSha, GuoXu, “High-Frequency Isolated Bidirectional Dual Active Bridge DC–DC Converters with Wide Voltage Gain”, Springer 2019

REFERENCE BOOKS

1. Fang Lin Luo, Hong Ye, “Essential DC/DC Converters”, First Edition, CRC, 2005
2. Fang Lin Luo, Hong Ye, “Power Electronics Advanced Conversion Technologies”, Second Edition, 2018 CRC press

COPO-MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	-	2	3	2	1
CO2	2	-	2	3	2	1
CO3	2	-	2	3	2	1
CO4	2	-	2	3	2	1
CO5	2	-	2	3	2	1
Avg.	2	-	2	3	2	1

PX4009

CONTROL OF POWER ELECTRONIC CIRCUITS

**L T P C
3 0 0 3**

OBJECTIVES:

- To inculcate knowledge on the basics of control for power electronic circuits
- To illustrate the concepts of feedback controllers for DC-DC converters
- To learn about the controller design for AC-DC converter circuits
- To impart knowledge on sliding mode control
- To equip with required skills to design flatness-based controllers

UNIT I CONTROLLER DESIGN FOR BASIC DC-DC CONVERTERS- PART I 9

Introduction, Review of Linear Control Theory, Linearization of Various Transfer Function Blocks, Feedback Controller Design in Voltage-Mode Control, Peak-Current Mode Control, Feedback Controller Design in DCM

UNIT II CONTROLLER DESIGN FOR BASIC DC-DC CONVERTERS- PART II 9

Introduction, Linear Feedback Control- Pole Placement by Full State Feedback, Pole Placement Based on Observer Design, Reduced Order Observers, Generalized Proportional Integral Controllers- Hamiltonian Systems Viewpoint - Application to power converters

UNIT III CONTROLLER DESIGN FOR BASIC AC-DC CONVERTER CIRCUITS 9

Introduction, Operating Principle of Single-Phase PFCs, Control of PFCs, Designing the Inner Average-Current-Control Loop, Designing the Outer Voltage-Control Loop, Example of Single-Phase PFC Systems

UNIT IV SLIDING MODE CONTROL 9

Introduction, Variable Structure Systems, Control of Single Switch Regulated Systems, Sliding Surfaces, Equivalent Control and the Ideal Sliding Dynamics, Accessibility of the Sliding Surface, Invariance Conditions for Matched Perturbations- Application to power converters

UNIT V FLATNESS BASED CONTROL 9

Flatness, the use of the differential flatness property, Controller development using flatness- Application to power converters

TOTAL : 45 PERIODS

OUTCOMES:

After completing the above course, students will be able to

- CO1 : Design controller for front end power factor corrector circuits.
- CO2: Design controllers for UPS application.
- CO3: Design controllers for AC-DC converters.
- CO4 : Design sliding mode control for power converters.
- CO5 : Design flatness based control for power converters.

TEXT BOOKS:

- 1. HeberttSira-Ramírez and Ramón Silva-Ortigoza, "Control Design Techniques in Power Electronics Devices " Springer-Verlag London Limited 2006
- 2. Ned Mohan, "Power Electronics: A First Course", Johnwiley, 2011
- 3. Marian K. Kazimierczuk and AgasthyaAyachit, "Laboratory Manual for Pulse-Width Modulated DC–DC Power Converters", Wiley 2016

REFERENCE BOOKS:

- 1. FarzinAsadi and Kei Eguchi, Morgan &Claypool, "Dynamics and Control of DC-DC Converters", 2018
- 2. Andre Kislovski, "Dynamic Analysis of Switching-Mode DC/DC Converters" ,Springer 1991
- 3. Azar, Ahmad Taher, Zhu, Quannmin, " Advances and Applications in sliding mode control systems" Springer, 2015
- 4. Levine, Jean, "Analysis and control of Non-linear systems A flatness-based approach" Springer, 2009

CO-PO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	-	3	2	2	2
CO2	2	-	2	2	2	2
CO3	2	-	3	2	2	2
CO4	3	-	2	1	3	1
CO5	3	-	2	1	3	1
Avg.	2.4	-	2.4	1.6	2.4	1.6

COURSE OBJECTIVES:

- To understand the various types of energy storage Technologies
 - To analyze thermal storage system
 - To analyze different battery storage technologies
 - To analyze the thermodynamics of Fuel Cell
 - To study the various applications of energy storage systems

UNIT I INTRODUCTION 9
Necessity of energy storage – types of energy storage –energy storage technologies – Applications.

UNIT II THERMAL STORAGE SYSTEM 9
Thermal storage – Types – Modeling of thermal storage units – Simple water and rock bed storage system – Pressurized water storage system – Modelling of phase change storage system – Simple units, Packed bed storage units - Modelling using porous medium approach,

UNIT III ELECTRICAL ENERGY STORAGE 9
Fundamental concept of batteries – Measuring of battery performance, charging and dis charging of a battery, storage density, energy density, and safety issues - Types of batteries: – Lead Acid, Nickel-Cadmium, Zinc-Manganese dioxide - Mathematical Modelling for Lead Acid Batteries – Flow Batteries.

UNIT IV FUEL CELL 9
Fuel Cell – History of Fuel cell, Principles of Electrochemical storage – Types: Hydrogen oxygen cells, Hydrogen air cell, Hydrocarbon air cell, Alkaline fuel cell -Detailed analysis – Advantages and disadvantages –Fuel Cell Thermodynamics.

UNIT V ALTERNATE ENERGY STORAGE TECHNOLOGIES 9
Flywheel, Super capacitors, Principles& Methods – Applications, Compressed air Energy storage, Concept of Hybrid Storage – Applications, Pumped Hydro Storage – Applications.

TOTAL: 45 PERIODS**COURSE OUTCOMES:**

Upon Completion of this course, the students will be able to

CO1: Understand the physics of energy storage

CO2: Model the different energy technologies.

CO3: Recognize the applications of various techniques.

CO4: Design and analyze the energy storage technologies.

CO5: Select and apply the appropriate technique based on the application.

REFERENCES

1. James Larminie and Andrew Dicks, 'Fuel cell systems Explained', Wiley publications, 2003.
2. Lunardini V.J, "Heat Transfer in Cold Climates", John Wiley and Sons 1981.
3. JiuJun Zhang (Editor), Lei Zhang (Editor), Hansan Liu (Editor), Andy Sun (Editor), Ru-Shi Liu (Editor), "Electrochemical technologies for energy storage and conversion", Two Volume Set, Wiley publications, 2012
4. Schmidt.F.W. and Willmott.A.J., "Thermal Storage and Regeneration", Hemisphere Publishing Corporation, 1981
5. Luisa F. Cabeza (Editor), "Advances in Thermal Energy Storage Systems: Methods and Applications", Woodhead Publishers, 2020.
6. Ibrahim Dinçer and Marc A. Rosen, "Thermal Energy Storage Systems and Applications", Wiley Publishers, 2021.

MAPPING OF CO'S WITH PO'S

CO	PO					
	1	2	3	4	5	6
1	-	1	-	-	2	-
2	2	1	2	-	3	-
3	2	2	2	-	3	-
4	3	2	3	-	3	3
5	2	2	2	2	2	3
AVG	2.25	1.6	2.25	1	2.6	3

PX4071

POWER QUALITY

L T P C
3 0 0 3

OBJECTIVES:

- To provide knowledge about various power quality issues.
- To understand the concept of power and power factor in single phase and three phase systems supplying nonlinear loads.
- To equip with required skills to design conventional compensation techniques for power factor correction and load voltage regulation.
- To introduce the control techniques for the active compensation.
- To understand the mitigation techniques using custom power devices such as DSTATCOM, DVR & UPQC

UNIT I INTRODUCTION 9

Introduction – Characterization of Electric Power Quality: Transients, short duration and long duration voltage variations, Voltage imbalance, waveform distortion, Voltage fluctuations, Power frequency variation, Power acceptability curves – power quality problems: poor load power factor, Non-linear and unbalanced loads, DC offset in loads, Notching in load voltage, Disturbance in supply voltage – Power quality standards.

UNIT II ANALYSIS OF SINGLE PHASE AND THREE PHASE SYSTEM 9

Single phase linear and non-linear loads – single phase sinusoidal, non-sinusoidal source – supplying linear and nonlinear loads – three phase balanced system – three phase unbalanced system – three phase unbalanced and distorted source supplying non-linear loads – concept of power factor – three phase- three wire – three phase - four wire system.

UNIT III CONVENTIONAL LOAD COMPENSATION METHODS 9

Principle of load compensation and voltage regulation – classical load balancing problem : open loop balancing – closed loop balancing, current balancing – harmonic reduction and voltage sag reduction– analysis of unbalance – instantaneous of real and reactive powers – Extraction of fundamental sequence component from measured.

UNIT IV LOAD COMPENSATION USING DSTATCOM**9**

Compensating single – phase loads – Ideal three phase shunt compensator structure – generating reference currents using instantaneous PQ theory – Instantaneous symmetrical components theory – Generating reference currents when the source is unbalanced –Realization and control of DSTATCOM – DSTATCOM in Voltage control mode

UNIT V SERIES COMPENSATION OF POWER DISTRIBUTION SYSTEM**9**

Rectifier supported DVR – DC Capacitor supported DVR – DVR Structure – Voltage Restoration – Series Active Filter – Unified Power Quality Conditioner.

TOTAL : 45 PERIODS**OUTCOMES:**

After completing the above course, students will be able to

CO1: comprehend the consequences of Power Quality issues.

CO2: conduct harmonic analysis of single phase and three phase systems supplying non-linear loads.

CO3: design passive filter for load compensation.

CO4: design active filters for load compensation.

CO5: understand the mitigation techniques using custom power devices such as distribution static compensator (DSTATCOM), dynamic voltage restorer (DVR) & UPQC.

TEXTBOOKS:

- 1.Arindam Ghosh and Gerad Ledwich “Power Quality Enhancement Using Custom Power Devices”,Kluwer Academic Publishers, First Edition,2002
- 2.G.T.Heydt, “Electric Power Quality”, Stars in a Circle Publications, Second Edition, 1994

REFERENCES:

1. R.C.Duggan “Electric Power Systems Quality”, Tata MC Graw Hill Publishers, Third Edition,2012
2. Arrillga “Power System Harmonics”, John Wiely and Sons,2003
3. Derek A.Paice “Power Electronic Converter Harmonics” IEEE Press, 1995

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	3	3	3	2
CO2	3	-	3	3	3	2
CO3	3	-	3	3	3	2
CO4	3	-	3	3	3	2
CO5	3	-	3	3	3	2
AVG	3	-	3	3	3	2

COURSE OBJECTIVES:

1. To understand various representation methods of DSP system
2. To provide insight about different DSP algorithms
3. To familiarize the various architectures of DSP system
4. To perform analysis of DSP architectures and to learn the implementation of DSP system in programmable hardware
5. To learn the details of DSP system interfacing with other peripherals

UNIT I REPRESENTATION OF DSP SYSTEM 9

Single Core and Multicore, Architectural requirement of DSPs - high throughput, low cost, low power, small code size, embedded applications. Representation of digital signal processing systems - block diagrams, signal flow graphs, data-flow graphs, dependence graphs. Techniques for enhancing computational throughput - parallelism and pipelining.

UNIT II DSP ALGORITHMS 9

DSP algorithms - Convolution, Correlation, FIR/IIR filters, FFT, adaptive filters, sampling rate converters, DCT, Decimator, Expander and Filter Banks. DSP applications. Computational characteristics of DSP algorithms and applications, Numerical representation of signals-word length effect and its impact, Carry free adders, Multiplier.

UNIT III SYSTEM ARCHITECTURE 9

Introduction, Basic Architectural Features, DSP Computational Building Blocks, Bus Architecture and Memory, Data Addressing Capabilities, Address Generation Unit, Programmability and Program Execution, Features for External Interfacing. VLIW architecture. Basic performance issue in pipelining, Simple implementation of MIPS, Instruction Level Parallelism, Dynamic Scheduling, Dynamic Hardware Prediction, Memory hierarchy. Study of Fixed point and floating point DSP architectures

UNIT IV ARCHITECTURE ANALYSIS ON PROGRAMMABLE HARDWARE 9

Analysis of basic DSP Architectures on programmable hardware. Algorithms for FIR, IIR, Lattice filter structures, architectures for real and complex fast Fourier transforms, 1D/2D Convolutions, Winograd minimal filtering algorithm. FPGA: Architecture, different sub-systems, design flow for DSP system design, mapping of DSP algorithms onto FPGA.

UNIT V SYSTEM INTERFACING 9

Examples of digital signal processing algorithms suitable for parallel architectures such as GPUs and multiGPUs. Interfacing: Introduction, Synchronous Serial Interface CODEC, A CODEC Interface Circuit, ADC interface.

TOTAL : 45 PERIODS**COURSE OUTCOMES:**

At the end of this course, the students will have the ability in

- CO 1: Evaluate the DSP system using various methods.
- CO 2: Design algorithm suitable for different DSP applications.
- CO 3: Explain various architectures of DSP system.
- CO 4: Implement DSP system in programmable hardware.
- CO 5: Build interfacing of DSP system with various peripherals.

CO	PO					
	1	2	3	4	5	6
1	-	3	-	-	-	-
2	3	3	3	2	3	2
3	-	3	-	-	-	-
4	3	-	3	3	3	3
5	2	-	3	2	3	3
Avg.	2.67	3	3	2.33	3	2.67

REFERENCES

1. Sen M Kuo, Woon Seng S Gan, Digital Signal Processors
2. Digital Signal Processing and Application with C6713 and C6416 DSK, Rulph Chassaing, Worcester Polytechnic Institute, A Wiley Interscience Publication
3. Architectures for Digital Signal Processing, Peter Pirsch John Weilly, 2007
4. DSP Processor and Fundamentals: Architecture and Features. Phil Lapsley, JBier, AmitSohan, Edward A Lee; Wiley IEEE Press
5. K. K. Parhi - VLSI Digital Signal Processing Systems - Wiley – 1999.
6. RulphChassaing, Digital signal processing and applications with C6713 and C6416 DSK, Wiley, 2005
7. Keshab K Parhi, VLSI Digital Signal Processing Systems:Design and Implementation, student Edition, Wiley, 1999.
8. Nasser Kehtarnavaz, Digital Signal Processing System Design: LabVIEW-Based Hybrid Programming, Academic Press, 2008

ET4072

MACHINE LEARNING AND DEEP LEARNING

L T P C
3 0 0 3

COURSE OBJECTIVES:

The course is aimed at

1. Understanding about the learning problem and algorithms
2. Providing insight about neural networks
3. Introducing the machine learning fundamentals and significance
4. Enabling the students to acquire knowledge about pattern recognition.
5. Motivating the students to apply deep learning algorithms for solving real life problems.

UNIT I LEARNING PROBLEMS AND ALGORITHMS

9

Various paradigms of learning problems, Supervised, Semi-supervised and Unsupervised algorithms

UNIT II NEURAL NETWORKS

9

Differences between Biological and Artificial Neural Networks - Typical Architecture, Common Activation Functions, Multi-layer neural network, Linear Separability, Hebb Net, Perceptron, Adaline, Standard Back propagation Training Algorithms for Pattern Association - Hebb rule and Delta rule, Hetero associative, Auto associative, Kohonen Self Organising Maps, Examples of Feature Maps, Learning Vector Quantization, Gradient descent, Boltzmann Machine Learning.

UNIT III MACHINE LEARNING – FUNDAMENTALS & FEATURE SELECTIONS & CLASSIFICATIONS

9

Classifying Samples: The confusion matrix, Accuracy, Precision, Recall, F1- Score, the curse of dimensionality, training, testing, validation, cross validation, overfitting, under-fitting the data, early stopping, regularization, bias and variance. Feature Selection, normalization, dimensionality reduction, Classifiers: KNN, SVM, Decision trees, Naïve Bayes, Binary classification, multi class classification, clustering.

UNIT IV DEEP LEARNING: CONVOLUTIONAL NEURAL NETWORKS 9

Feed forward networks, Activation functions, back propagation in CNN, optimizers, batch normalization, convolution layers, pooling layers, fully connected layers, dropout, Examples of CNNs.

UNIT V DEEP LEARNING: RNNs, AUTOENCODERS AND GANS 9

State, Structure of RNN Cell, LSTM and GRU, Time distributed layers, Generating Text, Autoencoders: Convolutional Autoencoders, Denoising autoencoders, Variational autoencoders, GANs: The discriminator, generator, DCGANs

TOTAL : 45 PERIODS**COURSE OUTCOMES (CO):**

At the end of the course the student will be able to

CO1 : Illustrate the categorization of machine learning algorithms.

CO2: Compare and contrast the types of neural network architectures, activation functions

CO3: Acquaint with the pattern association using neural networks

CO4: Elaborate various terminologies related with pattern recognition and architectures of convolutional neural networks

CO5: Construct different feature selection and classification techniques and advanced neural network architectures such as RNN, Autoencoders, and GANs.

CO	PO					
	1	2	3	4	5	6
1	1	3	1	-	-	-
2	2	3	2	-	-	-
3	3	-	3	-	3	-
4	2	3	3	-	-	-
5	3	3	3	-	3	-
6	3	3	3	-	3	-
7	3	3	3	-	3	-
Avg.	2.42	3	2.57	-	3	-

REFERENCES:

1. J. S. R. Jang, C. T. Sun, E. Mizutani, Neuro Fuzzy and Soft Computing - A Computational Approach to Learning and Machine Intelligence, 2012, PHI learning
2. Deep Learning, Ian Good fellow, YoshuaBengio and Aaron Courville, MIT Press, ISBN: 9780262035613, 2016.
3. The Elements of Statistical Learning. Trevor Hastie, Robert Tibshirani and Jerome Friedman. Second Edition. 2009.
4. Pattern Recognition and Machine Learning. Christopher Bishop. Springer. 2006.
5. Understanding Machine Learning. Shai Shalev-Shwartz and Shai Ben-David. Cambridge University Press. 2017.

COURSE OBJECTIVES:

1. To study about **Internet of Things** technologies and its role in real time applications.
2. To introduce the infrastructure required for IoT
3. To familiarize the accessories and communication techniques for IoT.
4. To provide insight about the embedded processor and sensors required for IoT
5. To familiarize the different platforms and Attributes for IoT

UNIT I INTRODUCTION TO INTERNET OF THINGS 9

Overview, Hardware and software requirements for IOT, Sensor and actuators, Technology drivers, Business drivers, Typical IoT applications, Trends and implications.

UNIT II IOT ARCHITECTURE 9

IoT reference model and architecture -Node Structure - Sensing, Processing, Communication, Powering, Networking - Topologies, Layer/Stack architecture, IoT standards, Cloud computing for IoT, Bluetooth, Bluetooth Low Energy beacons.

UNIT III PROTOCOLS AND WIRELESS TECHNOLOGIES FOR IOT 9**PROTOCOLS:**

NFC, SCADA and RFID, Zigbee MIPI, M-PHY, UniPro, SPMI, SPI, M-PCIe GSM, CDMA, LTE, GPRS, small cell.

Wireless technologies for IoT: WiFi (IEEE 802.11), Bluetooth/Bluetooth Smart, ZigBee/ZigBee Smart, UWB (IEEE 802.15.4), 6LoWPAN, Proprietary systems-Recent trends.

UNIT IV IOT PROCESSORS 9

Services/Attributes: Big-Data Analytics for IOT, Dependability, Interoperability, Security, Maintainability.

Embedded processors for IOT : Introduction to Python programming -Building IOT with RASPBERRY PI and Arduino.

UNIT V CASE STUDIES 9

Industrial IoT, Home Automation, smart cities, Smart Grid, connected vehicles, electric vehicle charging, Environment, Agriculture, Productivity Applications, IOT Defense

TOTAL: 45 PERIODS**COURSE OUTCOMES:**

At the end of this course, the students will have the ability to

CO1: Analyze the concepts of IoT and its present developments.

CO2: Compare and contrast different platforms and infrastructures available for IoT

CO3: Explain different protocols and communication technologies used in IoT

CO4: Analyze the big data analytic and programming of IoT

CO5: Implement IoT solutions for smart applications

CO	PO					
	1	2	3	4	5	6
1	1	2	1	-	-	-
2	-	2	-	-	-	-
3	1	2	-	1	3	-
4	2		3	3	3	3
5	3	2	3	3	3	3
Avg.	1.75	2	2.33	2.33	3	2

REFERENCES:

1. ArshdeepBahga and VijaiMadiseti : A Hands-on Approach "Internet of Things",Universities Press 2015.
2. Oliver Hersent , David Boswarthick and Omar Elloumi " The Internet of Things", Wiley,2016.
3. Samuel Greengard, " The Internet of Things", The MIT press, 2015.
4. Adrian McEwen and Hakim Cassimally"Designing the Internet of Things "Wiley,2014.
5. Jean- Philippe Vasseur, Adam Dunkels, "Interconnecting Smart Objects with IP: The Next Internet" Morgan Kuffmann Publishers, 2010.
6. Adrian McEwen and Hakim Cassimally, "Designing the Internet of Things", John Wiley and sons, 2014.
7. Lingyang Song/DusitNiyato/ Zhu Han/ Ekram Hossain," Wireless Device-to-Device Communications and Networks, CAMBRIDGE UNIVERSITY PRESS,2015.
8. OvidiuVermesan and Peter Friess (Editors), "Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems", River Publishers Series in Communication, 2013.
9. Vijay Madiseti , ArshdeepBahga, "Internet of Things (A Hands on-Approach)", 2014.
10. Zach Shelby, Carsten Bormann, "6LoWPAN: The Wireless Embedded Internet", John Wiley and sons, 2009.
11. Lars T.Berger and Krzysztof Iniewski, "Smart Grid applications, communications and security", Wiley, 2015.
12. JanakaEkanayake, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama and Nick Jenkins, " Smart Grid Technology and Applications", Wiley, 2015.
13. UpenaDalal,"Wireless Communications & Networks,Oxford,2015.

ET4018 MEMS DESIGN: SENSORS AND ACTUATORS **L T P C**
3 0 0 3

OBJECTIVES:

- To analyse the properties of materials, microstructure and fabrication methods.
- To design and modeling of Electrostatic sensors and actuators.
- To teach the characterizing thermal sensors and actuators through design and modeling.
- To understand the fundamentals of piezoelectric sensors and actuators through exposure to different MEMS and NEMS devices

UNIT I MICRO-FABRICATION, MATERIALS ANDELECTRO-MECHANICAL CONEPTS 9

Overview of micro fabrication – Silicon and other material based fabrication processes – Concepts: Conductivity of semiconductors-Crystal planes and orientation-stress and strain-flexural beam bending analysis- torsional deflections-Intrinsic stress- resonant frequency and quality factor.

UNIT II ELECTROSTATIC SENSORS AND ACTUATION 9

Principle, material, design and fabrication of parallel plate capacitors as electrostatic sensors and actuators-Applications

UNIT III THERMAL SENSING AND ACTUATION 9

Principle, material, design and fabrication of thermal couples, thermal bimorph sensors, thermal resistor sensors-Applications.

UNIT IV PIEZOELECTRIC SENSING AND ACTUATION 9

Piezoelectric effect-cantilever piezo electric actuator model-properties of piezoelectric materials Applications.

UNIT V CASE STUDIES**9**

Piezoresistive sensors, Magnetic actuation, Micro fluidics applications, Medical applications, Optical MEMS.-NEMS Devices

TOTAL: 45 PERIODS**OUTCOMES:****At the end of this course, the students will demonstrate the ability**

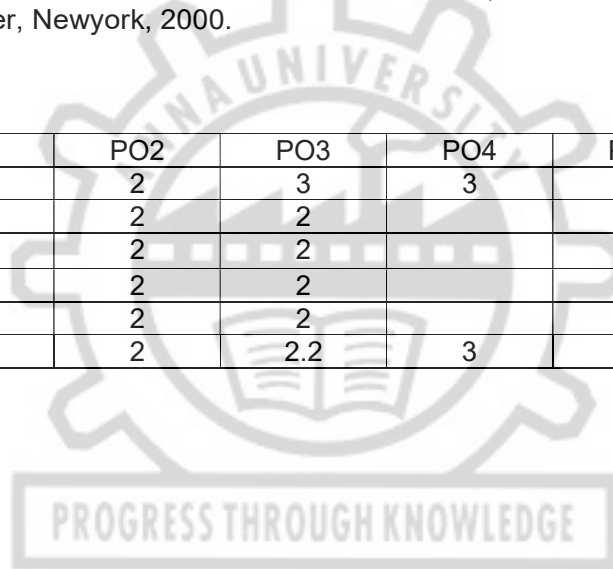
- CO1: To analyse the learning process to design of micro sensors, embedded sensors & actuators
- CO2: To analyse the electrostatic sensors and actuators through MEMS and NEMS devices
- CO3: To analyse the thermal sensors and actuators through MEMS and NEMS devices
- CO4: To analyse the piezoelectric sensors and actuators through MEMS and NEMS
- CO5: Design of piezoresistive sensors for biomedical and micro fluidic applications

REFERENCES:

1. Chang Liu, "Foundations of MEMS", Pearson International Edition, 2006.
2. Marc Madou , "Fundamentals of microfabrication",CRC Press, 1997.
3. Boston , "Micromachined Transducers Source book",WCB McGraw Hill, 1998.
4. M.H.Bao "Micromechanical transducers: Pressure sensors, accelerometers and gyroscopes", Elsevier, Newyork, 2000.

CO-PO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	3	3	3
CO2	3	2	2		3	
CO3	3	2	2		3	
CO4	3	2	2		3	
CO5	3	2	2		3	
Avg.	3	2	2.2	3	3	3



OBJECTIVES:

- To understand the non linear behavior of power electronic converters.
- To understand the techniques for investigation on non linear behavior of power electronic converters.
- To analyse the nonlinear phenomena in DC to DC converters.
- To analyse the nonlinear phenomena in AC and DC Drives.
- To introduce the control techniques for control of non linear behavior in power electronic systems.

UNIT I	BASICS OF NONLINEAR DYNAMICS	9
Basics of Nonlinear Dynamics: System, state and state space model, Vector field- Modeling of Linear, nonlinear and Linearized systems, Attractors , chaos, Poincare map, Dynamics of Discrete time system, Lyapunov Exponent, Bifurcations, Bifurcations of smooth map, Bifurcations in piece wise smooth maps, border crossing and border collision bifurcation.		
UNIT II	TECHNIQUES FOR INVESTIGATION OF NONLINEAR PHENOMENA	9
Techniques for experimental investigation, Techniques for numerical investigation, Computation of averages under chaos, Computations of spectral peaks, Computation of the bifurcation and analyzing stability.		
UNIT III	NONLINEAR PHENOMENA IN DC-DC CONVERTERS	9
Border collision in the Current Mode controlled Boost Converter, Bifurcation and chaos in the Voltage controlled Buck Converter with latch, Bifurcation and chaos in the Voltage controlled Buck Converter without latch, Bifurcation and chaos in Cuk Converter. Nonlinear phenomenon in the inverter under tolerance band control		
UNIT IV	NONLINEAR PHENOMENA IN DRIVES	9
Nonlinear Phenomenon in Current controlled and voltage controlled DC Drives, Nonlinear Phenomenon in PMSM Drives.		
UNIT V	CONTROL OF CHAOS	9
Hysteresis control, Sliding mode and switching surface control, OGY Method, Pyragas method, Time Delay control. Application of the techniques to the Power electronics circuit and drives.		
TOTAL		: 45 PERIODS

OUTCOMES:

- CO1 Ability to understand, model and simulate chaotic behavior in power electronic systems.
- CO2 Ability to investigate the various techniques of non linear phenomena
- CO3 Ability to analyze the nonlinear phenomena in DC-DC converter
- CO4 Ability to analyze the non linear phenomena in Drives
- CO5 Ability to mitigate chaotic behavior noticed in power system.

TEXT BOOKS:

1. George C. Vargheese, July 2001 Wiley – IEEE Press S Banerjee, Nonlinear Phenomenon Power Electronics, IEEE Press
2. Steven H Strogatz, Nonlinear Dynamics and Chaos, Westview Press

UNIT IV POWER SYSTEM STABILIZERS AND NETWORK DAMPING 9
CAPABILITY OF WIND

A Power System Stabilizer for a Synchronous Generator - A Power System Stabilizer for a DFIG - A Power System Stabilizer for a FRC Wind Farm.

UNIT V STAND ALONE AND GRID CONNECTED PV SYSTEM 9

Solar modules – storage systems – Basics of batteries – Batteries for PV Systems – Charge Controllers – MPPT and Inverters – Power Conditioning and Regulation – protection – Types of Solar PV systems - standalone PV systems design – sizing – PV systems in buildings – design issues for central power stations – safety – Economic aspect – efficiency and performance – International PV programs

TOTAL: 45 PERIODS

OUTCOMES:

- CO1: Know about the integration of various renewable energy sources into the grid.
- CO2: Able to analyze various grid issues due to renewable energy sources.
- CO3: Able to analyze the dynamics of network due to windfarm
- CO4: Know about power system stabilizers.
- CO5: Able to design the grid connected and standalone PV system.

REFERENCES:

1. Stuart R.Wenham, Martin A. Green, Muriel E. Watt and Richard Corkish, ‘Applied Photovoltaics’, Earthscan, UK, 2007.
2. Joshua Earnest, ‘Wind power technology’, II Edition, PHI, 2015.
3. Olimpo Anaya-Lara, Nick Jenkins, Janaka Ekanayake, Phill Cartwright and Mike Hughes, ‘WIND GENERATION Modelling and Control’, A John Wiley and Sons, Ltd., Publication, 2009.
4. Brenden Fox, Damian Flynn and Leslie Bryans, ‘Wind Power Integration Connection and system operational aspects’, Published by The Institute of Engineering and Technology, London, United Kingdom, 2007.
5. Frank S. Barnes & Jonah G. Levine, ‘Large Energy Storage Systems Handbook’, CRC Press, 2011.
6. S.P. Sukhatme, ‘Solar Energy’, Tata McGraw Hill, 1987.
7. Chetan Singh Solanki, ‘Solar Photovoltaic Technology and Systems’ – A Manual for Technicians, Trainees and Engineers, PHI, 2014.

CO-PO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	2	3	3	1
CO2	3	1	2	3	3	1
CO3	3	1	2	3	3	1
CO4	3	1	2	3	3	1
CO5	3	1	2	3	3	1
Avg.	3	1	2	3	3	1

OBJECTIVES:

To impart knowledge on

- Different types of renewable energy technologies
- Standalone operation, grid connected operation of renewable energy systems

UNIT I INTRODUCTION 9

Classification of energy sources – Co₂ Emission - Features of Renewable energy - Renewable energy scenario in India -Environmental aspects of electric energy conversion: impacts of renewable energy generation on environment Per Capital Consumption - CO₂ Emission - importance of renewable energy sources, Potentials – Achievements– Applications.

UNIT II SOLAR PHOTOVOLTAICS 9

Solar Energy: Sun and Earth-Basic Characteristics of solar radiation- angle of sunrays on solar collector-Estimating Solar Radiation Empirically - Equivalent circuit of PV Cell- Photovoltaic cell-characteristics: P-V and I-V curve of cell-Impact of Temperature and Insolation on I-V characteristics-Shading Impacts on I-V characteristics-Bypass diode -Blocking diode.

UNIT III PHOTOVOLTAIC SYSTEM DESIGN 9

Block diagram of solar photo voltaic system : Line commutated converters (inversion mode) - Boost and buck-boost converters - selection of inverter, battery sizing, array sizing - PV systems classification- standalone PV systems - Grid tied and grid interactive inverters- grid connection issues.

UNIT IV WIND ENERGY CONVERSION SYSTEMS 9

Origin of Winds: Global and Local Winds- Aerodynamics of Wind turbine-Derivation of Betz's limit-Power available in wind-Classification of wind turbine: Horizontal Axis wind turbine and Vertical axis wind turbine- Aerodynamic Efficiency-Tip Speed-Ratio-Solidity-Blade Count-Power curve of wind turbine - Configurations of wind energy conversion systems: Type A, Type B, Type C and Type D Configurations- Grid connection Issues - Grid integrated SCIG and PMSG based WECS.

UNIT V OTHER RENEWABLE ENERGY SOURCES 9

Qualitative study of different renewable energy resources: ocean, Biomass, Hydrogen energy systems, Fuel cells, Ocean Thermal Energy Conversion (OTEC), Tidal and wave energy, Geothermal Energy Resources.

TOTAL : 45 PERIODS

OUTCOMES:

After completion of this course, the student will be able to:

- CO1: Demonstrate the need for renewable energy sources.
- CO2: Develop a stand-alone photo voltaic system and implement a maximum power point tracking in the PV system.
- CO3: Design a stand-alone and Grid connected PV system.
- CO4: Analyze the different configurations of the wind energy conversion systems.
- CO5: Realize the basic of various available renewable energy sources

REFERENCES:

1. S.N.Bhadra, D. Kastha, & S. Banerjee "Wind Electrical Systems", Oxford University Press, 2009.
2. Rai. G.D, "Non conventional energy sources", Khanna publishes, 1993.
3. Rai. G.D," Solar energy utilization", Khanna publishes, 1993.
4. Chetan Singh Solanki, "Solar Photovoltaics: Fundamentals, Technologies and Applications", PHI Learning Private Limited, 2012.
5. John Twideu and Tony Weir, "Renewal Energy Resources" BSP Publications, 2006
6. Gray, L. Johnson, "Wind energy system", prentice hall of India, 1995.
7. B.H.Khan, " Non-conventional Energy sources", , McGraw-hill, 2nd Edition, 2009.
8. Fang Lin Luo Hong Ye, " Renewable Energy systems", Taylor & Francis Group,2013.

CO-PO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	2	2	2	1
CO2	3	-	2	3	3	3
CO3	3	-	2	3	3	3
CO4	3	-	2	3	3	2
CO5	3	-	2	2	2	2
Avg.	3	-	2	2.6	2.6	2.2

PX4013**WIND ENERGY CONVERSION SYSTEM**

L	T	P	C
3	0	0	3

OBJECTIVES:

- To learn about the basic concepts of wind energy conversion system
- To learn the design and control principles of Wind turbine.
- To understand the concepts of fixed speed wind energy conversion systems.
- To understand the concepts of Variable speed wind energy conversion systems.
- To 52odelin the grid integration issues.

UNIT I INTRODUCTION 9

Components of WECS-WECS schemes-Power obtained from wind-simple momentum theory- Power coefficient-Sabinin's theory-Aerodynamics of Wind turbine

UNIT II WINDTURBINES 9

HAWT-VAWT-Power developed-Thrust-Efficiency-Rotor selection-Rotor design considerations- Tip speed ratio-No. Of Blades-Blade profile-Power Regulation-yaw control-Pitch angle control- stall control-Schemes for maximum power extraction.

UNIT III FIXEDSPEEDSYSTEMS 9

Generating Systems- Constant speed constant frequency systems –Choice of Generators-Deciding factors-Synchronous Generator-Squirrel Cage Induction Generator- Model of Wind Speed- Model wind turbine rotor – Drive Train model- Generator model for Steady state and Transient stability analysis.

OBJECTIVES:

Students will be able to:

- understand the classification of optimization
- study the linear programming models and solution techniques
- study the different non-linear programming problem solution techniques
- understand the concept of dynamic programming
- study the fundamentals genetic algorithm and it applications.

UNIT I INTRODUCTION 9

Definition, Classification of optimization problems, Classical Optimization Techniques, Single and Multiple Optimization with and without inequality constraints.

UNIT II LINEAR PROGRAMMING (LP) 9

Simplex method of solving LPP, revised simplex method, duality, Constrained optimization, Theorems and procedure, Linear programming, mathematical model, solution technique, duality.

UNIT III NON LINEAR PROGRAMMING 9

Steepest descent method, conjugates gradient method, Newton's Method, Sequential quadratic programming, Penalty function method, augmented Lagrange multiplier method.

UNIT IV DYNAMIC PROGRAMMING (DP) 9

Multistage decision processes, concept of sub-optimization and principle of optimality, Recursive relations, Integer Linear programming, Branch and bound algorithm

UNIT V GENETIC ALGORITHM 9

Introduction to genetic Algorithm, working principle, coding of variables, fitness function, GA operators; Similarities and differences between Gas and traditional methods; Unconstrained and constrained optimization using genetic Algorithm, real coded gas, Advanced Gas, global optimization using GA, Applications to power system.

TOTAL : 45 PERIODS

OUTCOMES:

Students will be able to:

- CO1:learn about different classifications of optimization problems and techniques.
 CO2:attain knowledge on linear programming concepts
 CO3:understand the application of non-linear programming in optimization techniques
 CO4:understand the fundamental concepts of dynamic programming
 CO5:gain knowledge about Genetic algorithm and its application to power system optimization.

REFERENCES:

1. S.S. Rao, "Engineering Optimization – Theory and Practice", John Wiley & Sons, Inc.,2009.
2. Hamdy A. Taha, Operations Research: An Introduction, 10th Edition, Pearson, 2016.
3. David G. Luenberger, "Introduction to Linear and Nonlinear Programming", Addison-Wesley, 1973.
4. E. Polak, "Computational methods in Optimization", Academic Press,1971.
5. Pierre D.A., "Optimization Theory with Applications", Wiley Publications,1969.

CO-PO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	3	-	-	1
CO2	3	-	3	-	-	1
CO3	3	-	3	-	-	1
CO4	3	-	3	-	-	1
CO5	3	-	3	3	-	1
Avg.	3	-	3	3	-	1

PS4091**DISTRIBUTED GENERATION AND MICRO GRID****L T P C****3 0 0 3****COURSE OBJECTIVES:**

- To familiarize with the concept of Distributed Generation
- To expose the various distributed energy resources
- To focus on the planning and protection of Distributed Generation
- To study the concept of MicroGrid and to analyze the impact of MicroGrid
- To understand the major issues on MicroGrid economics

UNIT I INTRODUCTION TO DISTRIBUTED GENERATION 9

DG definition - Reasons for distributed generation-Benefits of integration - Distributed generation and the distribution system - Technical, Environmental and Economic impacts of distributed generation on the distribution system - Impact of distributed generation on the transmission system-Impact of distributed generation on central generation

UNIT II DISTRIBUTED ENERGY RESOURCES 9

Combined heat and power (CHP) systems-Wind energy conversion systems (WECS)- Solar photovoltaic (PV) systems-Small-scale hydroelectric power generation-Other renewable energy sources-Storage devices-Inverter interfaces

UNIT III DG PLANNING AND PROTECTION 9

Generation capacity adequacy in conventional thermal generation systems-Impact of distributed generation-Impact of distributed generation on network design-Protection of distributed generation-Protection of the generation equipment from internal Faults-Protection of the faulted distribution network from fault currents supplied by the distributed generator-Impact of distributed generation on existing distribution system protection.

UNIT IV CONCEPT OF MICROGRID 9

Microgrid Definition-A typical Microgrid configuration- Functions of Micro source controller and central controller- Energy Management Module (EMM) and Protection Co-ordination Module (PCM)- Modes of Operation- Grid connected and islanded modes- Modelling of Microgrid-Microturbine Model- PV Solar Cell Model- Wind Turbine Model-Role of Microgrid in power market competition.

UNIT V IMPACTS OF MICROGRID 9

Technical and economical advantages of Microgrid-Challenges and disadvantages of Microgrid development-Management and operational issues of a Microgrid- Impact on heat utilization-Impact on process optimization-Impact on market-Impact on environment-Impact on distribution system-Impact on communication standards and protocols.

Microgrid economics-Main issues of Microgrid economics-Microgrids and traditional power system economics-Emerging economic issues in Microgrids-Economic issues between Microgrids and bulk power systems-Potential benefits of Microgrid economics.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

Students able to

- CO1:** Understand the concepts of Distributed Generation and Microgrids.
- CO2:** Gain Knowledge about the various DG resources.
- CO3:** Familiarize with the planning and protection schemes of Distributed Generation.
- CO4:** Learn the concept of Microgrid and its mode of operation.
- CO5:** Acquire knowledge on the impacts of Microgrid.

REFERENCES:

1. Nick Jenkins, Janaka Ekanayake, Goran Strbac, "Distributed Generation", Institution of Engineering and Technology, London, UK, 2010.
2. S. Chowdhury, S.P. Chowdhury and P. Crossley, "Microgrids and Active Distribution Networks", The Institution of Engineering and Technology, London, United Kingdom, 2009.
3. Math H. Bollen, Fainan Hassan, "Integration of Distributed Generation in the Power System", John Wiley & Sons, New Jersey, 2011.
4. Magdi S. Mahmoud, Fouad M. AL-Sunni, "Control and Optimization of Distributed Generation Systems", Springer International Publishing, Switzerland, 2015.
5. Nadarajah Mithulananthan, Duong Quoc Hung, Kwang Y. Lee, "Intelligent Network Integration of Distributed Renewable Generation", Springer International Publishing, Switzerland, 2017.
6. Ali K., M.N. Marwali, Min Dai, "Integration of Green and Renewable Energy in Electric Power Systems", Wiley and sons, New Jersey, 2010.

MAPPING OF CO'S WITH PO'S

CO	PO					
	1	2	3	4	5	6
1	1	1	2	1	2	1
2	2	2	2	1	3	2
3	2	2	2	1	3	2
4	1	1	2	1	2	1
5	2	2	2	2	3	2
AVG	1.6	1.6	2	1.2	2.4	1.6

OBJECTIVES:

- To study the concepts behind economic analysis and load management
- To emphasize the energy management of various electrical equipment and metering
- To illustrate the concept of energy management technologies

UNIT I ENERGY SCENARIO**9**

Basics of Energy and its various forms - Conventional and non-conventional sources - Energy policy - Energy conservation act 2001, Amedments (India) in 2010 - Need for energy management- Designing and starting an energy management program - Energy managers and energy auditors - Roles and responsibilities of energy managers - Energy labelling and energy standards.

UNIT II ENERGY COST AND LOAD MANAGEMENT**9**

Important concepts in an economic analysis - Economic models-Time value of money-Utility rate structures- Cost of electricity-Loss evaluation- Load management: Demand control techniques-Utility monitoring and control system-HVAC and energy management-Economic justification.

UNIT III ENERGY MANAGEMENT**9**

Demand side management (DSM)– DSM planning – DSM techniques – Load management as a DSM strategy – Energy conservation – Tariff options for DSM.

UNIT IV ENERGY AUDITING**9**

Definition – Energy audit methodology: audit preparation, execution and reporting – Financial analysis – Sensitivity analysis – Project financing options - Instruments for energy audit – Energy audit for generation, distribution and utilization systems – Economic analysis.

UNIT V ENERGY EFFICIENT TECHNOLOGIES**9**

Energy saving opportunities in electric motors - Power factor improvement benefit and techniques- Shunt capacitor, Synchronous Condenser and Phase Advancer - Energy conservation in industrial drives, electric furnaces, ovens and boilers - Lighting techniques: Natural, CFL, LED lighting sources and fittings.

TOTAL : 45 PERIODS**OUTCOMES:**

Upon Completion of this course, the students will be able to

CO1: Understand the present energy scenario and role of energy managers.

CO2: Comprehend the Economic Models for cost and load management.

CO3: Configure the Demand side energy management through its control techniques, strategy and planning.

CO4: Understand the process of energy auditing.

CO5: Implement energy conservation aspects in industries.

REFERENCES

1. Barney L. Capehart, Wayne C. Turner, William J. Kennedy, "Guide to Energy Management", CRC press, Taylor & Francis group, Eighth Edition, 2016.
2. https://prsindia.org/files/bills_acts/bills_parliament/2010/The_Energy_Conservation_Amend ment_Bill_2010.pdf
3. Eastop T.D and Croft D.R, "Energy Efficiency for Engineers and Technologists", Logman Scientific & Technical, 1990.
4. IEEE Recommended Practice for Energy Management in Industrial and Commercial Facilities, IEEE, 1996.
5. Amit K. Tyagi, "Handbook on Energy Audits and Management", TERI, 2003.
6. <https://www.eeeguide.com/power-factor-improvement>.
7. Anil Kumar, ,**Om Prakash, Prashant Singh Chauhan**"Energy Management: Conservation and Audits, CRC Press, 2020.
8. Barney L. Capehart, Wayne C. Turner, William J. Kennedy, "Guide to Energy

Management”, CRC press, Taylor & Francis group, Eighth Edition, 2016.

9. S.C. Bhatia and Sarvesh Devraj, “Energy Conservation”, Woodhead Publishing India Pvt. Ltd, 2016.

CO	PO					
	1	2	3	4	5	6
1	2	2	2	-	2	-
2	2	3	2	1	2	1
3	2	2	2	1	2	2
4	1	2	2	3	-	-
5	3	3	2	3	3	3
AVG	2	2.4	2	2	2.25	2

PS4093

SMART GRID

L T P C
3 0 0 3

COURSE OBJECTIVES

- To Study about Smart Grid technologies, different smart meters and advanced metering infrastructure.
- To know about the function of smart grid.
- To familiarize the power quality management issues in Smart Grid.
- To familiarize the high performance computing for Smart Grid applications
- To get familiarized with the communication networks for Smart Grid applications

UNIT I INTRODUCTION TO SMART GRID 9

Evolution of Electric Grid, Concept, Definitions and Need for Smart Grid, Smart grid drivers, functions, opportunities, challenges and benefits, Difference between conventional & Smart Grid, Comparison of Micro grid and Smart grid, Present development & International policies in Smart Grid, Smart Grid Initiative for Power Distribution Utility in India – Case Study.

UNIT II SMART GRID TECHNOLOGIES 9

Technology Drivers, Smart Integration of energy resources, Smart substations, Substation Automation, Feeder Automation, Transmission systems: EMS, FACTS and HVDC, Wide area monitoring, Protection and control, Distribution systems: DMS, Volt/Var control, Fault Detection, Isolation and service restoration, Outage management, High-Efficiency Distribution Transformers, Phase Shifting Transformers, Plug in Hybrid Electric Vehicles (PHEV) – Grid to Vehicle and Vehicle to Grid charging concepts.

UNIT III SMART METERS AND ADVANCED METERING INFRASTRUCTURE 9

Introduction to Smart Meters, Advanced Metering infrastructure (AMI) drivers and benefits, AMI protocols, standards and initiatives, AMI needs in the smart grid, Phasor Measurement Unit(PMU) & their application for monitoring & protection. Demand side management and demand response programs, Demand pricing and Time of Use, Real Time Pricing, Peak Time Pricing.

UNIT IV POWER QUALITY MANAGEMENT IN SMART GRID 9

Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring, Power Quality Audit.

UNIT V HIGH PERFORMANCE COMPUTING FOR SMART GRID APPLICATIONS 9

Architecture and Standards -Local Area Network (LAN), House Area Network (HAN), Wide Area Network (WAN), Broadband over Power line (BPL), PLC, Zigbee, GSM, IP based Protocols, Basics of Web Service and CLOUD Computing, Cyber Security for Smart Grid.

TOTAL : 45 PERIODS**COURSE OUTCOME:**

Students able to

CO1: Relate with the smart resources, smart meters and other smart devices.**CO2:** Explain the function of Smart Grid.**CO3:** Experiment the issues of Power Quality in Smart Grid.**CO4:** Analyze the performance of Smart Grid.**CO5:** Recommend suitable communication networks for smart grid applications**REFERENCES**

1. Stuart Borlase 'Smart Grid: Infrastructure, Technology and Solutions', CRC Press 2012.
2. JanakaEkanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama, 'Smart Grid: Technology and Applications', Wiley, 2012.
3. Mini S. Thomas, John D McDonald, 'Power System SCADA and Smart Grids', CRC Press, 2015
4. Kenneth C.Budka, Jayant G. Deshpande, Marina Thottan, 'Communication Networks for Smart Grids', Springer, 2014
5. SMART GRID Fundamentals of Design and Analysis, James Momoh, IEEE press, A John Wiley & Sons, Inc., Publication.

MAPPING O CO'S WITH PO'S

CO	PO					
	1	2	3	4	5	6
1	3	2	-	2	2	2
2	3	-	2	2	-	2
3	2	-	1	-	-	-
4	1	-	-	3	3	1
5	-	2	2	2	2	3
AVG	2.25	2	1.66	2.25	2.3	2

PS4351**HVDC AND FACTS****LT P C****3 0 3****OBJECTIVES:**

- To emphasis the need for FACTS controllers.
- To learn the characteristics, applications and modeling of series and shunt FACTS controllers.
- To analyze the interaction of different FACTS controller and perform control coordination
- To impart knowledge on operation, modelling and control of HVDC link.
- To perform steady state analysis of AC/DC system.

UNIT I INTRODUCTION**9**

Review of basics of power transmission networks-control of power flow in AC transmission line- Analysis of uncompensated AC Transmission line- Passive reactive power compensation: Effect of series and shunt compensation at the mid-point of the line on power transfer- Need for FACTS controllers- types of FACTS controllers-Need for HVDC system-MTDC system-Review of basics of LCC and VSC HVDC system.Configurations-Monopolar Asymmetric and Symmetric MMC-HVDC Scheme- Bipolar and Homopolar HVDC Scheme- Multi-Terminal HVDC Configuration- Layout of HVDC system (LCC, VSC)

UNIT II THYRISTOR BASED FACTS CONTROLLERS**9**

Configuration of SVC- voltage regulation by SVC- Modelling of SVC for power flow analysis-Stability studies- Applications: transient stability enhancement and power oscillation damping of SMIB system with SVC connected at the mid-point of the line-Concepts of Controlled Series Compensation – Operation of TCSC- Analysis of TCSC – Modelling of TCSC for power flow and stability studies.

UNIT III ANALYSIS OF LCC HVDC CONVERTERS AND HVDC SYSTEM CONTROL**9**

Choice of converter configuration – Simplified analysis of Graetz circuit Converter bridge characteristics – characteristics of a twelve pulse converter- detailed analysis of converters. General principles of DC link control – Converter control characteristics – System control hierarchy - Firing angle control – Current and extinction angle control – Generation of harmonics and filtering - power control – Higher level controllers. Modelling of LCC HVDC system and controllers, transformer derating and core saturation instability, Concepts of Power Oscillation Damping Controller, Frequency Controller and Sub synchronous Damping controller in LCC HVDC.

UNIT IV VOLTAGE SOURCE CONVERTER BASED FACTS CONTROLLERS**9**

Static synchronous compensator (STATCOM) - Static synchronous series compensator (SSSC) Operation of STATCOM and SSSC-Power flow control with STATCOM and SSSC-Modelling of STATCOM and SSSC for power flow and transient stability studies –operation of Unified and Interline power flow controllers (UPFC) - Modelling of UPFC and IPFC for power flow and transient stability studies-Concepts of Power Oscillation Damping using FACTS controllers

UNIT V VOLTAGE SOURCE CONVERTER BASED HVDC SYSTEM AND CONTROLS**9**

Applications VSC based HVDC: Operation, Modelling for steady state and dynamic studies, .Introduction to Modular Multilevel converters- Main circuit design-Converter Operating Principle and Averaged Dynamic Model- Per-Phase Output-Current Control - Arm-Balancing (Internal) Control- Vector Output-Current Control-Higher-Level Control-Modulation and Submodule Energy Balancing- Offshore HVDC integration System Studies -Control and Protection of MMC-HVDC under AC and DC Network Fault Contingencies- Modeling and Simulation of MMC based MTDC Simulation exercises, Steady state, Fault recovery characteristics - Solution of DC load flow-Solution of AC-DC power flow: Sequential and Simultaneous methods.

TOTAL : 45 PERIODS**COURSE OUTCOMES:**

1. Learners will be able to refresh on basics of power transmission networks and need for FACTS controllers
2. Ability to design series and shunt compensating devices for power transfer enhancement
3. Learners will understand the significance about different voltage source converter based FACTS controllers
4. Learners will attain knowledge on AC/DC system coordinated control with FACTS and HVDC link
5. Learners will be capable to explore the MMC converter applications FACTS and MTDC system

REFERENCES

1. Mohan Mathur, R., Rajiv. K. Varma, "Thyristor – Based Facts Controllers for Electrical Transmission Systems", IEEE press and John Wiley & Sons, Inc.
2. K.R.Padiyar, "FACTS Controllers in Power Transmission and Distribution", New Age International(P) Ltd., Publishers, New Delhi, Reprint 2008.
3. K.R.Padiyar, "HVDC Power Transmission Systems", New Age International (P) Ltd., New Delhi, 2002.
4. J.Arrillaga, "High Voltage Direct Current Transmission", Peter Pregrinus, London, 1983.
5. V.K.Sood, "HVDC and FACTS controllers- Applications of Static Converters in Power System", Kluwer Academic Publishers 2004.

MAPPING OF CO'S WITH PO'S

CO	PO					
	1	2	3	4	5	6
CO1	3	2	1	-	1	-
CO2	1	1	2	-	3	-
CO3	2	-	3	1	1	2
CO4	3	3	1	2	-	1
CO5	2	2	2	-	3	-
AVG	2.2	2	1.8	1.5	2.33	1.5

ET4073

PYTHON PROGRAMMING FOR MACHINE LEARNING

L T P C

3 0 0 3

COURSE OBJECTIVES:

1. Students will understand and be able to use the basic programming principles such as data types, variable, conditionals, loops, recursion and function calls.
2. Students will learn how to use basic data structures such as List, Dictionary and be able to manipulate text files and images.
3. To make the students familiar with machine learning concepts & techniques.
4. Students will understand the process and will acquire skills necessary to effectively attempt a machine learning problem and implement it using Python.
5. To involve Discussions/ Practice/Exercise onto revising & familiarizing the concepts acquired over the 5 Units of the subject for improved research/employability skills

UNIT I INTRODUCTION TO MACHINE LEARNING AND PYTHON

9

Introduction to Machine Learning: Significance, Advantage and Applications – Categories of Machine Learning – Basic Steps in Machine Learning: Raw Data Collection, Pre-processing, Training a Model, Evaluation of Model, Performance Improvement

Introduction to Python and its significance – Difference between C, C++ and Python Languages; Compiler and Interpreters – Python3 Installation & Running – Basics of Python Programming Syntax: Variable Types, Basic Operators, Reading Input from User – Arrays/List, Dictionary and Set – Conditional Statements – Control Flow and loop control statements

UNIT II PYTHON FUNCTIONS AND PACKAGES 9

File Handling: Reading and Writing Data – Errors and Exceptions Handling – Functions & Modules – Package Handling in Python – Pip Installation & Exploring Functions in python package – Installing the Numpy Library and exploring various operations on Arrays: Indexing, Slicing, Multi-Dimensional Arrays, Joining Numpy Arrays, Array intersection and Difference, Saving and Loading Numpy Arrays – Introduction to SciPy Package & its functions - Introduction to Object Oriented Programming with Python

UNIT III IMPLEMENTATION OF MACHINE LEARNING USING PYTHON 9

Description of Standard Datasets: Coco, ImageNet, MNIST (Handwritten Digits) Dataset, Boston Housing Dataset – Introducing the concepts of Regression – Linear, Polynomial & Logistic Regression with analytical understanding - Introduction to SciPy Package & its functions – Python Application of Linear Regression and Polynomial Regression using SciPy – Interpolation, Overfitting and Underfitting concepts & examples using SciPy

UNIT IV CLASSIFICATION AND CLUSTERING CONCEPTS OF ML 9

Introduction to ML Concepts of Clustering and Classification – Types of Classification Algorithms – Support Vector Machines (SVM) - Decision Tree - Random Forest – Introduction to ML using scikit-learn – Using scikit-learn, Loading a sample dataset, Learning & prediction, interpolation & fitting, Multiclass fitting - Implementation of SVM using Blood Cancer Dataset, Decision Tree using data from csv.

Types of Clustering Algorithms & Techniques – K-means Algorithm, Mean Shift Algorithm & Hierarchical Clustering Algorithm – Introduction to Python Visualization using Matplotlib: Plotting 2-dimensional, 3-dimensional graphs; formatting axis values; plotting multiple rows of data in same graph – Implementation of K-means Algorithm and Mean Shift Algorithm using Python

UNIT V INTRODUCTION TO NEURAL NETWORKS AND EMBEDDED MACHINE LEARNING 9

Introduction to Neural Networks & Significance – Neural Network Architecture – Single Layer Perceptron & Multi-Layer Perceptron (MLP) – Commonly Used Activation Functions - Forward Propagation, Back Propagation, and Epochs – Gradient Descent – Introduction to Tensorflow and Keras ML Python packages – Implementation of MLP Neural Network on Iris Dataset – Introduction to Convolution Neural Networks – Implementation of Digit Classification using MNIST Dataset ML for Embedded Systems: Comparison with conventional ML – Challenges & Methods for Overcoming – TinyML and Tensorflow Lite for Microcontrollers – on-Board AI – ML Edge Devices: Arduino Nano BLE Sense, Google Edge TPU and Intel Movidius

TOTAL: 45 PERIODS**COURSE OUTCOMES:**

At the end of this course, the students will have the ability to

CO1: Develop skill in system administration and network programming by learning Python.

CO2: Demonstrating understanding in concepts of Machine Learning and its implementation using Python

CO3: Relate to use Python's highly powerful processing capabilities for primitives, modelling etc

CO4: Improved Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in embedded systems design.

CO5: Apply the concepts acquired over the advanced research/employability skills

CO	PO					
	1	2	3	4	5	6
1	-	-	2	3	3	-
2	3	1	3	-	3	1
3	2	1	2	-	3	3
4	3	2	3	3	3	3
5	-	-	-		3	-
AVg.	2.66	1.33	2.5	3	3	2.33

REFERENCES:

1. Mark Lutz, "Learning Python, Powerful OOPs, O'Reilly, 2011
2. Zelle, John "M. Python Programming: An Introduction to Computer Science.", Franklin Beedle & Associates, 2003
3. Andreas C. Müller, Sarah Guido, "Introduction to Machine Learning with Python", O'Reilly, 2016
4. Sebastian Raschka, Vahid Mirjalili, "Python Machine Learning - Third Edition", Packt, December 2019

AX4091

ENGLISH FOR RESEARCH PAPER WRITING

L T P C
2 0 0 0

OBJECTIVES

- Teach how to improve writing skills and level of readability
- Tell about what to write in each section
- Summarize the skills needed when writing a Title
- Infer the skills needed when writing the Conclusion
- Ensure the quality of paper at very first-time submission

UNIT I INTRODUCTION TO RESEARCH PAPER WRITING

6

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

UNIT II PRESENTATION SKILLS

6

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction

UNIT III TITLE WRITING SKILLS

6

Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check

UNIT IV RESULT WRITING SKILLS

6

Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions

UNIT V VERIFICATION SKILLS

6

Useful phrases, checking Plagiarism, how to ensure paper is as good as it could possibly be the first-time submission

TOTAL: 30 PERIODS

OUTCOMES

- CO1 – Understand that how to improve your writing skills and level of readability
- CO2 – Learn about what to write in each section
- CO3 – Understand the skills needed when writing a Title
- CO4 – Understand the skills needed when writing the Conclusion
- CO5 – Ensure the good quality of paper at very first-time submission

REFERENCES

1. Adrian Wallwork, English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011
2. Day R How to Write and Publish a Scientific Paper, Cambridge University Press 2006
3. Goldbort R Writing for Science, Yale University Press (available on Google Books) 2006

4. Highman N, Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book 1998.

AX4092

DISASTER MANAGEMENT

**LT P C
2 0 0 0**

OBJECTIVES

- Summarize basics of disaster
- Explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- Illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- Describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
- Develop the strengths and weaknesses of disaster management approaches

UNIT I INTRODUCTION

6

Disaster: Definition, Factors and Significance; Difference between Hazard And Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

UNIT II REPERCUSSIONS OF DISASTERS AND HAZARDS

6

Economic Damage, Loss of Human and Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

UNIT III DISASTER PRONE AREAS IN INDIA

6

Study of Seismic Zones; Areas Prone To Floods and Droughts, Landslides And Avalanches; Areas Prone To Cyclonic and Coastal Hazards with Special Reference To Tsunami; Post-Disaster Diseases and Epidemics

UNIT IV DISASTER PREPAREDNESS AND MANAGEMENT

6

Preparedness: Monitoring Of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological And Other Agencies, Media Reports: Governmental and Community Preparedness.

UNIT V RISK ASSESSMENT

6

Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival

TOTAL : 30 PERIODS

OUTCOMES

CO1: Ability to summarize basics of disaster

CO2: Ability to explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.

CO3: Ability to illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.

CO4: Ability to describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.

CO5: Ability to develop the strengths and weaknesses of disaster management approaches

REFERENCES

1. Goel S. L., Disaster Administration And Management Text And Case Studies", Deep & Deep Publication Pvt. Ltd., New Delhi, 2009.
2. Nishitha Rai, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "NewRoyal book Company, 2007.
3. Sahni, Pardeep Et. Al. , " Disaster Mitigation Experiences And Reflections", Prentice Hall Of India, New Delhi, 2001.

OBJECTIVES

Students will be able to:

- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional
- Role and entitlement to civil and economic rights as well as the emergence nation hood in the early years of Indian nationalism.
- To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.

UNIT I HISTORY OF MAKING OF THE INDIAN CONSTITUTION

History, Drafting Committee, (Composition & Working)

UNIT II PHILOSOPHY OF THE INDIAN CONSTITUTION

Preamble, Salient Features

UNIT III CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES

Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

UNIT IV ORGANS OF GOVERNANCE

Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.

UNIT V LOCAL ADMINISTRATION

District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO, Municipal Corporation. Pachayati raj: Introduction, Panchayat: Zila Pachayat. Elected officials and their roles, CEO Zila Pachayat: Position and role. Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy.

UNIT VI ELECTION COMMISSION

Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners - Institute and Bodies for the welfare of SC/ST/OBC and women.

TOTAL: 30 PERIODS

OUTCOMES

Students will be able to:

- Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
- Discuss the intellectual origins of the framework of argument that informed the conceptualization
- of social reforms leading to revolution in India.
- Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
- Discuss the passage of the Hindu Code Bill of 1956.

SUGGESTED READING

1. The Constitution of India, 1950 (Bare Act), Government Publication.
2. Dr. S.N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.

3. M.P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis,2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

AX4094	நற்றமிழ் இலக்கியம்	LTPC 2000
UNIT I	சங்க இலக்கியம்	6
	1. தமிழின் துவக்க நூல் தொல்காப்பியம் - எழுத்து, சொல், பொருள்	
	2. அகநானூறு (82) - இயற்கை இன்னிசை அரங்கம்	
	3. குறிஞ்சிப் பாட்டின் மலர்க்காட்சி	
	4. புறநானூறு (95,195) - போரை நிறுத்திய ஓளவையார்	
UNIT II	அறநெறித் தமிழ்	6
	1. அறநெறி வகுத்த திருவள்ளுவர் - அறம் வலியுறுத்தல், அன்புடைமை, ஒப்புரவறிதல், ஈகை, புகழ்	
	2. பிற அறநூல்கள் - இலக்கிய மருந்து - ஏலாதி, சிறுபஞ்சமூலம், திரிகடுகம், ஆசாரக்கோவை (தூய்மையை வலியுறுத்தும் நூல்)	
UNIT III	இரட்டைக் காப்பியங்கள்	6
	1. கண்ணகியின் புரட்சி - சிலப்பதிகார வழக்குரை காதை	
	2. சமூகசேவை இலக்கியம் மணிமேகலை - சிறைக்கோட்டம் அறக்கோட்டமாகிய காதை	
UNIT IV	அருள்நெறித் தமிழ்	6
	1. சிறுபாணாற்றுப்படை	

- பாரி முல்லைக்குத் தேர் கொடுத்தது, பேகன் மயிலுக்குப்
போர்வை கொடுத்தது, அதியமான் ஓளவைக்கு நெல்லிக்கனி
கொடுத்தது, அரசர் பண்புகள்

2. நற்றிணை

- அன்னைக்குரிய புன்னை சிறப்பு

3. திருமந்திரம் (617, 618)

- இயமம் நியமம் விதிகள்

4. தர்மச்சாலையை நிறுவிய வள்ளலார்

5. புறநானூறு

- சிறுவனே வள்ளலானான்

6. அகநானூறு (4) - வண்டு

நற்றிணை (11) - நண்டு

கலித்தொகை (11) - யானை, புறா

ஐந்திணை 50 (27) - மான்

ஆகியவை பற்றிய செய்திகள்

UNIT V

நவீன தமிழ் இலக்கியம்

6

1. உரைநடைத் தமிழ்,

- தமிழின் முதல் புதினம்,

- தமிழின் முதல் சிறுகதை,

- கட்டுரை இலக்கியம்,

- பயண இலக்கியம்,

- நாடகம்,

2. நாட்டு விடுதலை போராட்டமும் தமிழ் இலக்கியமும்,

3. சமுதாய விடுதலையும் தமிழ் இலக்கியமும்,

4. பெண் விடுதலையும் விளிம்பு நிலையினரின் மேம்பாட்டில் தமிழ்

இலக்கியமும்,

5. அறிவியல் தமிழ்,

6. இணையத்தில் தமிழ்,
7. சுற்றுச்சூழல் மேம்பாட்டில் தமிழ் இலக்கியம்.

தமிழ் இலக்கிய வெளியீடுகள் / புத்தகங்கள்

1. தமிழ் இணைய கல்விக்கழகம் (Tamil Virtual University)

- www.tamilvu.org

2. தமிழ் விக்கிப்பீடியா (Tamil Wikipedia)

-<https://ta.wikipedia.org>

3. தர்மபுர ஆதீன வெளியீடு

4. வாழ்வியல் களஞ்சியம்

- தமிழ்ப் பல்கலைக்கழகம், தஞ்சாவூர்

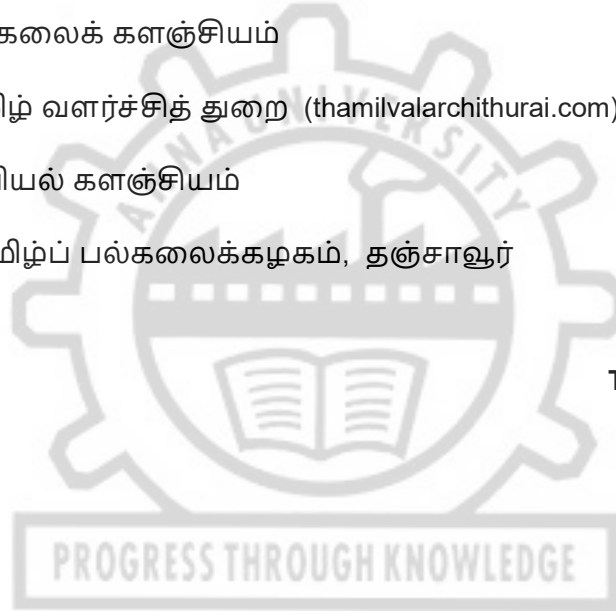
5. தமிழ்கலைக் களஞ்சியம்

- தமிழ் வளர்ச்சித் துறை (thamilvalarchithurai.com)

6. அறிவியல் களஞ்சியம்

- தமிழ்ப் பல்கலைக்கழகம், தஞ்சாவூர்

TOTAL: 30 PERIODS



OUTCOMES:

- CO1** Capture to fundamental concepts and terms which are to be applied and understood all through the study.
- CO2** Comprehend the various factors affecting water sanitation and health through the lens of third world scenario.
- CO3** Critically analyse and articulate the underlying common challenges in water, sanitation and health.
- CO4** Acquire knowledge on the attributes of governance and its say on water sanitation and health.
- CO5** Gain an overarching insight in to the aspects of sustainable resource management in the absence of a clear level playing field in the developmental aspects.

REFERENCES

1. Bonitha R., Beaglehole R., Kjellstorm, 2006, "Basic Epidemiology", 2nd Edition, World Health Organization.
2. Van Note Chism, N. and Bickford, D. J. (2002), Improving the environment for learning: An expanded agenda. *New Directions for Teaching and Learning*, 2002: 91–98. doi: 10.1002/tl.83Improving the Environment for learning: An Expanded Agenda
3. National Research Council. *Global Issues in Water, Sanitation, and Health: Workshop Summary*. Washington, DC: The National Academies Press, 2009.
4. Sen, Amartya 1997. *On Economic Inequality*. Enlarged edition, with annex by James Foster and Amartya Sen, Oxford: Clarendon Press, 1997.
5. *Intersectoral Water Allocation Planning and Management*, 2000, World Bank Publishers [www. Amazon.com](http://www.Amazon.com)
6. *Third World Network.org* (www.twn.org).

OCE433

PRINCIPLES OF SUSTAINABLE DEVELOPMENT

LT P C
3 0 0 3

OBJECTIVES:

- To impart knowledge on environmental, social and economic dimensions of sustainability and the principles evolved through landmark events so as to develop an action mindset for sustainable development.

UNIT I SUSTAINABILITY AND DEVELOPMENT CHALLENGES 9

Definition of sustainability – environmental, economical and social dimensions of sustainability - sustainable development models – strong and weak sustainability – defining development-millennium development goals – mindsets for sustainability: earthly, analytical, precautionary, action and collaborative– syndromes of global change: utilisation syndromes, development syndromes, and sink syndromes – core problems and cross cutting Issues of the 21 century - global, regional and local environmental issues – social insecurity - resource degradation –climate change – desertification.

UNIT II PRINCIPLES AND FRAME WORK 9

History and emergence of the concept of sustainable development - our common future - Stockholm to Rio plus 20– Rio Principles of sustainable development – Agenda 21 natural step-peoples earth charter – business charter for sustainable development –UN Global Compact - Role

OBJECTIVES:

- To make the students to understand environmental clearance, its legal requirements and to provide knowledge on overall methodology of EIA, prediction tools and models, environmental management plan and case studies.

UNIT I INTRODUCTION 9

Historical development of Environmental Impact Assessment (EIA). Environmental Clearance- EIA in project cycle. legal and regulatory aspects in India – types and limitations of EIA –EIA process- screening – scoping - terms of reference in EIA- setting – analysis – mitigation. Cross sectoral issues –public hearing in EIA- EIA consultant accreditation.

UNIT II IMPACT IDENTIFICATION AND PREDICTION 10

Matrices – networks – checklists – cost benefit analysis – analysis of alternatives – expert systems in EIA. prediction tools for EIA – mathematical modeling for impact prediction – assessment of impacts – air – water – soil – noise – biological — cumulative impact assessment

UNIT III SOCIO-ECONOMIC IMPACT ASSESSMENT 8

Socio-economic impact assessment - relationship between social impacts and change in community and institutional arrangements. factors and methodologies- individual and family level impacts. communities in transition-rehabilitation

UNIT IV EIA DOCUMENTATION AND ENVIRONMENTAL MANAGEMENT PLAN 9

Environmental management plan - preparation, implementation and review – mitigation and rehabilitation plans – policy and guidelines for planning and monitoring programmes – post project audit – documentation of EIA findings – ethical and quality aspects of environmental impact assessment

UNIT V CASE STUDIES 9

Mining, power plants, cement plants, highways, petroleum refining industry, storage & handling of hazardous chemicals, common hazardous waste facilities, CETPs, CMSWMF, building and construction projects

TOTAL: 45 PERIODS**OUTCOMES:**

- On completion of the course, the student is expected to be able to
 - CO1** Understand need for environmental clearance, its legal procedure, need of EIA, its types, stakeholders and their roles
 - CO2** Understand various impact identification methodologies, prediction techniques and model of impacts on various environments
 - CO3** Understand relationship between social impacts and change in community due to development activities and rehabilitation methods
 - CO4** Document the EIA findings and prepare environmental management and monitoring plan
 - CO5** Identify, predict and assess impacts of similar projects based on case studies

REFERENCES:

- EIA Notification 2006 including recent amendments, by Ministry of Environment, Forest and Climate Change, Government of India
- Sectoral Guidelines under EIA Notification by Ministry of Environment, Forest and Climate Change, Government of India
- Canter, L.W., Environmental Impact Assessment, McGraw Hill, New York. 1996

4. Lawrence, D.P., Environmental Impact Assessment – Practical solutions to recurrent problems, Wiley-Interscience, New Jersey. 2003
5. Lee N. and George C. 2000. Environmental Assessment in Developing and Transitional Countries. Chichester: Willey
6. World Bank –Source book on EIA ,1999
7. Sam Mannan, Lees' Loss Prevention in the Process Industries, Hazard Identification Assessment and Control, 4th Edition, Butterworth Heineman, 2012.

OIC431

BLOCKCHAIN TECHNOLOGIES

L T P C
3 0 0 3

COURSE OBJECTIVES:

- This course is intended to study the basics of Blockchain technology.
- During this course the learner will explore various aspects of Blockchain technology like application in various domains.
- By implementing, learners will have idea about private and public Blockchain, and smart contract.

UNIT I INTRODUCTION OF CRYPTOGRAPHY AND BLOCKCHAIN 9

Introduction to Blockchain, Blockchain Technology Mechanisms & Networks, Blockchain Origins, Objective of Blockchain, Blockchain Challenges, Transactions and Blocks, P2P Systems, Keys as Identity, Digital Signatures, Hashing, and public key cryptosystems, private vs. public Blockchain.

UNIT II BITCOIN AND CRYPTOCURRENCY 9

Introduction to Bitcoin, The Bitcoin Network, The Bitcoin Mining Process, Mining Developments, Bitcoin Wallets, Decentralization and Hard Forks, Ethereum Virtual Machine (EVM), Merkle Tree, Double-Spend Problem, Blockchain and Digital Currency, Transactional Blocks, Impact of Blockchain Technology on Cryptocurrency.

UNIT III INTRODUCTION TO ETHEREUM 9

Introduction to Ethereum, Consensus Mechanisms, Metamask Setup, Ethereum Accounts, Transactions, Receiving Ethers, Smart Contracts.

UNIT IV INTRODUCTION TO HYPERLEDGER AND SOLIDITY PROGRAMMING 10

Introduction to Hyperledger, Distributed Ledger Technology & its Challenges, Hyperledger & Distributed Ledger Technology, Hyperledger Fabric, Hyperledger Composer. Solidity - Language of Smart Contracts, Installing Solidity & Ethereum Wallet, Basics of Solidity, Layout of a Solidity Source File & Structure of Smart Contracts, General Value Types.

UNIT V BLOCKCHAIN APPLICATIONS 8

Internet of Things, Medical Record Management System, Domain Name Service and Future of Blockchain, Alt Coins.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After the completion of this course, student will be able to

CO1: Understand and explore the working of Blockchain technology

CO2: Analyze the working of Smart Contracts

CO3: Understand and analyze the working of Hyperledger

CO4: Apply the learning of solidity to build de-centralized apps on Ethereum

CO5: Develop applications on Blockchain

REFERENCES:

1. Imran Bashir, "Mastering Blockchain: Distributed Ledger Technology, Decentralization, and Smart Contracts Explained", Second Edition, Packt Publishing, 2018.
2. Narayanan, J. Bonneau, E. Felten, A. Miller, S. Goldfeder, "Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction" Princeton University Press, 2016
3. Antonopoulos, Mastering Bitcoin, O'Reilly Publishing, 2014. .
4. Antonopoulos and G. Wood, "Mastering Ethereum: Building Smart Contracts and Dapps", O'Reilly Publishing, 2018.
5. D. Drescher, Blockchain Basics. Apress, 2017.

COURSE OBJECTIVES:

- Develop and Train Deep Neural Networks.
- Develop a CNN, R-CNN, Fast R-CNN, Faster-R-CNN, Mask-RCNN for detection and recognition
- Build and train RNNs, work with NLP and Word Embeddings
- The internal structure of LSTM and GRU and the differences between them
- The Auto Encoders for Image Processing

UNIT I DEEP LEARNING CONCEPTS**6**

Fundamentals about Deep Learning. Perception Learning Algorithms. Probabilistic modelling. Early Neural Networks. How Deep Learning different from Machine Learning. Scalars. Vectors. Matrixes, Higher Dimensional Tensors. Manipulating Tensors. Vector Data. Time Series Data. Image Data. Video Data.

UNIT II NEURAL NETWORKS**9**

About Neural Network. Building Blocks of Neural Network. Optimizers. Activation Functions. Loss Functions. Data Pre-processing for neural networks, Feature Engineering. Overfitting and Underfitting. Hyperparameters.

UNIT III CONVOLUTIONAL NEURAL NETWORK**10**

About CNN. Linear Time Invariant. Image Processing Filtering. Building a convolutional neural network. Input Layers, Convolution Layers. Pooling Layers. Dense Layers. Backpropagation Through the Convolutional Layer. Filters and Feature Maps. Backpropagation Through the Pooling Layers. Dropout Layers and Regularization. Batch Normalization. Various Activation Functions. Various Optimizers. LeNet, AlexNet, VGG16, ResNet. Transfer Learning with Image Data. Transfer Learning using Inception Oxford VGG Model, Google Inception Model, Microsoft ResNet Model. R-CNN, Fast R-CNN, Faster R-CNN, Mask-RCNN, YOLO

UNIT IV NATURAL LANGUAGE PROCESSING USING RNN**10**

About NLP & its Toolkits. Language Modeling . Vector Space Model (VSM). Continuous Bag of Words (CBOW). Skip-Gram Model for Word Embedding. Part of Speech (PoS) Global Co-occurrence Statistics-based Word Vectors. Transfer Learning. Word2Vec. Global Vectors for Word Representation GloVe. Backpropagation Through Time. Bidirectional RNNs (BRNN) . Long Short Term Memory (LSTM). Bi-directional LSTM. Sequence-to-Sequence Models (Seq2Seq). Gated recurrent unit GRU.

UNIT V DEEP REINFORCEMENT & UNSUPERVISED LEARNING**10**

About Deep Reinforcement Learning. Q-Learning. Deep Q-Network (DQN). Policy Gradient Methods. Actor-Critic Algorithm. About Autoencoding. Convolutional Auto Encoding. Variational Auto Encoding. Generative Adversarial Networks. Autoencoders for Feature Extraction. Auto Encoders for Classification. Denoising Autoencoders. Sparse Autoencoders

COURSE OUTCOMES:

CO1: Feature Extraction from Image and Video Data

CO2: Implement Image Segmentation and Instance Segmentation in Images

CO3: Implement image recognition and image classification using a pretrained network (Transfer Learning)

CO4: Traffic Information analysis using Twitter Data

CO5: Autoencoder for Classification & Feature Extraction

TOTAL : 45 PERIODS

REFERENCES

1. Deep Learning A Practitioner's Approach Josh Patterson and Adam Gibson O'Reilly Media, Inc.2017
2. Learn Keras for Deep Neural Networks, Jojo Moolayil, Apress,2018
3. Deep Learning Projects Using TensorFlow 2, Vinita Silaparasetty, Apress, 2020
4. Deep Learning with Python, FRANÇOIS CHOLLET, MANNING SHELTER ISLAND,2017
5. Pro Deep Learning with TensorFlow, Santanu Pattanayak, Apress,2017

OME431

VIBRATION AND NOISE CONTROL STRATEGIES

L T P C
3 0 0 3

OBJECTIVES

- To appreciate the basic concepts of vibration in damped and undamped systems
- To appreciate the basic concepts of noise, its effect on hearing and related terminology
- To use the instruments for measuring and analyzing the vibration levels in a body
- To use the instruments for measuring and analyzing the noise levels in a system
- To learn the standards of vibration and noise levels and their control techniques

UNIT I BASICS OF VIBRATION

9

Introduction – Sources and causes of Vibration-Mathematical Models - Displacement, velocity and Acceleration - Classification of vibration: free and forced vibration, undamped and damped vibration, linear and non-linear vibration - Single Degree Freedom Systems - Vibration isolation - Determination of natural frequencies

UNIT II BASICS OF NOISE

9

Introduction - Anatomy of human ear - Mechanism of hearing - Amplitude, frequency, wavelength and sound pressure level - Relationship between sound power, sound intensity and sound pressure level - Addition, subtraction and averaging decibel levels - sound spectra -Types of sound fields - Octave band analysis - Loudness.

UNIT III INSTRUMENTATION FOR VIBRATION MEASUREMENT

9

Experimental Methods in Vibration Analysis.- Vibration Measuring Instruments - Selection of Sensors - Accelerometer Mountings - Vibration Exciters - Mechanical, Hydraulic, Electromagnetic and Electrodynamics – Frequency Measuring Instruments -. System Identification from Frequency Response -Testing for resonance and mode shapes

UNIT IV INSTRUMENTATION FOR NOISE MEASUREMENT AND ANALYSIS

9

Microphones - Weighting networks - Sound Level meters, its classes and calibration - Noise measurements using sound level meters - Data Loggers - Sound exposure meters - Recording of noise - Spectrum analyser - Intensity meters - Energy density sensors - Sound source localization.

UNIT V METHODS OF VIBRATION CONTROL, SOURCES OF NOISE AND ITS CONTROL

9

Specification of Vibration Limits – Vibration severity standards - Vibration as condition Monitoring Tool – Case Studies - Vibration Isolation methods - Dynamic Vibration Absorber – Need for Balancing - Static and Dynamic Balancing machines – Field balancing - Major sources of noise - Noise survey techniques – Measurement technique for vehicular noise - Road vehicles Noise standard – Noise due to construction equipment and domestic appliances – Industrial noise sources and its strategies – Noise control at the source – Noise control along the path – Acoustic

OUTCOMES:

On Completion of the course the student will be able to

1. apply the basic concepts of vibration in damped and undamped systems
2. apply the basic concepts of noise and to understand its effects on systems
3. select the instruments required for vibration measurement and its analysis
4. select the instruments required for noise measurement and its analysis.
5. recognize the noise sources and to control the vibration levels in a body and to control noise under different strategies.

REFERENCES:

1. Singiresu S. Rao, "Mechanical Vibrations", Pearson Education Incorporated, 2017.
2. Graham Kelly. Sand Shashidhar K. Kudari, "Mechanical Vibrations", Tata McGraw –Hill Publishing Com. Ltd., 2007.
3. Ramamurti. V, "Mechanical Vibration Practice with Basic Theory", Narosa Publishing House, 2000.
4. William T. Thomson, "Theory of Vibration with Applications", Taylor & Francis, 2003.
5. G.K. Grover, "Mechanical Vibrations", Nem Chand and Bros., Roorkee, 2014.
6. A.G. Ambekar, "Mechanical Vibrations and Noise Engineering", PHI Learning Pvt. Ltd., 2014.
7. David A. Bies and Colin H. Hansen, "Engineering Noise Control – Theory and Practice", Spon Press, London and New York, 2009.

OME432	ENERGY CONSERVATION AND MANAGEMENT IN DOMESTIC SECTORS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To learn the present energy scenario and the need for energy conservation.
2. To understand the different measures for energy conservation in utilities.
3. Acquaint students with principle theories, materials, and construction techniques to create energy efficient buildings.
4. To identify the energy demand and bridge the gap with suitable technology for sustainable habitat
5. To get familiar with the energy technology, current status of research and find the ways to optimize a system as per the user requirement

UNIT I ENERGY SCENARIO 9

Primary energy resources - Sectorial energy consumption (domestic, industrial and other sectors), Energy pricing, Energy conservation and its importance, Energy Conservation Act-2001 and its features – Energy star rating.

UNIT II HEATING, VENTILLATION & AIR CONDITIONING 9

Basics of Refrigeration and Air Conditioning – COP / EER / SEC Evaluation – SPV system design & optimization for Solar Refrigeration.

UNIT III LIGHTING, COMPUTER, TV 9

Specification of Luminaries – Types – Efficacy – Selection & Application – Time Sensors – Occupancy Sensors – Energy conservation measures in computer – Television – Electronic devices.

UNIT IV ENERGY EFFICIENT BUILDINGS 9

Conventional versus Energy efficient buildings – Landscape design – Envelope heat loss and heat gain – Passive cooling and heating – Renewable sources integration.

UNIT V ENERGY STORAGE TECHNOLOGIES**9**

Necessity & types of energy storage – Thermal energy storage – Battery energy storage, charging and discharging– Hydrogen energy storage & Super capacitors – energy density and safety issues – Applications.

TOTAL: 45 PERIODS**COURSE OUTCOMES:**

Upon completion of this course, the students will be able to:

1. Understand technical aspects of energy conservation scenario.
2. Energy audit in any type for domestic buildings and suggest the conservation measures.
3. Perform building load estimates and design the energy efficient landscape system.
4. Gain knowledge to utilize an appliance/device sustainably.
5. Understand the status and current technological advancement in energy storage field.

REFERENCES:

1. Yogi Goswami, Frank Kreith, Energy Efficiency and Renewable energy Handbook, CRC Press, 2016
2. ASHRAE Handbook 2020 – HVAC Systems & Equipment
3. Paolo Bertoldi, Andrea Ricci, Anibal de Almeida, Energy Efficiency in Household Appliances and Lighting, Conference proceedings, Springer, 2001
4. David A. Bainbridge, Ken Haggard, Kenneth L. Haggard, Passive Solar Architecture: Heating, Cooling, Ventilation, Daylighting, and More Using Natural Flows, Chelsea Green Publishing, 2011.
5. Guide book for National Certification Examination for Energy Managers and Energy Auditors (Could be downloaded from www.energymanagertraining.com)
6. Ibrahim Dincer and Mark A. Rosen, Thermal Energy Storage Systems and Applications, John Wiley & Sons 2002.
7. Robert Huggins, Energy Storage: Fundamentals, Materials and Applications, 2nd edition, Springer, 2015
8. Ru-shiliu, Leizhang, Xueliang sun, Electrochemical technologies for energy storage and conversion, Wiley publications, 2012.

OME433**ADDITIVE MANUFACTURING****L T P C
3 0 0 3****UNIT I INTRODUCTION****9**

Need - Development - Rapid Prototyping Rapid Tooling – Rapid Manufacturing – Additive Manufacturing. AM Process Chain- Classification – Benefits.

UNIT II DESIGN FOR ADDITIVE MANUFACTURING**9**

CAD Model Preparation - Part Orientation and Support Structure Generation -Model Slicing - Tool Path Generation Customized Design and Fabrication - Case Studies.

UNIT III VAT POLYMERIZATION**9**

Stereolithography Apparatus (SLA)- Materials -Process -Advantages Limitations- Applications. Digital Light Processing (DLP) - Materials – Process - Advantages - Applications. Multi Jet Modelling (MJM) - Principles - Process - Materials - Advantages and Limitations.

UNIT IV MATERIAL EXTRUSION AND SHEET LAMINATION**9**

Fused Deposition Modeling (FDM)- Process-Materials - Applications and Limitations. Sheet Lamination Process: Laminated Object Manufacturing (LOM)- Basic Principle- Mechanism: Gluing or Adhesive Bonding – Thermal Bonding- Materials- Application and Limitation - Bio-Additive Manufacturing Computer Aided Tissue Engineering (CATE) – Case studies

POWDER BASED PROCESS

Selective Laser Sintering (SLS): Process –Mechanism– Typical Materials and Application- Multi Jet Fusion - Basic Principle– Materials- Application and Limitation - Three Dimensional Printing - Materials -Process - Benefits and Limitations. Selective Laser Melting (SLM) and Electron Beam Melting (EBM): Materials – Process - Advantages and Applications. Beam Deposition Process: Laser Engineered Net Shaping (LENS)- Process -Material Delivery - Process Parameters - Materials -Benefits -Applications.

UNIT V CASE STUDIES AND OPPORTUNITIES ADDITIVE MANUFACTURING PROCESSES 9

Education and training - Automobile- pattern and mould - tooling - Building Printing-Bio Printing - medical implants -development of surgical tools Food Printing -Printing Electronics. Business Opportunities and Future Directions - Intellectual Property.

TOTAL: 45 PERIODS**REFERENCES:**

1. Andreas Gebhardt and Jan-Steffen Hötter “Additive Manufacturing: 3D Printing for Prototyping and Manufacturing”, Hanser publications, United States, 2015, ISBN: 978-1- 56990-582-1.
2. Ian Gibson, David W. Rosen and Brent Stucker “Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing”, 2nd edition, Springer., United States, 2015, ISBN13: 978-1493921126.
3. Amit Bandyopadhyay and Susmita Bose, “Additive Manufacturing”, 1st Edition, CRC Press., United States, 2015, ISBN-13: 978-1482223590
4. Andreas Gebhardt, “Understanding Additive Manufacturing: Rapid Prototyping, Rapid Manufacturing”, Hanser Gardner Publication, Cincinnati., Ohio, 2011, ISBN :9783446425521.
5. Chua C.K., Leong K.F., and Lim C.S., “Rapid prototyping: Principles and applications”, Third edition, World Scientific Publishers, 2010.

OME434**ELECTRIC VEHICLE TECHNOLOGY****L T P C
3 0 0 3****UNIT I NEED FOR ELECTRIC VEHICLES****9**

History and need for electric and hybrid vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies, comparison of diesel, petrol, electric and hybrid vehicles, limitations, technical challenges

UNIT II ELECTRIC VEHICLE ARCHITECTURE**9**

Electric vehicle types, layout and power delivery, performance – traction motor characteristics, tractive effort, transmission requirements, vehicle performance, energy consumption, Concepts of hybrid electric drive train, architecture of series and parallel hybrid electric drive train, merits and demerits, mild and full hybrids, plug-in hybrid electric vehicles and range extended hybrid electric vehicles, Fuel cell vehicles.

UNIT III ENERGY STORAGE**9**

Batteries – types – lead acid batteries, nickel based batteries, and lithium based batteries, electrochemical reactions, thermodynamic voltage, specific energy, specific power, energy efficiency, Battery modeling and equivalent circuit, battery charging and types, battery cooling, Ultra-capacitors, Flywheel technology, Hydrogen fuel cell, Thermal Management of the PEM fuel cell

UNIT IV ELECTRIC DRIVES AND CONTROL 9

Types of electric motors – working principle of AC and DC motors, advantages and limitations, DC motor drives and control, Induction motor drives and control, PMSM and brushless DC motor - drives and control , AC and Switch reluctance motor drives and control – Drive system efficiency – Inverters – DC and AC motor speed controllers

UNIT V DESIGN OF ELECTRIC VEHICLES 9

Materials and types of production, Chassis skate board design, motor sizing, power pack sizing, component matching, Ideal gear box – Gear ratio, torque–speed characteristics, Dynamic equation of vehicle motion, Maximum tractive effort – Power train tractive effort Acceleration performance, rated vehicle velocity – maximum gradability, Brake performance, Electronic control system, safety and challenges in electric vehicles. Case study of Nissan leaf, Toyota Prius, tesla model 3, and Renault Zoe cars.

TOTAL: 45 PERIODS

REFERENCES:

1. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, 2nd edition CRC Press, 2011.
2. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
3. James Larminie, John Lowry, Electric Vehicle Technology Explained - Wiley, 2003.
4. Ehsani, M, "Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design", CRC Press, 2005

OME435	NEW PRODUCT DEVELOPMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

The main learning objective of this course is to prepare the students for:

1. Applying the principles of generic development process; and understanding the organization structure for new product design and development.
2. Identifying opportunity and planning for new product design and development.
3. Conducting customer need analysis; and setting product specification for new product design and development.
4. Generating, selecting, and testing the concepts for new product design and development.
5. Applying the principles of Industrial design and prototype for new product design and development.

UNIT I INTRODUCTION TO PRODUCT DESIGN & DEVELOPMENT 9

Introduction - Characteristics of Successful Product Development - People involved in Product Design and Development - Duration and Cost of Product Development - The Challenges of Product Development - The Product Development Process - Concept Development: The Front-End Process - Adapting the Generic Product Development Process - Product Development Process Flows - Product Development Organizations.

UNIT II OPPORTUNITY IDENTIFICATION & PRODUCT PLANNING 9

Opportunity Identification: Definition – Types of Opportunities – Tournament Structure of Opportunity Identification – Effective Opportunity Tournaments – Opportunity Identification Process – Product Planning: Four types of Product Development Projects – The Process of Product Planning.

UNIT III IDENTIFYING CUSTOMER NEEDS & PRODUCT SPECIFICATIONS 9

Identifying Customer Needs: The Importance of Latent Needs - The Process of Identifying Customer Needs. Product Specifications: Definition - Time of Specifications Establishment - Establishing Target Specifications - Setting the Final Specifications

UNIT IV CONCEPT GENERATION, SELECTION & TESTING 9

Concept Generation: Activity of Concept Generation - Structured Approach - Five step method of Concept Generation. Concept Selection: Methodology - Concept Screening and Concepts Scoring. Concept testing: Seven Step activities of concept testing.

UNITV INDUSTRIAL DESIGN & PROTOTYPING 9

Industrial Design: Need and Impact-Industrial Design Process. Prototyping - Principles of Prototyping - Prototyping Technologies - Planning for Prototypes.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

1. Apply the principles of generic development process; and understand the organization structure for new product design and development.
2. Identify opportunity and plan for new product design and development.
3. Conduct customer need analysis; and set product specification for new product design and development.
4. Generate, select, and test the concepts for new product design and development.
5. Apply the principles of Industrial design and prototype for design and develop new products.

TEXT BOOK:

1. Ulrich K.T., Eppinger S. D. and Anita Goyal, "Product Design and Development "McGraw-Hill Education; 7 edition, 2020.

REFERENCES:

1. Belz A., 36-Hour Course: "Product Development" McGraw-Hill, 2010.
2. Rosenthal S., "Effective Product Design and Development", Business One Orwin, Homewood, 1992, ISBN1-55623-603-4.
3. Pugh.S, "Total Design Integrated Methods for Successful Product Engineering", Addison Wesley Publishing, 1991, ISBN0-202-41639-5.
4. Chitale, A. K. and Gupta, R. C., Product Design and Manufacturing, PHI Learning, 2013.
5. Jamnia, A., Introduction to Product Design and Development for Engineers, CRC Press, 2018.

COURSE OBJECTIVES:

- To provide students with fundamental knowledge of the notion of corporate sustainability.
- To determine how organizations impacts on the environment and socio-technical systems, the relationship between social and environmental performance and competitiveness, the approaches and methods.

UNIT I MANAGEMENT OF SUSTAINABILITY 9

Management of sustainability -rationale and political trends: An introduction to sustainability management, International and European policies on sustainable development, theoretical pillars in sustainability management studies.

UNIT II CORPORATE SUSTAINABILITY AND RESPONSIBILITY 9

Corporate sustainability parameter, corporate sustainability institutional framework, integration of sustainability into strategic planning and regular business practices, fundamentals of stakeholder engagement.

UNIT III SUSTAINABILITY MANAGEMENT: STRATEGIES AND APPROACHES 9

Corporate sustainability management and competitiveness: Sustainability-oriented corporate strategies, markets and competitiveness, Green Management between theory and practice, Sustainable Consumption and Green Marketing strategies, Environmental regulation and strategic postures; Green Management approaches and tools; Green engineering: clean technologies and innovation processes; Sustainable Supply Chain Management and Procurement.

UNIT IV SUSTAINABILITY AND INNOVATION 9

Socio-technical transitions and sustainability, Sustainable entrepreneurship, Sustainable pioneers in green market niches, Smart communities and smart specializations.

UNIT V SUSTAINABLE MANAGEMENT OF RESOURCES, COMMODITIES AND COMMONS 9

Energy management, Water management, Waste management, Wild Life Conservation, Emerging trends in sustainable management, Case Studies.

TOTAL: 45 PERIODS**COURSE OUTCOMES:**

- CO1: An understanding of sustainability management as an approach to aid in evaluating and minimizing environmental impacts while achieving the expected social impact.
- CO2: An understanding of corporate sustainability and responsible Business Practices
- CO3: Knowledge and skills to understand, to measure and interpret sustainability performances.
- CO4: Knowledge of innovative practices in sustainable business and community management
- CO5: Deep understanding of sustainable management of resources and commodities

REFERENCES:

1. Daddi, T., Iraldo, F., Testa, Environmental Certification for Organizations and Products: Management, 2015
2. Christian N. Madu, Handbook of Sustainability Management 2012
3. Petra Molthan-Hill, The Business Student's Guide to Sustainable Management: Principles and Practice, 2014
4. Margaret Robertson, Sustainability Principles and Practice, 2014
5. Peter Rogers, An Introduction to Sustainable Development, 2006

COURSE OBJECTIVES

- To familiarize students with the theory and practice of small business management.
- To learn the legal issues faced by small business and how they impact operations.

UNIT I INTRODUCTION TO SMALL BUSINESS 9

Creation, Innovation, entrepreneurship and small business - Defining Small Business –Role of Owner – Manager – government policy towards small business sector –elements of entrepreneurship –evolution of entrepreneurship –Types of Entrepreneurship – social, civic, corporate - Business life cycle - barriers and triggers to new venture creation – process to assist start ups – small business and family business.

UNIT II SCREENING THE BUSINESS OPPORTUNITY AND FORMULATING THE BUSINESS PLAN 9

Concepts of opportunity recognition; Key factors leading to new venture failure; New venture screening process; Applying new venture screening process to the early stage small firm Role planning in small business – importance of strategy formulation – management skills for small business creation and development.

UNIT III BUILDING THE RIGHT TEAM AND MARKETING STRATEGY 9

Management and Leadership – employee assessments – Tuckman’s stages of group development - The entrepreneurial process model - Delegation and team building - Comparison of HR management in small and large firms - Importance of coaching and how to apply a coaching model.

Marketing within the small business - success strategies for small business marketing - customer delight and business generating systems, - market research, - assessing market performance- sales management and strategy - the marketing mix and marketing strategy.

UNIT IV FINANCING SMALL BUSINESS 9

Main sources of entrepreneurial capital; Nature of ‘bootstrap’ financing - Difference between cash and profit - Nature of bank financing and equity financing - Funding-equity gap for small firms. Importance of working capital cycle - Calculation of break-even point - Power of gross profit margin- Pricing for profit - Credit policy issues and relating these to cash flow management and profitability.

UNIT V VALUING SMALL BUSINESS AND CRISIS MANAGEMENT 9

Causes of small business failure - Danger signals of impending trouble - Characteristics of poorly performing firms - Turnaround strategies - Concept of business valuation - Different valuation measurements - Nature of goodwill and how to measure it - Advantages and disadvantages of buying an established small firm - Process of preparing a business for sale.

TOTAL: 45 PERIODS**COURSE OUTCOMES**

- CO1. Familiarise the students with the concept of small business
 CO2. In depth knowledge on small business opportunities and challenges
 CO3. Ability to devise plans for small business by building the right skills and marketing strategies
 CO4. Identify the funding source for small start ups
 CO5. Business evaluation for buying and selling of small firms

REFERENCES

1. Hankinson,A.(2000). “The key factors in the profile of small firm owner-managers that influence business performance. The South Coast Small Firms Survey, 1997-2000.” Industrial and Commercial Training 32(3):94-98.

2. Parker,R.(2000). "Small is not necessarily beautiful: An evaluation of policy support for small and medium-sized enterprise in Australia." Australian Journal of Political Science 35(2):239-253.
3. Journal articles on SME's.

OBA433

INTELLECTUAL PROPERTY RIGHTS

L T P C
3 0 0 3

COURSE OBJECTIVE

- To understand intellectual property rights and its valuation.

UNIT I INTRODUCTION 9

Intellectual property rights - Introduction, Basic concepts, Patents, Copyrights, Trademarks, Trade Secrets, Geographic Indicators; Nature of Intellectual Property, Technological Research, Inventions and Innovations, History - the way from WTO to WIPO, TRIPS.

UNIT II PROCESS 9

New Developments in IPR, Procedure for grant of Patents, TM, GIs, Patenting under Patent Cooperation Treaty, Administration of Patent system in India, Patenting in foreign countries.

UNIT III STATUTES 9

International Treaties and conventions on IPRs, The TRIPs Agreement, PCT Agreement, The Patent Act of India, Patent Amendment Act (2005), Design Act, Trademark Act, Geographical Indication Act, Bayh-Dole Act and Issues of Academic Entrepreneurship.

UNIT IV STRATEGIES IN INTELLECTUAL PROPERTY 9

Strategies for investing in R&D, Patent Information and databases, IPR strength in India, Traditional Knowledge, Case studies.

UNIT V MODELS 9

The technologies Know-how, concept of ownership, Significance of IP in Value Creation, IP Valuation and IP Valuation Models, Application of Real Option Model in Strategic Decision Making, Transfer and Licensing.

TOTAL: 45 PERIODS

COURSE OUTCOMES

- CO1: Understanding of intellectual property and appreciation of the need to protect it
- CO2: Awareness about the process of patenting
- CO3: Understanding of the statutes related to IPR
- CO4: Ability to apply strategies to protect intellectual property
- CO5: Ability to apply models for making strategic decisions related to IPR

REFERENCES

1. V. Sople Vinod, Managing Intellectual Property by (Prentice hall of India Pvt.Ltd), 2006.
2. Intellectual Property rights and copyrights, EssEss Publications.
3. Primer, R. Anita Rao and Bhanoji Rao, Intellectual Property Rights, Lastain Book company.
4. Edited by Derek Bosworth and Elizabeth Webster, The Management of Intellectual Property, Edward Elgar Publishing Ltd., 2006.
5. WIPO Intellectual Property Hand book.

COURSE OBJECTIVE

- To help students develop knowledge and competence in ethical management and decision making in organizational contexts.

UNIT I ETHICS AND SOCIETY**9**

Ethical Management- Definition, Motivation, Advantages-Practical implications of ethical management. Managerial ethics, professional ethics, and social Responsibility-Role of culture and society's expectations- Individual and organizational responsibility to society and the community.

UNIT II ETHICAL DECISION MAKING AND MANAGEMENT IN A CRISIS**9**

Managing in an ethical crisis, the nature of a crisis, ethics in crisis management, discuss case studies, analyze real-world scenarios, develop ethical management skills, knowledge, and competencies. Proactive crisis management.

UNIT III STAKEHOLDERS IN ETHICAL MANAGEMENT**9**

Stakeholders in ethical management, identifying internal and external stakeholders, nature of stakeholders, ethical management of various kinds of stakeholders: customers (product and service issues), employees (leadership, fairness, justice, diversity) suppliers, collaborators, business, community, the natural environment (the sustainability imperative, green management, Contemporary issues).

UNIT IV INDIVIDUAL VARIABLES IN ETHICAL MANAGEMENT**9**

Understanding individual variables in ethics, managerial ethics, concepts in ethical psychology-ethical awareness, ethical courage, ethical judgment, ethical foundations, ethical emotions/intuitions/intensity. Utilization of these concepts and competencies for ethical decision-making and management.

UNIT V PRACTICAL FIELD-GUIDE, TECHNIQUES AND SKILLS**9**

Ethical management in practice, development of techniques and skills, navigating challenges and dilemmas, resolving issues and preventing unethical management proactively. Role modelling and creating a culture of ethical management and human flourishing.

TOTAL: 45 PERIODS**COURSE OUTCOMES**

- CO1: Role modelling and influencing the ethical and cultural context.
- CO2: Respond to ethical crises and proactively address potential crises situations.
- CO3: Understand and implement stakeholder management decisions.
- CO4: Develop the ability, knowledge, and skills for ethical management.
- CO5: Develop practical skills to navigate, resolve and thrive in management situations

REFERENCES

1. Brad Agle, Aaron Miller, Bill O' Rourke, The Business Ethics Field Guide: the essential companion to leading your career and your company, 2016.
2. Steiner & Steiner, Business, Government & Society: A managerial Perspective, 2011.
3. Lawrence & Weber, Business and Society: Stakeholders, Ethics, Public Policy, 2020.

COURSE OBJECTIVES:

- To learn the core fundamentals of system and web security concepts
- To have through understanding in the security concepts related to networks
- To deploy the security essentials in IT Sector
- To be exposed to the concepts of Cyber Security and cloud security
- To perform a detailed study of Privacy and Storage security and related Issues

UNIT I SYSTEM SECURITY 9

Model of network security – Security attacks, services and mechanisms – OSI security architecture -A Cryptography primer- Intrusion detection system- Intrusion Prevention system - Security web applications- Case study: OWASP - Top 10 Web Application Security Risks.

UNIT II NETWORK SECURITY 9

Internet Security - Intranet security- Local Area Network Security - Wireless Network Security - Wireless Sensor Network Security- Cellular Network Security - Mobile security - IOT security - Case Study - Kali Linux.

UNIT III SECURITY MANAGEMENT 9

Information security essentials for IT Managers- Security Management System - Policy Driven System Management- IT Security - Online Identity and User Management System. Case study: Metasploit

UNIT IV CYBER SECURITY AND CLOUD SECURITY 9

Cyber Forensics- Disk Forensics – Network Forensics – Wireless Forensics – Database Forensics – Malware Forensics – Mobile Forensics – Email Forensics- Best security practices for automate Cloud infrastructure management – Establishing trust in IaaS, PaaS, and SaaS Cloud types. Case study: DVWA

UNIT V PRIVACY AND STORAGE SECURITY 9

Privacy on the Internet - Privacy Enhancing Technologies - Personal privacy Policies - Detection of Conflicts in security policies- privacy and security in environment monitoring systems. Storage Area Network Security - Storage Area Network Security Devices - Risk management - Physical Security Essentials.

TOTAL: 45 PERIODS**COURSE OUTCOMES:**

- CO1:** Understand the core fundamentals of system security
CO2: Apply the security concepts to wired and wireless networks
CO3: Implement and Manage the security essentials in IT Sector
CO4: Explain the concepts of Cyber Security and Cyber forensics
CO5: Be aware of Privacy and Storage security Issues.

REFERENCES

1. John R. Vacca, Computer and Information Security Handbook, Third Edition, Elsevier 2017
2. Michael E. Whitman, Herbert J. Mattord, Principles of Information Security, Seventh Edition, Cengage Learning, 2022
3. Richard E. Smith, Elementary Information Security, Third Edition, Jones and Bartlett Learning, 2019
4. Mayor, K.K.Mookhey, Jacopo Cervini, Fairuzan Roslan, Kevin Beaver, Metasploit Toolkit for Penetration Testing, Exploit Development and Vulnerability Research, Syngress publications, Elsevier, 2007. ISBN : 978-1-59749-074-0.

5. John Sammons, "The Basics of Digital Forensics- The Primer for Getting Started in Digital Forensics", Syngress, 2012
6. Cory Altheide and Harlan Carvey, "Digital Forensics with Open Source Tools", 2011 Syngress, ISBN: 9781597495875.
7. Siani Pearson, George Yee "Privacy and Security for Cloud Computing" Computer Communications and Networks, Springer, 2013.

MP4251

CLOUD COMPUTING TECHNOLOGIES

**L T P C
3 0 0 3**

COURSE OBJECTIVES:

- To gain expertise in Virtualization, Virtual Machines and deploy practical virtualization solution
- To understand the architecture, infrastructure and delivery models of cloud computing.
- To explore the roster of AWS services and illustrate the way to make applications in AWS
- To gain knowledge in the working of Windows Azure and Storage services offered by Windows Azure
- To develop the cloud application using various programming model of Hadoop and Aneka

UNIT I VIRTUALIZATION AND VIRTUALIZATION INFRASTRUCTURE 6

Basics of Virtual Machines - Process Virtual Machines – System Virtual Machines –Emulation – Interpretation – Binary Translation - Taxonomy of Virtual Machines. Virtualization –Management Virtualization — Hardware Maximization – Architectures – Virtualization Management – Storage Virtualization – Network Virtualization- Implementation levels of virtualization – virtualization structure – virtualization of CPU, Memory and I/O devices – virtual clusters and Resource Management – Virtualization for data center automation

UNIT II CLOUD PLATFORM ARCHITECTURE 12

Cloud Computing: Definition, Characteristics - Cloud deployment models: public, private, hybrid, community – Categories of cloud computing: Everything as a service: Infrastructure, platform, software- A Generic Cloud Architecture Design – Layered cloud Architectural Development – Architectural Design Challenges

UNIT III AWS CLOUD PLATFORM - IAAS 9

Amazon Web Services: AWS Infrastructure- AWS API- AWS Management Console - Setting up AWS Storage - Stretching out with Elastic Compute Cloud - Elastic Container Service for Kubernetes- AWS Developer Tools: AWS Code Commit, AWS Code Build, AWS Code Deploy, AWS Code Pipeline, AWS code Star - AWS Management Tools: Cloud Watch, AWS Auto Scaling, AWS control Tower, Cloud Formation, Cloud Trail, AWS License Manager

UNIT IV PAAS CLOUD PLATFORM 9

Windows Azure: Origin of Windows Azure, Features, The Fabric Controller – First Cloud APP in Windows Azure- Service Model and Managing Services: Definition and Configuration, Service runtime API- Windows Azure Developer Portal- Service Management API- Windows Azure Storage Characteristics-Storage Services- REST API- Blops

UNIT V PROGRAMMING MODEL 9

Introduction to Hadoop Framework - Mapreduce, Input splitting, map and reduce functions, specifying input and output parameters, configuring and running a job –Developing Map Reduce Applications - Design of Hadoop file system –Setting up Hadoop Cluster- Aneka: Cloud Application

COURSE OUTCOMES:

- CO1:** Employ the concepts of virtualization in the cloud computing
- CO2:** Identify the architecture, infrastructure and delivery models of cloud computing
- CO3:** Develop the Cloud Application in AWS platform
- CO4:** Apply the concepts of Windows Azure to design Cloud Application
- CO5:** Develop services using various Cloud computing programming models.

REFERENCES

1. Bernard Golden, Amazon Web Service for Dummies, John Wiley & Sons, 2013.
2. Raoul Alongi, AWS: The Most Complete Guide to Amazon Web Service from Beginner to Advanced Level, Amazon Asia- Pacific Holdings Private Limited, 2019.
3. Sriram Krishnan, Programming: Windows Azure, O'Reilly, 2010.
4. Rajkumar Buyya, Christian Vacchiola, S.Thamarai Selvi, Mastering Cloud Computing , MCGraw Hill Education (India) Pvt. Ltd., 2013.
5. Danielle Ruest, Nelson Ruest, —Virtualization: A Beginner"s Guidell, McGraw-Hill Osborne Media, 2009.
6. Jim Smith, Ravi Nair , "Virtual Machines: Versatile Platforms for Systems and Processes", Elsevier/Morgan Kaufmann, 2005.
7. John W.Rittinghouse and James F.Ransome, "Cloud Computing: Implementation, Management, and Security", CRC Press, 2010.
8. Toby Velte, Anthony Velte, Robert Elsenpeter, "Cloud Computing, A Practical Approach", McGraw-Hill Osborne Media, 2009.
9. Tom White, "Hadoop: The Definitive Guide", Yahoo Press, 2012.

IF4072

DESIGN THINKING

**L T P C
3 0 0 3**

COURSE OBJECTIVES:

- To provide a sound knowledge in UI & UX
- To understand the need for UI and UX
- Research Methods used in Design
- Tools used in UI & UX
- Creating a wireframe and prototype

UNIT I

UX LIFECYCLE TEMPLATE

8

Introduction. A UX process lifecycle template. Choosing a process instance for your project. The system complexity space. Meet the user interface team. Scope of UX presence within the team. More about UX lifecycles. Business Strategy. Value Innovation. Validated User Research. Killer UX Design. The Blockbuster Value Proposition. What Is a Value Proposition?.

UNIT II

CONTEXTUAL INQUIRY

10

The system concept statement. User work activity data gathering. Look for emotional aspects of work practice. Abridged contextual inquiry process. Data-driven vs. model-driven inquiry. Organizing concepts: work roles and flow model. Creating and managing work activity notes. Constructing your work activity affinity diagram (WAAD). Abridged contextual analysis process. History of affinity diagrams.

UNIT III DESIGN THINKING, IDEATION, AND SKETCHING 9

Design-informing models: second span of the bridge . Some general “how to” suggestions. A New example domain: slideshow presentations. User models. Usage models. Work environment models. Barrier summaries. Model consolidation. Protecting your sources. Abridged methods for design-informing models extraction. Design paradigms. Design thinking. Design perspectives. User personas. Ideation. Sketching

UNIT IV UX GOALS, METRICS, AND TARGETS 8

Introduction. UX goals. UX target tables. Work roles, user classes, and UX goals. UX measures. Measuring instruments. UX metrics. Baseline level. Target level. Setting levels. Observed results. Practical tips and cautions for creating UX targets. How UX targets help manage the user experience engineering process.

UNIT V ANALYSING USER EXPERIENCE 10

Sharpening Your Thinking Tools. UX Research and Strength of Evidence. Agile Personas. How to Prioritize Usability Problems. Creating Insights, Hypotheses and Testable Design Ideas. How to Manage Design Projects with User Experience Metrics. Two Measures that Will Justify Any Design Change. Evangelizing UX Research. How to Create a User Journey Map. Generating Solutions to Usability Problems. Building UX Research Into the Design Studio Methodology. Dealing with Common objections to UX Research. The User Experience Debrief Meeting. Creating a User Experience Dashboard.

SUGGESTED ACTIVITIES:

- 1: Hands on Design Thinking process for a product
- 2: Defining the Look and Feel of any new Project
- 3: Create a Sample Pattern Library for that product (Mood board, Fonts, Colors based on UI principles)
- 4: Identify a customer problem to solve.
- 5: Conduct end-to-end user research - User research, creating personas, Ideation process (User stories, Scenarios), Flow diagrams, Flow Mapping

TOTAL : 45 PERIODS

COURSE OUTCOMES:

- CO1:** Build UI for user Applications
- CO2:** Use the UI Interaction behaviors and principles
- CO3:** Evaluate UX design of any product or application
- CO4:** Demonstrate UX Skills in product development
- CO5:** Implement Sketching principles

REFERENCES

1. UX for Developers: How to Integrate User-Centered Design Principles Into Your Day-to-Day Development Work, Westley Knight. Apress, 2018
2. The UX Book: Process and Guidelines for Ensuring a Quality User Experience, Rex Hartson, Pardha Pyla. Morgan Kaufmann, 2012
3. UX Fundamentals for Non-UX Professionals: User Experience Principles for Managers, Writers, Designers, and Developers, Edward Stull. Apress, 2018
4. Lean UX: Designing Great Products with Agile Teams, Gothelf, Jeff, Seiden, and Josh. O'Reilly Media, 2016
5. Designing UX: Prototyping: Because Modern Design is Never Static, Ben Coleman, and Dan Goodwin. SitePoint, 2017

COURSE OBJECTIVES:

- To get familiarity with gamut of multimedia and its significance
- To acquire knowledge in multimedia components.
- To acquire knowledge about multimedia tools and authoring.
- To acquire knowledge in the development of multimedia applications.
- To explore the latest trends and technologies in multimedia

UNIT I INTRODUCTION**9**

Introduction to Multimedia – Characteristics of Multimedia Presentation – Multimedia Components – Promotion of Multimedia Based Components – Digital Representation – Media and Data Streams – Multimedia Architecture – Multimedia Documents, Multimedia Tasks and Concerns, Production, sharing and distribution, Hypermedia, WWW and Internet, Authoring, Multimedia over wireless and mobile networks.

Suggested Activities:

1. Flipped classroom on media Components.
2. External learning – Interactive presentation.

Suggested Evaluation Methods:

1. Tutorial – Handling media components
2. Quizzes on different types of data presentation.

UNIT II ELEMENTS OF MULTIMEDIA**9**

Text-Types, Font, Unicode Standard, File Formats, Graphics and Image data representations – data types, file formats, color models; video – color models in video, analog video, digital video, file formats, video display interfaces, 3D video and TV: Audio – Digitization, SNR, SQNR, quantization, audio quality, file formats, MIDI; Animation- Key Frames and Tweening, other Techniques, 2D and 3D Animation.

Suggested Activities:

1. Flipped classroom on different file formats of various media elements.
2. External learning – Adobe after effects, Adobe Media Encoder, Adobe Audition.

Suggested Evaluation Methods:

1. Demonstration on after effects animations.
2. Quizzes on file formats and color models.

UNIT III MULTIMEDIA TOOLS**9**

Authoring Tools – Features and Types – Card and Page Based Tools – Icon and Object Based Tools – Time Based Tools – Cross Platform Authoring Tools – Editing Tools – Painting and Drawing Tools – 3D Modeling and Animation Tools – Image Editing Tools – Sound Editing Tools – Digital Movie Tools.

Suggested Activities:

1. Flipped classroom on multimedia tools.
2. External learning – Comparison of various authoring tools.

Suggested Evaluation Methods:

1. Tutorial – Audio editing tool.
2. Quizzes on animation tools.

UNIT IV MULTIMEDIA SYSTEMS

9

Compression Types and Techniques: CODEC, Text Compression: GIF Coding Standards, JPEG standard – JPEG 2000, basic audio compression – ADPCM, MPEG Psychoacoustics, basic Video compression techniques – MPEG, H.26X – Multimedia Database System – User Interfaces – OS Multimedia Support – Hardware Support – Real Time Protocols – Play Back Architectures – Synchronization – Document Architecture – Hypermedia Concepts: Hypermedia Design – Digital Copyrights, Content analysis.

Suggested Activities:

1. Flipped classroom on concepts of multimedia hardware architectures.
2. External learning – Digital repositories and hypermedia design.

Suggested Evaluation Methods:

1. Quizzes on multimedia hardware and compression techniques.
2. Tutorial – Hypermedia design.

UNIT V MULTIMEDIA APPLICATIONS FOR THE WEB AND MOBILE PLATFORMS

9

ADDIE Model – Conceptualization – Content Collection – Storyboard–Script Authoring Metaphors – Testing – Report Writing – Documentation. Multimedia for the web and mobile platforms. Virtual Reality, Internet multimedia content distribution, Multimedia Information sharing – social media sharing, cloud computing for multimedia services, interactive cloud gaming. Multimedia information retrieval.

Suggested Activities:

1. External learning – Game consoles.
2. External learning – VRML scripting languages.

Suggested Evaluation Methods:

1. Demonstration of simple interactive games.
2. Tutorial – Simple VRML program.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

CO1:Handle the multimedia elements effectively.

CO2:Articulate the concepts and techniques used in multimedia applications.

CO3:Develop effective strategies to deliver Quality of Experience in multimedia applications.

CO4:Design and implement algorithms and techniques applied to multimedia objects.

CO5:Design and develop multimedia applications following software engineering models.

REFERENCES:

1. Li, Ze-Nian, Drew, Mark, Liu, Jiangchuan, “Fundamentals of Multimedia”, Springer, Third Edition, 2021.
2. Prabhat K.Andleigh, Kiran Thakrar, “MULTIMEDIA SYSTEMS DESIGN”, Pearson Education, 2015.
3. Gerald Friedland, Ramesh Jain, “Multimedia Computing”, Cambridge University Press, 2018. (digital book)
4. Ranjan Parekh, “Principles of Multimedia”, Second Edition, McGraw-Hill Education, 2017

COURSE OBJECTIVES:

- To understand the basics of big data analytics
- To understand the search methods and visualization
- To learn mining data streams
- To learn frameworks
- To gain knowledge on R language

UNIT I INTRODUCTION TO BIG DATA 9

Introduction to Big Data Platform – Challenges of Conventional Systems - Intelligent data analysis –Nature of Data - Analytic Processes and Tools - Analysis Vs Reporting - Modern Data Analytic Tools- Statistical Concepts: Sampling Distributions - Re-Sampling - Statistical Inference - Prediction Error.

UNIT II SEARCH METHODS AND VISUALIZATION 9

Search by simulated Annealing – Stochastic, Adaptive search by Evaluation – Evaluation Strategies –Genetic Algorithm – Genetic Programming – Visualization – Classification of Visual Data Analysis Techniques – Data Types – Visualization Techniques – Interaction techniques – Specific Visual data analysis Techniques

UNIT III MINING DATA STREAMS 9

Introduction To Streams Concepts – Stream Data Model and Architecture - Stream Computing - Sampling Data in a Stream – Filtering Streams – Counting Distinct Elements in a Stream – Estimating Moments – Counting Oneness in a Window – Decaying Window - Real time Analytics Platform(RTAP) Applications - Case Studies - Real Time Sentiment Analysis, Stock Market Predictions

UNIT IV FRAMEWORKS 9

MapReduce – Hadoop, Hive, MapR – Sharding – NoSQL Databases - S3 - Hadoop Distributed File Systems – Case Study- Preventing Private Information Inference Attacks on Social Networks-Grand Challenge: Applying Regulatory Science and Big Data to Improve Medical Device Innovation

UNIT V R LANGUAGE 9

Overview, Programming structures: Control statements -Operators -Functions -Environment and scope issues -Recursion -Replacement functions, R data structures: Vectors -Matrices and arrays - Lists -Data frames -Classes, Input/output, String manipulations

COURSE OUTCOMES:

CO1: understand the basics of big data analytics

CO2: Ability to use Hadoop, Map Reduce Framework.

CO3: Ability to identify the areas for applying big data analytics for increasing the business outcome.

CO4: gain knowledge on R language

CO5: Contextually integrate and correlate large amounts of information to gain faster insights.

TOTAL:45 PERIODS

REFERENCE:

1. Michael Berthold, David J. Hand, Intelligent Data Analysis, Springer, 2007.
2. Anand Rajaraman and Jeffrey David Ullman, Mining of Massive Datasets, Cambridge University Press, 3rd edition 2020.
3. Norman Matloff, The Art of R Programming: A Tour of Statistical Software Design, No Starch Press, USA, 2011.
4. Bill Franks, Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics, John Wiley & sons, 2012.
5. Glenn J. Myatt, Making Sense of Data, John Wiley & Sons, 2007.

COURSE OBJECTIVES:

- To understand Smart Objects and IoT Architectures
- To learn about various IOT-related protocols
- To build simple IoT Systems using Arduino and Raspberry Pi.
- To understand data analytics and cloud in the context of IoT
- To develop IoT infrastructure for popular applications

UNIT I FUNDAMENTALS OF IoT 9

Introduction to IoT – IoT definition – Characteristics – IoT Complete Architectural Stack – IoT enabling Technologies – IoT Challenges. Sensors and Hardware for IoT – Hardware Platforms – Arduino, Raspberry Pi, Node MCU. A Case study with any one of the boards and data acquisition from sensors.

UNIT II PROTOCOLS FOR IoT 9

Infrastructure protocol (IPV4/V6/RPL), Identification (URIs), Transport (Wifi, Lifi, BLE), Discovery, Data Protocols, Device Management Protocols. – A Case Study with MQTT/CoAP usage-IoT privacy, security and vulnerability solutions.

UNIT III CASE STUDIES/INDUSTRIAL APPLICATIONS 9

Case studies with architectural analysis: IoT applications – Smart City – Smart Water – Smart Agriculture – Smart Energy – Smart Healthcare – Smart Transportation – Smart Retail – Smart waste management.

UNIT IV CLOUD COMPUTING INTRODUCTION 9

Introduction to Cloud Computing - Service Model – Deployment Model- Virtualization Concepts – Cloud Platforms – Amazon AWS – Microsoft Azure – Google APIs.

UNIT V IoT AND CLOUD 9

IoT and the Cloud - Role of Cloud Computing in IoT - AWS Components - S3 – Lambda - AWS IoT Core -Connecting a web application to AWS IoT using MQTT- AWS IoT Examples. Security Concerns, Risk Issues, and Legal Aspects of Cloud Computing- Cloud Data Security

TOTAL:45 PERIODS**COURSE OUTCOMES:**

At the end of the course, the student will be able to:

CO1: Understand the various concept of the IoT and their technologies..

CO2: Develop IoT application using different hardware platforms

CO3: Implement the various IoT Protocols

CO4: Understand the basic principles of cloud computing.

CO5: Develop and deploy the IoT application into cloud environment

REFERENCES

1. "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", by Pethuru Raj and Anupama C. Raman ,CRC Press, 2017
2. Adrian McEwen, Designing the Internet of Things, Wiley,2013.
3. EMC Education Services, "Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data", Wiley publishers, 2015.
4. Simon Walkowiak, "Big Data Analytics with R" PackT Publishers, 2016
5. Bart Baesens, "Analytics in a Big Data World: The Essential Guide to Data Science and its Applications", Wiley Publishers, 2015.

COURSE OBJECTIVES:

- To explain the basic concepts of robots and types of robots
- To discuss the designing procedure of manipulators, actuators and grippers
- To impart knowledge on various types of sensors and power sources
- To explore various applications of Robots in Medicine
- To impart knowledge on wearable robots

UNIT I INTRODUCTION TO ROBOTICS 9

Introduction to Robotics, Overview of robot subsystems, Degrees of freedom, configurations and concept of workspace, Dynamic Stabilization

Sensors and Actuators

Sensors and controllers, Internal and external sensors, position, velocity and acceleration sensors, Proximity sensors, force sensors Pneumatic and hydraulic actuators, Stepper motor control circuits, End effectors, Various types of Grippers, PD and PID feedback actuator models

UNIT II MANIPULATORS & BASIC KINEMATICS 9

Construction of Manipulators, Manipulator Dynamic and Force Control, Electronic and pneumatic manipulator, Forward Kinematic Problems, Inverse Kinematic Problems, Solutions of Inverse Kinematic problems

Navigation and Treatment Planning

Variable speed arrangements, Path determination – Machinery vision, Ranging – Laser – Acoustic, Magnetic, fiber optic and Tactile sensor

UNIT III SURGICAL ROBOTS 9

Da Vinci Surgical System, Image guided robotic systems for focal ultrasound based surgical applications, System concept for robotic Tele-surgical system for off-pump, CABG surgery, Urologic applications, Cardiac surgery, Neuro-surgery, Pediatric and General Surgery, Gynecologic Surgery, General Surgery and Nanorobotics. Case Study

UNIT IV REHABILITATION AND ASSISTIVE ROBOTS 9

Pediatric Rehabilitation, Robotic Therapy for the Upper Extremity and Walking, Clinical-Based Gait Rehabilitation Robots, Motion Correlation and Tracking, Motion Prediction, Motion Replication. Portable Robot for Tele rehabilitation, Robotic Exoskeletons – Design considerations, Hybrid assistive limb. Case Study

UNIT V WEARABLE ROBOTS 9

Augmented Reality, Kinematics and Dynamics for Wearable Robots, Wearable Robot technology, Sensors, Actuators, Portable Energy Storage, Human–robot cognitive interaction (cHRI), Human–robot physical interaction (pHRI), Wearable Robotic Communication - case study

TOTAL:45 PERIODS**COURSE OUTCOMES:**

CO1: Describe the configuration, applications of robots and the concept of grippers and actuators

CO2: Explain the functions of manipulators and basic kinematics

CO3: Describe the application of robots in various surgeries

CO4: Design and analyze the robotic systems for rehabilitation

CO5: Design the wearable robots

REFERENCES

1. Nagrath and Mittal, "Robotics and Control", Tata McGraw Hill, First edition, 2003
2. Spong and Vidhyasagar, "Robot Dynamics and Control", John Wiley and Sons, First edition, 2008
3. Fu.K.S, Gonzalez. R.C., Lee, C.S.G, "Robotics, control", sensing, Vision and Intelligence, Tata McGraw Hill International, First edition, 2008

4. Bruno Siciliano, Oussama Khatib, Springer Handbook of Robotics, 1st Edition, Springer, 2008
5. Shane (S.Q.) Xie, Advanced Robotics for Medical Rehabilitation - Current State of the Art and Recent Advances, Springer, 2016
6. Sashi S Kommu, Rehabilitation Robotics, I-Tech Education and Publishing, 2007
7. Jose L. Pons, Wearable Robots: Biomechatronic Exoskeletons, John Wiley & Sons Ltd, England, 2008
8. Howie Choset, Kevin Lynch, Seth Hutchinson, "Principles of Robot Motion: Theory, Algorithms, and Implementations", Prentice Hall of India, First edition, 2005
9. Philippe Coiffet, Michel Chirouze, "An Introduction to Robot Technology", Tata McGraw Hill, First Edition, 1983
10. Jacob Rosen, Blake Hannaford & Richard M Satava, "Surgical Robotics: System Applications & Visions", Springer 2011
11. Jocelyn Troccaz, Medical Robotics, Wiley, 2012
12. Achim Schweikard, Floris Ernst, Medical Robotics, Springer, 2015

VE4202

EMBEDDED AUTOMATION

L T P C
3 0 0 3

COURSE OBJECTIVES:

- To learn about the process involved in the design and development of real-time embedded system
- To develop the embedded C programming skills on 8-bit microcontroller
- To study about the interfacing mechanism of peripheral devices with 8-bit microcontrollers
- To learn about the tools, firmware related to microcontroller programming
- To build a home automation system

UNIT I INTRODUCTION TO EMBEDDED C PROGRAMMING 9

C Overview and Program Structure - C Types, Operators and Expressions - C Control Flow - C Functions and Program Structures - C Pointers And Arrays - FIFO and LIFO - C Structures - Development Tools

UNIT II AVR MICROCONTROLLER 9

ATMEGA 16 Architecture - Nonvolatile and Data Memories - Port System - Peripheral Features : Time Base, Timing Subsystem, Pulse Width Modulation, USART, SPI, Two Wire Serial Interface, ADC, Interrupts - Physical and Operating Parameters

UNIT III HARDWARE AND SOFTWARE INTERFACING WITH 8-BIT SERIES CONTROLLERS 9

Lights and Switches - Stack Operation - Implementing Combinational Logic - Expanding I/O - Interfacing Analog To Digital Convertors - Interfacing Digital To Analog Convertors - LED Displays : Seven Segment Displays, Dot Matrix Displays - LCD Displays - Driving Relays - Stepper Motor Interface - Serial EEPROM - Real Time Clock - Accessing Constants Table - Arbitrary Waveform Generation - Communication Links - System Development Tools

UNIT IV VISION SYSTEM 9

Fundamentals of Image Processing - Filtering - Morphological Operations - Feature Detection and Matching - Blurring and Sharpening - Segmentation - Thresholding - Contours - Advanced Contour Properties - Gradient - Canny Edge Detector - Object Detection - Background Subtraction

UNIT V HOME AUTOMATION 9

Home Automation - Requirements - Water Level Notifier - Electric Guard Dog - Tweeting Bird Feeder - Package Delivery Detector - Web Enabled Light Switch - Curtain Automation - Android Door Lock - Voice Controlled Home Automation - Smart Lighting - Smart Mailbox - Electricity Usage Monitor - Proximity Garage Door Opener - Vision Based Authentic Entry System

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of this course, students will be able to

CO1: analyze the 8-bit series microcontroller architecture, features and pin details

CO2: write embedded C programs for embedded system application

CO3: design and develop real time systems using AVR microcontrollers

CO4: design and develop the systems based on vision mechanism

CO5: design and develop a real time home automation system

REFERENCES:

1. Dhananjay V. Gadre, "Programming and Customizing the AVR Microcontroller", McGraw-Hill, 2001.
2. Joe Pardue, "C Programming for Microcontrollers ", Smiley Micros, 2005.
3. Steven F. Barrett, Daniel J. Pack, "ATMEL AVR Microcontroller Primer : Programming and Interfacing", Morgan & Claypool Publishers, 2012
4. Mike Riley, "Programming Your Home - Automate With Arduino, Android and Your Computer", the Pragmatic Programmers, Llc, 2012.
5. Richard Szeliski, "Computer Vision: Algorithms and Applications", Springer, 2011.
6. Kevin P. Murphy, "Machine Learning - a Probabilistic Perspective", the MIT Press Cambridge, Massachusetts, London, 2012.

CX4016	ENVIRONMENTAL SUSTAINABILITY	L	T	P	C
		3	0	0	3
UNIT I	INTRODUCTION				9
	Valuing the Environment: Concepts, Valuing the Environment: Methods, Property Rights, Externalities, and Environmental Problems				
UNIT II	CONCEPT OF SUSTAINABILITY				9
	Sustainable Development: Defining the Concept, the Population Problem, Natural Resource Economics: An Overview, Energy, Water, Agriculture				
UNIT III	SIGNIFICANCE OF BIODIVERSITY				9
	Biodiversity, Forest Habitat, Commercially Valuable Species, Stationary - Source Local Air Pollution, Acid Rain and Atmospheric Modification, Transportation				
UNIT IV	POLLUTION IMPACTS				9
	Water Pollution, Solid Waste and Recycling, Toxic Substances and Hazardous Wastes, Global Warming.				
UNIT V	ENVIRONMENTAL ECONOMICS				9
	Development, Poverty, and the Environment, Visions of the Future, Environmental economics and policy by Tom Tietenberg, Environmental Economics				
TOTAL : 45 PERIODS					

UNIT I	BASICS OF NANOCOMPOSITES	9
Nomenclature, Properties, features and processing of nanocomposites. Sample Preparation and Characterization of Structure and Physical properties. Designing, stability and mechanical properties and applications of super hard nanocomposites.		
UNIT II	METAL BASED NANOCOMPOSITES	9
Metal-metal nanocomposites, some simple preparation techniques and their properties. Metal-Oxide or Metal-Ceramic composites, Different aspects of their preparation techniques and their final properties and functionality. Fractal based glass-metal nanocomposites, its designing and fractal dimension analysis. Core-Shell structured nanocomposites		
UNIT III	POLYMER BASED NANOCOMPOSITES	9
Preparation and characterization of diblock Copolymer based nanocomposites; Polymer Carbon nanotubes based composites, their mechanical properties, and industrial possibilities.		
UNIT IV	NANOCOMPOSITE FROM BIOMATERIALS	9
Natural nanocomposite systems - spider silk, bones, shells; organic-inorganic nanocomposite formation through self-assembly. Biomimetic synthesis of nanocomposites material; Use of synthetic nanocomposites for bone, teeth replacement.		
UNIT V	NANOCOMPOSITE TECHNOLOGY	9
Nanocomposite membrane structures- Preparation and applications. Nanotechnology in Textiles and Cosmetics-Nano-fillers embedded polypropylene fibers – Soil repellence, Lotus effect - Nano finishing in textiles (UV resistant, anti-bacterial, hydrophilic, self-cleaning, flame retardant finishes), Sun-screen dispersions for UV protection using titanium oxide – Colour cosmetics. Nanotechnology in Food Technology - Nanopackaging for enhanced shelf life - Smart/Intelligent packaging.		

TOTAL : 45 PERIODS**REFERENCES:**

1. Introduction to Nanocomposite Materials. Properties, Processing, Characterization- Thomas E. Twardowski. 2007. DEStech Publications. USA.
2. Nanocomposites Science and Technology - P. M. Ajayan, L.S. Schadler, P. V. Braun 2006.
3. Physical Properties of Carbon Nanotubes- R. Saito 1998.
4. Carbon Nanotubes (Carbon , Vol 33) - M. Endo, S. Iijima, M.S. Dresselhaus 1997.
5. The search for novel, superhard materials- Stan Vepřek (Review Article) JVST A, 1999
6. Nanometer versus micrometer-sized particles-Christian Brosseau, Jamal BeN Youssef, Philippe Talbot, Anne-Marie Konn, (Review Article) J. Appl. Phys, Vol 93, 2003
7. Diblock Copolymer, - Aviram (Review Article), Nature, 2002
8. Bikramjit Basu, Kantesh Balani Advanced Structural Ceramics, A John Wiley & Sons, Inc.,
9. P. Brown and K. Stevens, Nanofibers and Nanotechnology in Textiles, Woodhead publication, London, 2006.

UNIT I IPR**9**

Intellectual property rights – Origin of the patent regime – Early patents act & Indian pharmaceutical industry – Types of patents – Patent Requirements – Application preparation filing and prosecution – Patentable subject matter – Industrial design, Protection of GMO's IP as a factor in R&D, IP's of relevance to biotechnology and few case studies.

UNIT II AGREEMENTS, TREATIES AND PATENT FILING PROCEDURES**9**

History of GATT Agreement – Madrid Agreement – Hague Agreement – WIPO Treaties – Budapest Treaty – PCT – Ordinary – PCT – Conventional – Divisional and Patent of Addition – Specifications – Provisional and complete – Forms and fees Invention in context of “prior art” – Patent databases – Searching International Databases – Country-wise patent searches (USPTO, espacenet(EPO) – PATENT Scope (WIPO) – IPO, etc National & PCT filing procedure – Time frame and cost – Status of the patent applications filed – Precautions while patenting – disclosure/non-disclosure – Financial assistance for patenting – Introduction to existing schemes Patent licensing and agreement Patent infringement – Meaning, scope, litigation, case studies

UNIT III BIOSAFETY**9**

Introduction – Historical Background – Introduction to Biological Safety Cabinets – Primary Containment for Biohazards – Biosafety Levels – Biosafety Levels of Specific Microorganisms – Recommended Biosafety Levels for Infectious Agents and Infected Animals – Biosafety guidelines – Government of India.

UNIT IV GENETICALLY MODIFIED ORGANISMS**9**

Definition of GMOs & LMOs – Roles of Institutional Biosafety Committee – RCGM – GEAC etc. for GMO applications in food and agriculture – Environmental release of GMOs – Risk Analysis – Risk Assessment – Risk management and communication – Overview of National Regulations and relevant International Agreements including Cartagena Protocol.

UNIT V ENTREPRENEURSHIP DEVELOPMENT**9**

Introduction – Entrepreneurship Concept – Entrepreneurship as a career – Entrepreneurial personality – Characteristics of successful Entrepreneur – Factors affecting entrepreneurial growth – Entrepreneurial Motivation – Competencies – Mobility – Entrepreneurship Development Programmes (EDP) - Launching Of Small Enterprise - Definition, Characteristics – Relationship between small and large units – Opportunities for an Entrepreneurial career – Role of small enterprise in economic development – Problems of small scale industries – Institutional finance to entrepreneurs - Institutional support to entrepreneurs.

TOTAL : 45 PERIODS**REFERENCES**

1. Bouchoux, D.E., “Intellectual Property: The Law of Trademarks, Copyrights, Patents, and Trade Secrets for the Paralegal”, 3rd Edition, Delmar Cengage Learning, 2008.
2. Fleming, D.O. and Hunt, D.L., “Biological Safety: Principles and Practices”, 4th Edition, American Society for Microbiology, 2006.

3. Irish, V., "Intellectual Property Rights for Engineers", 2nd Edition, The Institution of Engineering and Technology, 2005.
4. Mueller, M.J., "Patent Law", 3rd Edition, Wolters Kluwer Law & Business, 2009.
5. Young, T., "Genetically Modified Organisms and Biosafety: A Background Paper for Decision- Makers and Others to Assist in Consideration of GMO Issues" 1st Edition, World Conservation Union, 2004.
6. S.S Khanka, "Entrepreneurial Development", S.Chand & Company LTD, New Delhi, 2007.



ANNA UNIVERSITY, CHENNAI
NON- AUTONOMOUS COLLEGES AFFILIATED ANNA UNIVERSITY
M.E. MANUFACTURING ENGINEERING
REGULATIONS 2021
CHOICE BASED CREDIT SYSTEM
I TO IV SEMESTERS CURRICULA & SYLLABI

1. PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

I.	To prepare students to know and utilize the modern manufacturing facility in order to improve productivity.
II.	To impart skills to use smart machines and apply latest technology in manufacturing field to innovate production process that will be useful to the Society
III.	To imbibe skills for integrated problem-solving techniques to optimize the Manufacturing resources for sustainable development
IV.	To develop research attitude, new product, and process to solve problems in the field of manufacturing and to prepare the necessary reports.

2. PROGRAMME OUTCOMES (POs):

PO	Programme Outcomes
1.	An ability to independently carry out research/investigation and development work to solve practical problems
2.	An ability to write and present a substantial technical report/document
3.	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program
4.	An ability to design systems, components, or processes meeting specified needs for the manufacturing industry and to improve its efficiency.
5.	To use modern equipment and problem-solving tools for improving the manufacturing systems and processes in all aspects including technical, financial and management
6.	To pursue higher studies / pursue their career or entrepreneur in manufacturing and allied industries

3. PEO / PO Mapping:

PEO	PO					
	1	2	3	4	5	6
I	-	-	3	-	3	2
II	2	2	-	3	3	-
III	1	-	2	3	3	-
IV	3	2	-	-	-	2

PROGRAM ARTICULATION MATRIX OF M.E. MANUFACTURING ENGINEERING

Year	Semester	Course Name	PO						
			1	2	3	4	5	6	
I	I	Applied Probability and Statistics for Manufacturing Engineering	2	-	3	1	1	2	
		Advances in Manufacturing Processes	1	-	3	1	2	2	
		Advances in Casting and Welding	1.3	-	2.5	3	2	1.3	
		Theory of Metal Cutting	1	-	2.3	1.5	2	1	
		Computer Aided Manufacturing	1.5	2	-	2.5	2	1.3	
		Research Methodology and IPR	2	2	2.5	2.4	2	1	
		Audit Course – I*							
		CAD/CAM Laboratory	1	2	-	2.5	2.25	1.25	
		Technical Seminar	1	1.6	3	-	2	-	
	II	II	Optimization Techniques in Manufacturing	1.25	2	-	2.5	2.33	2
			Advances in Metrology and Inspection	1	-	3	1	1.75	1.25
			Theory of Metal Forming	1	-	1.5	2	1.5	2.5
			Additive Manufacturing	1.5	-	2.5	3	2	2.5
			Fluid Power Automation	1	-	3	2	3	2.5
			Professional Elective -I						
			Professional Elective -II						
			Audit Course – II*						
			Automation and Metal Forming Laboratory	-	2	1	2	2.33	1
			Advanced Manufacturing Processes Laboratory	1	1	3	2	3	2
			II	III	Professional Elective –III				
Professional Elective -IV									
Professional Elective -V									
Open Elective									
Project Work I	1.75	2			2.5	2.5	2	2	
IV	IV	Project Work II		1.75	2	2.5	2.5	2	2

ANNA UNIVERSITY, CHENNAI
NON- AUTONOMOUS COLLEGES AFFILIATED TO ANNA UNIVERSITY
M.E. MANUFACTURING ENGINEERING
REGULATIONS 2021
CHOICE BASED CREDIT SYSTEM
I TO IV SEMESTERS CURRICULA AND SYLLABUS

SEMESTER I

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	MA4155	Applied Probability and Statistics for Manufacturing Engineering	FC	3	1	0	4	4
2.	MF4101	Advances in Manufacturing Processes	PCC	3	0	0	3	3
3.	MF4102	Advances in Casting and Welding	PCC	3	0	0	3	3
4.	MF4103	Theory of Metal Cutting	PCC	3	0	0	3	3
5.	CM4151	Computer Aided Manufacturing	PCC	3	0	0	3	3
6.	RM4151	Research Methodology and IPR	RMC	2	0	0	2	2
7.		Audit Course – I*	AC	2	0	0	2	0
PRACTICALS								
8.	MF4111	CAD/CAM Laboratory	PCC	0	0	4	4	2
9.	MF4112	Technical Seminar	EEC	0	0	2	2	1
TOTAL				19	1	6	26	21

* Audit Course is optional

SEMESTER II

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	MF4201	Optimization Techniques in Manufacturing	PCC	3	0	0	3	3
2.	MF4202	Advances in Metrology and Inspection	PCC	3	0	0	3	3
3.	MF4203	Theory of Metal Forming	PCC	3	0	0	3	3
4.	MF4204	Additive Manufacturing	PCC	3	0	0	3	3
5.	MF4205	Fluid Power Automation	PCC	3	0	0	3	3
6.		Professional Elective I	PEC	3	0	0	3	3
7.		Professional Elective II	PEC	3	0	0	3	3
8.		Audit Course II*	AC	2	0	0	2	0
PRACTICALS								
9.	MF4211	Automation and Metal Forming Laboratory	PCC	0	0	3	3	1.5
10.	MF4212	Advanced Manufacturing Processes Laboratory	PCC	0	0	3	3	1.5
TOTAL				23	0	6	29	24

* Audit Course is optional

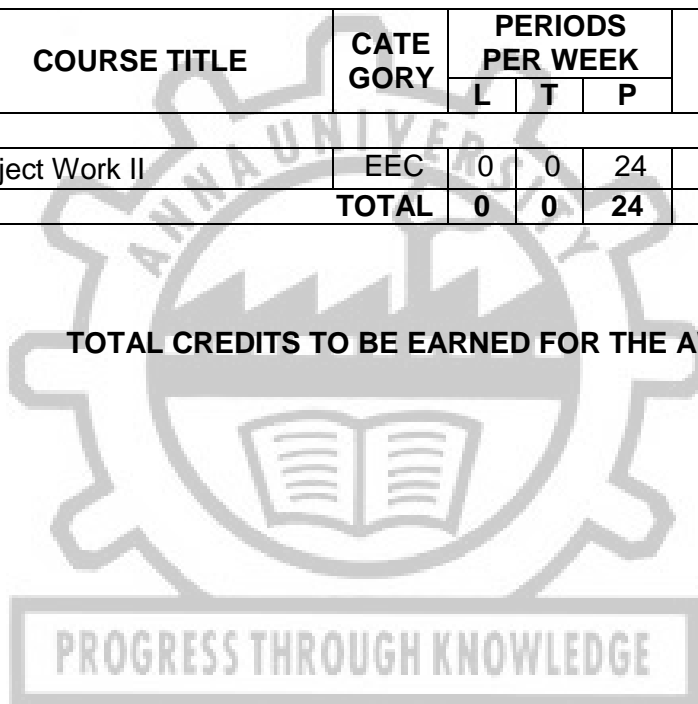
SEMESTER III

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.		Professional Elective III	PEC	3	0	0	3	3
2.		Professional Elective IV	PEC	3	0	0	3	3
3.		Professional Elective V	PEC	3	0	0	3	3
4.		Open Elective	OEC	3	0	0	3	3
PRACTICALS								
5.	MF4311	Project Work I	EEC	0	0	12	12	6
TOTAL				12	0	12	24	18

SEMESTER IV

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
PRACTICALS								
1.	MF4411	Project Work II	EEC	0	0	24	24	12
TOTAL				0	0	24	24	12

TOTAL CREDITS TO BE EARNED FOR THE AWARD OF THE DEGREE = 75



FOUNDATION COURSES (FC)

SL. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	MA4155	Applied Probability and Statistics for Manufacturing	3	1	0	4	1

PROFESSIONAL CORE COURSES (PCC)

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	MF4101	Advances in Manufacturing Processes	PCC	3	0	0	3	3
2.	MF4102	Advances in Casting and Welding	PCC	3	0	0	3	3
3.	MF4103	Theory of Metal Cutting	PCC	3	0	0	3	3
4.	CM4151	Computer Aided Manufacturing	PCC	3	0	0	3	3
5.	MF4111	CAD/CAM Laboratory	PCC	0	0	4	4	2
6.	MF4201	Optimization Techniques in Manufacturing	PCC	3	0	0	3	3
7.	MF4202	Advances in Metrology and Inspection	PCC	3	0	0	3	3
8.	MF4203	Theory of Metal Forming	PCC	3	0	0	3	3
9.	MF4204	Additive Manufacturing	PCC	3	0	0	3	3
10.	MF4205	Fluid Power Automation	PCC	3	0	0	3	3
11.	MF4211	Automation and Metal Forming Laboratory	PCC	0	0	3	3	1.5
12.	MF4212	Advanced Manufacturing Processes Laboratory	PCC	0	0	3	3	1.5

PROGRESS THROUGH KNOWLEDGE

RESEARCH METHODOLOGY AND IPR COURSES (RMC)

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	RM4151	Research Methodology and IPR	2	0	0	2	1
TOTAL CREDITS						2	

PROFESSIONAL ELECTIVES FOR M.E. MANUFACTURING ENGINEERING

SEMESTER II, ELECTIVES - I & II

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	MF4071	Design for Manufacture and Assembly	PEC	3	0	0	3	3
2.	MF4001	Micro Manufacturing	PEC	3	0	0	3	3
3.	MF4002	Quality and Reliability Engineering	PEC	3	0	0	3	3
4.	MF4003	Finite Element Methods for Manufacturing Engineering	PEC	3	0	0	3	3
5.	MF4004	Materials Management	PEC	3	0	0	3	3
6.	MF4005	Industrial Ergonomics	PEC	3	0	0	3	3
7.	MF4006	Polymers and Composite Materials	PEC	3	0	0	3	3
8.	MF4092	Non-Destructive Testing	PEC	3	0	0	3	3
9.	MF4007	Lean Manufacturing	PEC	3	0	0	3	3
10.	MF4008	Robot Design and Programming	PEC	3	0	0	3	3
11.	MF4009	MEMS and Nanotechnology	PEC	3	0	0	3	3
12.	CM4091	Green Manufacturing	PEC	3	0	0	3	3

PROGRESS THROUGH KNOWLEDGE

SEMESTER III, ELECTIVES - III, IV & V

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	MF4010	Computer Aided Product Design	PEC	3	0	0	3	3
2.	MF4011	Process Planning and Cost Estimation	PEC	3	0	0	3	3
3.	MF4091	Manufacturing Management	PEC	3	0	0	3	3
4.	MF4012	Nanotechnology	PEC	3	0	0	3	3
5.	MF4013	Materials Testing and Characterization Techniques	PEC	3	0	0	3	3
6.	MF4014	Mechatronics	PEC	3	0	0	3	3
7.	MR4071	Internet of Things for Manufacturing	PEC	3	0	0	3	3
8.	IS4071	Data Analytics	PEC	3	0	0	3	3
9.	CM4071	Manufacturing System Simulation	PEC	3	0	0	3	3
10.	PD4391	Product Lifecycle Management	PEC	3	0	0	3	3
11.	MF4015	Product Design and Development	PEC	3	0	0	3	3
12.	MF4016	Entrepreneurship Development	PEC	3	0	0	3	3
13.	MF4020	Industrial Safety	PEC	3	0	0	3	3
14.	MF4017	Advances in Materials	PEC	3	0	0	3	3
15.	MF4018	Artificial Intelligence	PEC	3	0	0	3	3
16.	MF4019	Smart Manufacturing	PEC	3	0	0	3	3

PROGRESS THROUGH KNOWLEDGE

AUDIT COURSES (AC)

Registration for any of these courses is optional to students

SL. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS
			L	T	P	
1.	AX4091	English for Research Paper Writing	2	0	0	0
2.	AX4092	Disaster Management	2	0	0	0
3.	AX4093	Constitution of India	2	0	0	0
4.	AX4094	நற்றமிழ் இலக்கியம்	2	0	0	0

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
	MF4112	Technical Seminar	0	0	2	1	1
1.	MF4311	Project Work - I	0	0	12	6	3
2.	MF4411	Project Work-II	0	0	24	12	4

LIST OF OPEN ELECTIVES FOR PG PROGRAMMES

SL. NO.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS
			L	T	P	
1.	OCE431	Integrated Water Resources Management	3	0	0	3
2.	OCE432	Water, Sanitation and Health	3	0	0	3
3.	OCE433	Principles of Sustainable Development	3	0	0	3
4.	OCE434	Environmental Impact Assessment	3	0	0	3
5.	OIC431	Blockchain Technologies	3	0	0	3
6.	OIC432	Deep Learning	3	0	0	3
7.	OBA431	Sustainable Management	3	0	0	3
8.	OBA432	Micro and Small Business Management	3	0	0	3
9.	OBA433	Intellectual Property Rights	3	0	0	3
10.	OBA434	Ethical Management	3	0	0	3
11.	ET4251	IoT for Smart Systems	3	0	0	3
12.	ET4072	Machine Learning and Deep Learning	3	0	0	3
13.	PX4012	Renewable Energy Technology	3	0	0	3
14.	PS4093	Smart Grid	3	0	0	3
15.	CP4391	Security Practices	3	0	0	3
16.	MP4251	Cloud Computing Technologies	3	0	0	3
17.	IF4072	Design Thinking	3	0	0	3
18.	MU4153	Principles of Multimedia	3	0	0	3

19.	DS4015	Big Data Analytics	3	0	0	3
20.	NC4201	Internet of Things and Cloud	3	0	0	3
21.	MX4073	Medical Robotics	3	0	0	3
22.	VE4202	Embedded Automation	3	0	0	3
23.	CX4016	Environmental Sustainability	3	0	0	3
24.	TX4092	Textile Reinforced Composites	3	0	0	3
25.	NT4002	Nanocomposite Materials	3	0	0	3
26.	BY4016	IPR, Biosafety and Entrepreneurship	3	0	0	3



MA4155 APPLIED PROBABILITY AND STATISTICS FOR MANUFACTURING ENGINEERING

L T P C
3 1 0 4

COURSE OBJECTIVES:

1. To understand the basics of random variables with emphasis on the standard discrete and continuous distributions.
2. To understand the basic probability concepts with respect to two dimensional random variables along with the relationship between the random variables.
3. To apply the small and large sample tests through test of hypothesis.
4. To understand the basic concepts of sampling distributions and statistical properties of point estimators.
5. To understand the concept of analysis of variance and use it to investigate factorial dependence.

UNIT I PROBABILITY AND RANDOM VARIABLES 12

Probability – Axioms of probability – Conditional probability – Baye’s theorem - Random variables - Probability function – Moments – Moment generating functions and their properties – Binomial, Poisson, Geometric, Uniform, Exponential, Gamma and Normal distributions – Function of a random variable.

UNIT II TWO DIMENSIONAL RANDOM VARIABLES 12

Joint distributions – Marginal and conditional distributions – Functions of two dimensional random variables – Regression curve – Correlation.

UNIT III TESTING OF HYPOTHESIS 12

Sampling distributions - Type I and Type II errors - Tests based on Normal, t, Chi square and F distributions for testing of mean, variance and proportions – Tests for independence of attributes and goodness of fit.

UNIT IV ESTIMATION THEORY 12

Interval estimation for population mean - Standard deviation - Difference in means, proportion ratio of standard deviations and variances.

UNIT V DESIGN OF EXPERIMENTS 12

Completely randomized design – Randomized block design – Latin square design – 2² Factorial design.

TOTAL: 60 PERIODS

COURSE OUTCOMES :

At the end of the course, students will be able to

- Analyze the performance in terms of probabilities and distributions achieved by the determined solutions.
- Be familiar with some of the commonly encountered two dimensional random variables and be equipped for a possible extension to multivariate analysis.
- Apply the basic principles underlying statistical inference(hypothesis testing).
- Demonstrate knowledge of applicable large sample theory of estimators and tests.
- Obtain a better understanding of the importance of the methods in modern industrial processes.

REFERENCES :

1. Devore, J. L., "Probability and Statistics for Engineering and Sciences", 8th Edition, Cengage Learning, 2014.
2. Gupta S.C. and Kapoor V.K., "Fundamentals of Mathematical Statistics", 12th Edition, Sultan and Sons, New Delhi, 2020.
3. Johnson, R.A., Miller, I and Freund J., "Miller and Freund's Probability and Statistics for Engineers", 9th Edition, Pearson Education, Asia, 2016.
4. Rice, J. A., "Mathematical Statistics and Data Analysis", 3rd Edition, Cengage Learning, 2015.
5. Ross, S. M., "Introduction to Probability and Statistics for Engineers and Scientists", 5th Edition, Elsevier, 2014.

CO-PO Mapping

CO	PO					
	1	2	3	4	5	6
1	2	-	-	-	-	2
2	-	-	-	-	-	-
3	2	-	-	-	1	2
4	-	-	3	1	-	-
5	-	-	3	-	-	2
Avg.	2	-	3	1	1	2

MF4101**ADVANCES IN MANUFACTURING PROCESSES**

L	T	P	C
3	0	0	3

OBJECTIVES:

1. To inculcate specialized knowledge and skill in advanced manufacturing processes using the principles and methods of engineering analysis and design.
2. To impart knowledge about the significance of controlling process parameters for the optimal performance for newly developed engineering materials used in industries and research organizations.
3. To impart knowledge about principles and criteria of yielding during forming of metals, analysis of different bulk metal forming processes following different analysis approach.
4. To give awareness of different techniques used in Micro and Nano manufacturing.
5. To introduce students the basics of /rapid prototyping and its applications in various fields, reverse engineering techniques

UNIT I ENERGY ASSISTED MANUFACTURING PROCESSES**9**

Introduction – mechanism of materials removal and operating parameters of: Plasma Arc Machining – Laser Beam Machining – Electron Beam Machining – Electrical Discharge Machining – Ultrasonic Machining – Water Jet Machining – Abrasive water jet Machining – Abrasive jet Machining – Ion Beam Machining.

UNIT II PRECISION MACHINING**9**

Electro chemical Machining- Ultra Precision turning and grinding- Chemical Mechanical Polishing (CMP) - ELID process – Partial ductile mode grinding-Ultra precision grinding- Binderless wheel – Free form optics. aspherical surface generation Grinding wheel- Design and selection of grinding wheel-High-speed grinding- High-speed milling- Diamond turning.

UNIT III ADVANCES IN METAL FORMING**9**

Orbital forging, Isothermal forging, Warm forging, Overview of Powder Metal techniques –Hot and Cold isostatic pressing - high speed extrusion, rubber pad forming, Hydroforming, Superplastic forming, Peen forming-micro blanking –Powder rolling – Tooling and process parameters.

UNIT IV MICRO MACHINING AND NANO FABRICATION**9**

Theory of micromachining – Micromachining Processes – Micro-milling – Micro-drilling – Micro-turning – Micro-grinding – Micro-polishing – Principle of Micro EDM – Micro wire EDM – Planetary Micro EDM – Reverse Micro EDM – Advantages, Challenges. Nano fabrication process - Nano machining techniques – Top / Bottom up Nano fabrication techniques - Sub micron lithographic technique, conventional film growth technique, Chemical etching, Quantum dot fabrication techniques – MOCVD – Epitaxy techniques.

UNIT V RAPID PROTOTYPING AND SURFACE MODIFICATION TECHNIQUES 9

Introduction – Classification – Principle advantages limitations and applications- Rapid Prototyping - Rapid Manufacturing - Rapid Tooling and Future Rapid Prototyping Processes -Stereolithography (SLA) – 3D Printing (3DP) – Selective Laser Sintering (SLS) – Laminated Object Manufacturing (LOM) – Fused Deposition Modelling (FDM) Introduction, Process descriptions, Materials, process variations, economic considerations, applications, design aspects and quality issues – CVD – PVD – Electroplating – Hot Dip Coating – Thermal Spraying.

TOTAL: 45 PERIODS**OUTCOMES:**

At the end of the course, students will be able to

1. Analyze the processes and evaluate the role of each process parameter during machining of various advanced materials.
2. Understand requirements to achieve maximum material removal rate and best quality of machined surface while machining various industrial engineering materials.
3. Analyze the different bulk metal forming process mechanics using different analysis
4. Acquire the knowledge in mechanical micromachining processes.
5. Demonstrate the knowledge of Additive Manufacturing and Rapid Prototyping Technologies

REFERENCES

1. Benedict,G.F.,"Non Traditional manufacturing Processes",CRC press,2011
2. Madou, M.J., Fundamentals of Micro fabrication: The Science of Miniaturization, Second Edition, CRC Press (ISBN: 0849308267),2006
3. McGeough,J.A.,"Advanced methods of Machining",Springer,2011
4. Narayanaswamy, R., Theory of Metal Forming Plasticity, Narosa Publishers,2000.
5. Pandey, P.S. and Shah.N., "Modern Manufacturing Processes", Tata McGraw Hill, 2017.
6. Serope Kalpakjian., "Manufacturing Engineering and Technology" Pearson Education,2018

CO-PO Mapping

CO	PO					
	1	2	3	4	5	6
1	1	-	-	-	-	-
2	-	-	-	-	2	-
3	-	-	3	-	-	2
4	1	-	-	-	2	-
5	-	-	-	1	-	-
Avg.	1	-	3	1	2	2

MF4102**ADVANCES IN CASTING AND WELDING****L T P C
3 0 0 3**

COURSE OBJECTIVES:

1. To study the metallurgical concepts and applications of casting and welding process.
2. To acquire knowledge in CAD of casting and automation of the welding process.
3. To know various solid state and special welding processes.
4. To introduce metallurgy of welding.
5. To design the weldments for various materials. To gain knowledge on various welding defects and inspection methods.

UNIT I CASTING DESIGN

9

Heat transfer between metal and mould — Design considerations in casting – Designing for directional solidification and minimum stresses - principles and design of gating and riser-Melting and casting quality

UNIT II CASTING METALLURGY

9

Solidification of pure metal and alloys – shrinkage in cast metals – progressive and directional solidification – Degasification of the melt-casting defects – Castability of steel, Cast Iron, Al alloys, Babbitt alloy and Cu alloy.

UNIT III RECENT TRENDS IN CASTING AND FOUNDRY LAYOUT

9

Shell moulding, precision investment casting, CO₂ moulding, centrifugal casting, Die casting, Continuous casting, Counter gravity low pressure casting, Squeeze casting and semisolid processes. Layout of mechanized foundry – sand reclamation – material handling in foundry pollution control in foundry — Computer aided design of casting.

UNIT IV WELDING METALLURGY AND DESIGN

9

Heat affected Zone and its characteristics – Weldability of steels, cast iron, stainless steel, aluminum, Mg, Cu, Zirconium and titanium alloys – Carbon Equivalent of Plain and alloy steels Hydrogen embrittlement – Lamellar tearing – Residual stress – Distortion and its control. Heat transfer and solidification - Analysis of stresses in welded structures – pre and post welding heat treatments – weld joint design – welding defects – Testing of weldment- welding thermal cycle.

UNIT V RECENT TRENDS IN WELDING

9

Friction welding, Friction stir welding – Explosive welding – Diffusion bonding – High frequency induction welding – Ultrasonic welding – Electron beam welding – Laser beam welding –Plasma welding – Electroslag welding- Narrow gap, Hybrid twin wire active TIG – Tandem MIG- Modern brazing and soldering techniques – Induction, Dip resistance, Diffusion processes – Hot gas, Wave and vapour phase soldering. Overview of automation of welding in aerospace, Nuclear, surface transport vehicles and underwater welding.

COURSE OUTCOMES:

- At the end of this course the students are expected to impart knowledge on basic concepts and advances in casting and welding processes.
- Know and perform solid state and special welding processes.
- Understand and analyze the material structures after welding.
- Design the weldments for various materials.
- Attain the knowledge about various welding defects and inspection methods.

TOTAL: 45 PERIODS

REFERENCES:

1. ASM Handbook vol.6, welding Brazing & Soldering, 2010
2. ASM Handbook, Vol 15, Casting, 2008
3. Carry B., Modern Welding Technology, Prentice Hall Pvt Ltd., 2005

4. Cornu.J. Advanced welding systems – Volumes I, II and III, JAICO Publishers, 1994.
5. Heinelooper & Rosenthal, Principles of Metal Casting, Tata McGraw Hill, 2017.
6. Iotrowski – Robotic welding – A guide to selection and application – Society of mechanical Engineers, 1987.
7. Jain P.L., Principles of Foundry Technology, Tata McGraw Hill Publishers, 2003
8. Lancaster.J.F. – Metallurgy of welding – George Alien & Unwin Publishers, 1999.
9. Parmer R.S., Welding Engineering and Technology, Khanna Publishers,2002
10. Schwariz, M.M. – Source book on innovative welding processes – American Society for Metals (OHIO), 1981
11. Srinivasan N.K., Welding Technology, Khanna Tech Publishers, 2002
12. P N Rao Manufacturing Technology , Vol 1, 3rd edition ,2011

CO-PO Mapping

CO	PO					
	1	2	3	4	5	6
1	1	-	-	-	-	1
2	-	-	2	3	2	-
3	1	-	-	-	2	1
4	-	-	-	-	-	2
5	2	-	3	-	-	-
Avg.	1.33	-	2.5	3	2	1.33

MF4103 **THEORY OF METAL CUTTING** **L T P C**
3 0 0 3 **COURSE**

OBJECTIVES:

1. To make the students to familiar with the basic principles of metal cutting
2. To familiarise the students various cutting tool materials and its wear mechanisms during the machining operation.
3. Differentiate between single point and multi point cutting tools
4. To study the heat generation during machining and the necessity for cutting fluid
5. To study the effect of vibrations during machining

UNIT I INTRODUCTION **9**

Need for rational approach to the problem of cutting materials-observation made in the cutting of metals-basic mechanism of chip formation-thin and thick zone modes-types of chips-chip breaker-orthogonal Vs oblique cutting-force velocity relationship for shear plane angle in orthogonal cutting-energy consideration in machining-review of Merchant, Lee and Shafter theories-critical comparison.

UNIT II SYSTEM OF TOOL NOMENCLATURE **9**

Nomenclature of single point cutting tool and nomenclature of multi point cutting tools – Twist Drill – milling cutter - System of tool nomenclature and conversion of rake angles-nomenclature of multi point tools like drills, milling-conventional Vs climb milling, mean cross sectional area of chip in milling-specific cutting pressure.

UNIT III THERMAL ASPECTS OF MACHINING **9**

Heat distribution in machining-effects of various parameters on temperature-methods of temperature measurement in machining-hot machining- Cutting fluid – properties – types of cutting fluids – Selection of cutting fluids.

UNIT IV TOOL MATERIALS, TOOL LIFE AND TOOL WEAR**9**

Essential requirements of tool materials-development of tool materials-ISO specification for inserts and tool holders- Tool geometry - Mechanisms of tool wear – Abrasion – Adhesion – Diffusion – Types of tool wear – flank wear – crater wear – Tool life – Tool life equations - factors affecting tool life – Illustrative problems- conventional and accelerated tool life tests-concept of machinability index-economics of machining.

UNIT V WEAR MECHANISMS AND CHATTER IN MACHINING**9**

Processing and Machining – Measuring Techniques – Reasons for failure of cutting tools and forms of wear-mechanisms of wear-chatter in machining-factors affecting chatter in machining-types of chatter-mechanism of chatter.

COURSE OUTCOMES:

At the end of the course students will be familiar with

- Basics of orthogonal cutting, oblique cutting and chip formation
- Different tool materials, tool life and tool wear mechanisms
- Necessity for a cutting fluid and cutting efficiency
- Single and Multipoint cutting tools
- Effect of vibrations and surface roughness during machining

TOTAL: 45 PERIODS**REFERENCES**

1. Bhattacharya.A., Metal Cutting Theory and practice, Central Book Publishers, India,2012..
2. Boothroid D.G. & Knight W.A., Fundamentals of machining and machine tools, Marcel Dekker, Newyork, 2005.
3. Shaw.M.C.Metal cutting principles, Oxford Clare don press, 2012.
4. B L Juneja and G S Sekhon., Fundamentals of Metal Cutting and Machine Tools, 2017.

CM4151**COMPUTER AIDED MANUFACTURING****L T P C****3 0 0 3****COURSE OBJECTIVES:**

1. To introduce the evolution of CAD, CAM, CIM, engineering product specification and interpreting geometric specifications.
2. To train the candidates on the integration of Computer Aided Design and Computer Aided Manufacturing.
3. To impart knowledge on manual part program and generation of CNC part program using Computer Aided Manufacturing packages.
4. To introduce with the implementation of CAD and CAM in manufacturing process.
5. To introduce the importance of Internet of Things in Computer Aided Manufacturing.

UNIT I INTRODUCTION TO CAM**9**

Introduction CAD, CAM, CAE, CIM, system configuration for CAM including hardware and software, evolution of product realization, historical development, engineering product specification. Geometric Tolerancing - ASME standard, interpreting geometric specifications, multiple part features and datum.

UNIT II CAD AND CAM INTEGRATION**9**

Introduction - Networking - Techniques, components, interface cards, network standards, Graphics standards - Graphical kernel system, Data exchange format - IGES and STEP.
 Process planning, Computer Aided Process Planning (CAPP), Product life cycle management (PLM), Enterprise resource planning (ERP).

UNIT III PROGRAMMING OF CNC MACHINES 9

Structure of CNC program, Coordinate system, G & M codes, cutter radius compensation, tool nose radius compensation, tool wear compensation, canned cycles, mirroring features, Manual part programming for CNC turning, machining center, wire electric discharge machining, abrasive water jet cutting machine, bulk and sheet metal forming, generation of CNC program using CAM softwares.

UNIT IV CAD AND CAM FOR MANUFACTURING PROCESSES 9

Classification of Manufacturing process, construction and operations, Integration of CAD and CAM in CNC turning center, machining center, electric discharge machining, wire electric discharge machining, abrasive water jet cutting machine, bulk forming, sheet metal forming.

UNIT V IOT IN CAM 9

Introduction, overview of IOT enabled manufacturing system, Real-time and multi-source manufacturing information sensing system, IOT enabled smart assembly station, cloud computing based manufacturing resources configuration method, Real-time key production performances analysis method, Real-time information driven production scheduling system.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students shall be able to:

- CO1: Recognize the importance of CAD, CAM, CIM, Engineering product specification and interpreting geometric specifications.
- CO2: Improve knowledge on the integration of CAD and CAM.
- CO3: Exhibit competency in manual part program and generation of CNC part program using CAM packages.
- CO4: Describe the implementation of CAD and CAM in manufacturing processes.
- CO5: Explain applications of IOT in computer aided manufacturing.

REFERENCES:

1. Chang T.C., Wysk, R.A. and Wang.H.P., "Computer Aided Manufacturing", Pearson Prentice Hall, India ,2009, ISBN: 978-0131429192.
2. HMT, "Mechatronics", Tata McGraw-Hill Publishing Company Limited, New Delhi, 2017.
3. Rao P.N., "CAD/CAM", 3rd Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, India, 2012, ISBN-13: 978-0070681934.
4. Radhakrishnan P., "Computer Numerical Control ", New Central Book Agency, India,2013.
5. Nee Y.C., Soh K. Ong, Yun G. Wang., "Computer Applications in Near Net-Shape Operations", Springer, United Kingdom, 2012.
6. Yingfeng Zhang and Fei Tao, "Optimization of Manufacturing Systems Using the Internet of

CO-PO Mapping

CO	PO					
	1	2	3	4	5	6
1	-	-	-	2	2	-
2	-	-	-	-	2	1
3	1	2	-	3	-	-
4	2	-	-	-	1	2

5	-	-	-	-	3	1
Avg.	1.5	2	-	2.5	2	1.33

**RM4151 RESEARCH METHODOLOGY AND IPR L T P C
2 0 0 2**

UNIT I RESEARCH DESIGN 6

Overview of research process and design, Use of Secondary and exploratory data to answer the research question, Qualitative research, Observation studies, Experiments and Surveys.

UNIT II DATA COLLECTION AND SOURCES 6

Measurements, Measurement Scales, Questionnaires and Instruments, Sampling and methods. Data - Preparing, Exploring, examining and displaying.

UNIT III DATA ANALYSIS AND REPORTING 6

Overview of Multivariate analysis, Hypotheses testing and Measures of Association-Presenting Insights and findings using written reports and oral presentation.

UNIT IV INTELLECTUAL PROPERTY RIGHTS 6

Intellectual Property – The concept of IPR, Evolution and development of concept of IPR, IPR development process, Trade secrets, utility Models, IPR & Bio diversity, Role of WIPO and WTO in IPR establishments, Right of Property, Common rules of IPR practices, Types and Features of IPR Agreement, Trademark, Functions of UNESCO in IPR maintenance.

UNIT V PATENTS 6

Patents – objectives and benefits of patent, Concept, features of patent, Inventive step, Specification, Types of patent application, process E-filing, Examination of patent, Grant of patent, Revocation, Equitable Assignments, Licences, Licensing of related patents, patent agents, Registration of patent agents.

TOTAL :30 PERIODS

REFERENCES

1. Cooper Donald R, Schindler Pamela S and Sharma JK, "Business Research Methods", Tata McGraw Hill Education, 11e (2012).
2. Catherine J. Holland, "Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets", Entrepreneur Press, 2007.
3. David Hunt, Long Nguyen, Matthew Rodgers, "Patent searching: tools & techniques", Wiley, 2007.
4. The Institute of Company Secretaries of India, Statutory body under an Act of parliament, "Professional Programme Intellectual Property Rights, Law and practice", September 2013.

**MF4111 CAD / CAM LABORATORY L T P C
0 0 4 2**

COURSE OBJECTIVES:

1. To introduce components and assemblies used in machines and use of 3D parametric CAD, CAM software for mechanical design.
2. To provide an experiential learning environment using projects done by student groups, while applying CAD, CAE software tools to design mechanisms and structures for mechanical design evaluation,

optimization of mass properties, static-stresses, deformations, etc. with experimental validation of simulation models.

3. To do some exercises in tool pre-setting and work piece referencing on CNC machine tools, manual part programming for CNC turning and milling centres.
4. Use of software for simulation of turned and milled parts and simple surfaces, Automatic Cutter location data generation from CAD Models in APT format and post-processing for machining on CNC machines using standard CAD/CAM software
5. To produce an industrial component and measure to verify its conformity with the design

CAM LABORATORY

1. Exercise on CNC Lathe: Plain Turning, Step turning, Taper turning, Threading, Grooving canned cycle
2. Exercise on CNC Milling Machine: Profile Milling, Mirroring, Scaling & canned cycle. Study of Sensors, Transducers & PLC: Hall-effect sensor, Pressure sensors, Strain gauge, PLC, LVDT, Load cell, Angular potentiometer, Torque, Temperature & Optical Transducers.
3. Standards, types, applications and working of following components and assemblies, Machine Components: Screw fasteners, Riveted joints, Keys, Cotters and joints, Shaft couplings, Pipe joints and fittings. Assemblies: Bearings, Hangers and brackets, Steam and IC engine parts, Valves, Some important machine assemblies.
4. Mechanical Drawing: Machining and surface finish symbols and tolerances in dimensioning.
5. CAD: Introduction to CAD, CAM, software in product life cycle.
6. Geometric Modelling: Parametric sketching and modelling, constrained model dimensioning, Relating dimensions and parameters. Feature and sequence of feature editing. Material addition and removal for extrude, revolve, blend, helical sweep, swept blend, variable section sweep. References and construction features of points, axis, curves, planes, surfaces. Cosmetic features, representation of welded joints, Draft and ribs features, chamfers, rounds, standard holes. Assembly modelling. Automatic production drawing creation and detailing for dimensions, BOM, Ballooning, sectioned views etc.
7. Productivity Enhancement Tools in CAD Software: Feature patterns, duplication, grouping, suppression. Top-down vs. bottom-up design

2D modelling and 3D modelling of components such as

1. Bearing
2. Couplings
3. Gears
4. Sheet metal components
5. Jigs, Fixtures and Die assemblies.

CAD LABORATORY

PROGRESS THROUGH KNOWLEDGE **TOTAL: 60 PERIODS**

COURSE OUTCOMES:

At the end of this course the students are expected to;

1. Interpret mechanical drawings for components, assemblies and use parametric 3D CAD software tools in the correct manner for creating their geometric part models, assemblies and automated drawings.
2. Apply the concepts of machining for the purpose of selection of appropriate machining centres, machining parameters, select appropriate cutting tools for CNC milling and turning equipment, set-up, program, and operate CNC milling and turning equipment.
3. Create and validate NC part program data using manual data input (MDI) and automatically using standard commercial CAM package for manufacturing of required component using CNC milling or turning applications.
4. Produce an industrial component by interpreting 3D part model/ part drawings using Computer Aided Manufacturing technology through programming, setup, and ensuring safe operation of Computer Numerical Control (CNC) machine tools.
5. Create and demonstrate the technical documentation for design/ selection of suitable drive technologies, precision components and an overall CNC machine tool system for automation of machining operations using appropriate multi-axis CNC technology.

CO-PO Mapping

CO	PO					
	1	2	3	4	5	6
1	1	-	-	-	2	1
2	-	-	-	3	2	1
3	-	-	-	-	2	1
4	-	2	-	2	3	-
5	-	-	-	-	-	2
Avg.	1	2	-	2.5	2.25	1.25

MF4112

TECHNICAL SEMINAR

L T P C
0 0 2 1

OBJECTIVES:

- (1) To enrich the communication skills of the student through presentation of topics in recent advances in engineering/technology
- (2) To ensure that students possess a comprehensive understanding of the latest development in his chosen area
- (3) To ensure that students are getting updated with latest technology

A group of 2 students have to choose a problem and carry out scientific systematic investigation experimentally/theoretically in suggesting a viable solution. At the end of the semester, each group of students have to submit a report for evaluation.

Depth of understanding, coverage, quality of presentation material (PPT/OHP) and communication skill of the student will be taken as measures for evaluation.

OUTCOMES:

At the end of this course the students are expected;

- (1) To develop skills to search, read, write, comprehend and present research papers in the areas of manufacturing engineering.
- (2) Updated with the latest technology in the field of Manufacturing Engineering
- (3) Able to plot graph, sketch, bring out the visual about his understanding on various topics

TOTAL: 30 PERIODS

CO-PO Mapping

CO	PO					
	1	2	3	4	5	6
1	1	1	-	-	2	-
2	1	2	3	-	2	-
3	1	2	3	-	2	-
4	-	-	-	-	-	-
5	-	-	-	-	-	-
Avg.	1	1.66	3	-	2	-

OBJECTIVES:

- 1) To make use of the optimization techniques while modelling and solving the engineering problems of different fields.
- 2) To apply Linear Programming and Dynamic Programming to provide solutions for different problems
- 3) Learn classical optimization techniques and numerical methods of optimization.
- 4) Know the basics of different evolutionary algorithms.
- 5) To understand and differentiate traditional and non-traditional methods of Optimization

UNIT I	INTRODUCTION	9
Optimization – Historical Development – Engineering applications of optimization – Statement of an Optimization problem – classification of optimization problems.		
UNIT II	CLASSIC OPTIMIZATION TECHNIQUES	9
Linear programming - Graphical method – simplex method – dual simplex method – revised simplex method – duality in LP – Parametric Linear programming – Goal Programming.		
UNIT III	NON-LINEAR PROGRAMMING	9
Introduction – Lagrangeon Method – Kuhn-Tucker conditions – Quadratic programming – Separable programming – Stochastic programming – Geometric programming		
UNIT IV	INTEGER PROGRAMMING AND DYNAMIC PROGRAMMING AND NETWORK TECHNIQUES	9
Integer programming - Cutting plane algorithm, Branch and bound technique, Zero-one implicit enumeration – Dynamic Programming – Formulation, Various applications using Dynamic Programming. Network Techniques – Shortest Path Model – Minimum Spanning Tree Problem – Maximal flow problem.		
UNIT V	ADVANCES IN SIMULATION	9
Genetic algorithms – simulated annealing – Neural Network and Fuzzy systems		

TOTAL: 45 PERIODS

OUTCOMES:

- 1) At the end of this course the students will be expected to introduce the various optimization techniques and their advancements.
- 2) Ability to go in research by applying optimization techniques in problems of Engineering and Technology
- 3) Use classical optimization techniques and numerical methods of optimization.
- 4) Describe the basics of different evolutionary algorithms
- 5) Ability to solve the mathematical results and numerical techniques of optimization theory to concrete Engineering problems by using computer software

REFERENCES:

1. Hamdy A. Taha, Operations Research – An Introduction, Prentice Hall of India, 1997
2. J.K.Sharma, Operations Research – Theory and Applications – Macmillan India Ltd., 1997
3. P.K. Guptha and Man-Mohan, Problems in Operations Research – Sultan chand & Sons, 1994

4. R. Panneerselvam, "Operations Research", Prentice Hall of India Private Limited, New Delhi 1 – 2005
5. Ravindran, Philips and Solberg, Operations Research Principles and Practice, John Wiley & Sons, Singapore, 1992

CO-PO Mapping

CO	PO					
	1	2	3	4	5	6
1	2	-	-	3	2	-
2	1	-	-	2	3	-
3	1	-	-	2	2	-
4	-	2	-	-	-	-
5	1	-	-	3	-	2
<u>Avg.</u>	<u>1.25</u>	<u>2</u>	<u>-</u>	<u>2.5</u>	<u>2.33</u>	<u>2</u>

MF4202

ADVANCES IN METROLOGY AND INSPECTION

L T P C
3 0 0 3

OBJECTIVES:

- 1) To teach the students basic concepts in various methods of engineering measurement techniques and applications
- 2) To make them understand the importance of measurement and inspection in manufacturing industries.
- 3) To understand the use of Light rays and Laser beams for measurement and their merits
- 4) To make the students capable of learning to operate and use advanced metrological devices with ease in industrial environments.
- 5) To teach the use of computer for measuring and processing of measured quantity

UNIT I CONCEPTS OF METROLOGY

9

Terminologies – Standards of measurement – Errors in measurement – Interchangeability and Selective assembly – Accuracy and Precision – Calibration of instruments – Basics of Dimensional metrology and Form metrology

UNIT II MEASUREMENT OF SURFACE ROUGHNESS

9

Definitions – Types of Surface Texture: Surface Roughness Measurement Methods- Comparison, Contact and Non-Contact type roughness measuring devices, 3D Surface Roughness Measurement, Nano Level Surface Roughness Measurement – Instruments.

UNIT III INTERFEROMETRY

9

Introduction, Principles of light interference – Interferometers – Measurement and Calibration – Laser Interferometry applications - strain –pressure – displacement – vibration

UNIT IV MEASURING MACHINES AND LASER METROLOGY

9

Tool Makers Microscope –height gauges- Coordinate Measuring Machines – Applications – Laser Micrometer, Laser Scanning gauge, Computer Aided Inspection techniques - In-process inspection, Machine Vision system-automated visual inspection -Applications.

UNIT V IMAGE PROCESSING FOR METROLOGY

9

Overview, Computer imaging systems, Image Analysis, Pre-processing, Human vision system, Image model, Image enhancement, grey scale models, histogram models, Image Transforms - Examples.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course the students are expected to

1. Understand the advanced measurement principles with ease.
2. Operate sophisticated and accurate measuring instruments.
3. Understand the various inspection methods and tools
4. Design and develop new measuring methods.
5. Apply computers in Measurement

REFERENCES

1. "ASTE Handbook of Industries Metrology", Prentice Hall of India Ltd., 1992.
2. Bewoor, A.K. and Kulkarni,V.A., "Metrology and Measurement", Tata Mc Graw-Hill, 2009.
3. Galyer, F.W. and Shotbolt, C.R., "Metrology for engineers", ELBS, 1990.
4. Gupta, I.C., "A Text Book of engineering metrology", Dhanpat Rai and Sons, 1996.
5. Jain ,R.K., "Engineering Metrology", Khqanna Publishers, 2008.
6. Rajput,R.K., "Engineering Metrology and Instrumentations", Kataria & Sons Publishers, 2001.
7. Smith,G.T., "Industrial Metrology", Springer, 2002
8. Sonka,M., Hlavac,V. and Boyle.R., "Image Processing, Analysis, and Machine Vision", Cengage-Engineering, 2007.
9. Whitehouse,D.J., "Surface and their measurement", Hermes Penton Ltd, 2004.

CO-PO Mapping

CO	PO					
	1	2	3	4	5	6
1	1	-	-	1	1	-
2	1	-	-	1	-	2
3	1	-	3	-	2	1
4	1	-	-	1	2	1
5	-	-	-	1	2	1
Avg.	1	-	3	1	1.75	1.25

PROGRESS THROUGH KNOWLEDGE

MF4203

THEORY OF METAL FORMING

L T P C
3 0 0 3

OBJECTIVES:

- 1) To study the basic concepts of metal forming techniques and to develop force calculation in metal forming process.
- 2) To study the thermo mechanical regimes and its requirements of metal forming
- 3) To learn the art of processing and making of powder metallurgy components
- 4) To learn the effect of friction and lubrication in Metal forming
- 5) To study the various surface treatment processes

UNIT I THEORY OF PLASTICITY

9

Theory of plastic deformation – Yield criteria – Tresca and Von-Mises – Distortion energy – Stress-strain relation – Mohr’s circle representation of a state of stress – cylindrical and spherical co-ordinate system – upper and lower bound solution methods – Overview of FEM applications in Metal Forming analysis.

UNIT II THEORY AND PRACTICE OF BULK FORMING PROCESSES 9

Analysis of plastic deformation in Forging, Rolling, Extrusion, rod/wire drawing and tube drawing – Effect of friction – calculation of forces, work done – Process parameters, equipment used – Defects – applications – Recent advances in Forging, Rolling, Extrusion and Drawing processes – Design consideration in forming – Equal Channel Angular Pressing-High Pressure Torsion- Repetitive Corrugation and Straightening- Accumulative Roll bonding.

UNIT III SHEET METAL FORMING 9

Formability studies – Conventional processes – H E R F techniques – Superplastic forming techniques – Hydro forming – Stretch forming – Water hammer forming – Principles and process parameters – Advantages, Limitations and applications

UNIT IV POWDER METALLURGY AND SPECIAL FORMING PROCESSES 9

Overview of P/M technique – Advantages – applications – Powder preform forging – powder rolling – Tooling, process parameters and applications. - Orbital forging – Isothermal forging – Hot and cold isostatic pressing – High speed extrusion – Rubber pad forming – Fine blanking – LASER beam forming

UNIT V SURFACE TREATMENT AND METAL FORMING APPLICATIONS 9

Experiment techniques of evaluation of friction in metal forming selection – influence of temperature and gliding velocity – Friction heat generation – Friction between metallic layers – Lubrication carrier layer – Surface treatment for drawing, sheet metal forming, Extrusion, hot and cold forging. Processing of thin Al tapes – Cladding of Al alloys – Duplex and triplex steel rolling – Thermo mechanical regimes of Ti and Al alloys during deformation – Formability of welded blank sheet – Laser structured steel sheet - Formability of laminated sheet.

OUTCOMES:

- 1) At the end of this course the students are expected to upgrade their knowledge on various metal forming techniques and formability
- 2) Apply the theory of plasticity for various types of metal forming process.
- 3) Apply the concept of powder metallurgy to make prismatic components
- 4) Understand Non-traditional forming processes.
- 5) Understand the purpose of surface treatment in metal forming applications

TOTAL: 45 PERIODS

REFERENCES:

1. Altan T., Metal forming – Fundamentals and applications – American Society of Metals, Metals park, 2003
2. ALTAN.T, SOO-IK-oh, GEGEL, HL – Metal forming, fundamentals and Applications, American Society of Metals, Metals Park, Ohio, 1995.
3. ASM Hand book, Forming and Forging, Ninth edition, Vol – 14, 2003
4. Dieter G.E., Mechanical Metallurgy (Revised Edition II) McGraw Hill Co., 1988
5. Helmi A Youssef, Hassan A. El-Hofy, Manufacturing Technology: Materials, Processes and Equipment, CRC publication press, 2012.
6. Marciniak,Z., Duncan J.L., Hu S.J., 'Mechanics of Sheet Metal Forming', Butterworth-Heinemann An Imprint of Elsevier, 2006
7. Nagpal G.R., Metal Forming Processes- Khanna publishers, 2005.
8. SAE Transactions, Journal of Materials and Manufacturing Section 5, 1993-2007
9. SHIRO KOBAYASHI, SOO-IK-oh-ALTAN, T, Metal forming and Finite Element Method, Oxford University Press, 2001.
10. Surender Kumar, Technology of Metal Forming Processes, Prentice Hall India Publishers, 2010

CO-PO Mapping

CO	PO					
	1	2	3	4	5	6
1	-	-	-	-	-	-
2	1	-	-	-	-	-
3	1	-	-	2	1	2
4	1	-	2	2	-	-
5	-	-	1	-	2	3
Avg.	1	-	1.5	2	1.5	2.5

MF4204

ADDITIVE MANUFACTURING

L T P C
3 0 0 3

OBJECTIVES:

- 1) To educate students with fundamental and advanced knowledge in the field of Additive manufacturing technology
- 2) Gain insights on the need, advantages and limitations of additive manufacturing (AM) versus traditional manufacturing
- 3) Find out the various applications of AM, Deployment levels, Innovative and optimized product design
- 4) To explore the potential of additive manufacturing in different industrial sectors.
- 5) To apply 3D printing technology for additive manufacturing.

UNIT I INTRODUCTION

9

Need - Development of AM systems – AM process chain - Impact of AM on Product Development - Virtual Prototyping- Rapid Tooling – RP to AM -Classification of AM processes-Benefits- Applications.

UNIT II REVERSE ENGINEERING AND CAD MODELLING

9

Basic concept- Digitization techniques – Model reconstruction – Data Processing for Rapid Prototyping: CAD model preparation, Data requirements – Geometric modelling techniques: Wire frame, surface and solid modelling – data formats - Data interfacing, Part orientation and support generation, Support structure design, Model Slicing, Tool path generation-Software for AM- Case studies.

UNIT III LIQUID BASED AND SOLID BASED ADDITIVE MANUFACTURING SYSTEMS 9

Stereolithography Apparatus (SLA): Principle, pre-build process, part-building and post-build processes, photo polymerization of SL resins, part quality and process planning, recoating issues, materials, advantages, limitations and applications.

Solid Ground Curing (SGC): working principle, process, strengths, weaknesses and applications. Fused deposition Modelling (FDM): Principle, details of processes, process variables, types, products, materials and applications. Laminated Object Manufacturing (LOM): Working Principles, details of processes, products, materials, advantages, limitations and applications - Case studies.

UNIT IV POWDER BASED ADDITIVE MANUFACTURING SYSTEMS

9

Selective Laser Sintering (SLS): Principle, process, Indirect and direct SLS- powder structures, materials, post processing, surface deviation and accuracy, Applications. Laser Engineered Net Shaping (LENS): Processes, materials, products, advantages, limitations and applications– Case Studies.

UNIT V OTHER ADDITIVE MANUFACTURING SYSTEMS

9

Three-dimensional Printing (3DP): Principle, basic process, Physics of 3DP, types of printing, process capabilities, material system. Solid based, Liquid based and powder based 3DP systems, strength and weakness, Applications and case studies. Shape Deposition Manufacturing (SDM), Ballistic Particle Manufacturing (BPM), Selective Laser Melting, Electron Beam Melting.

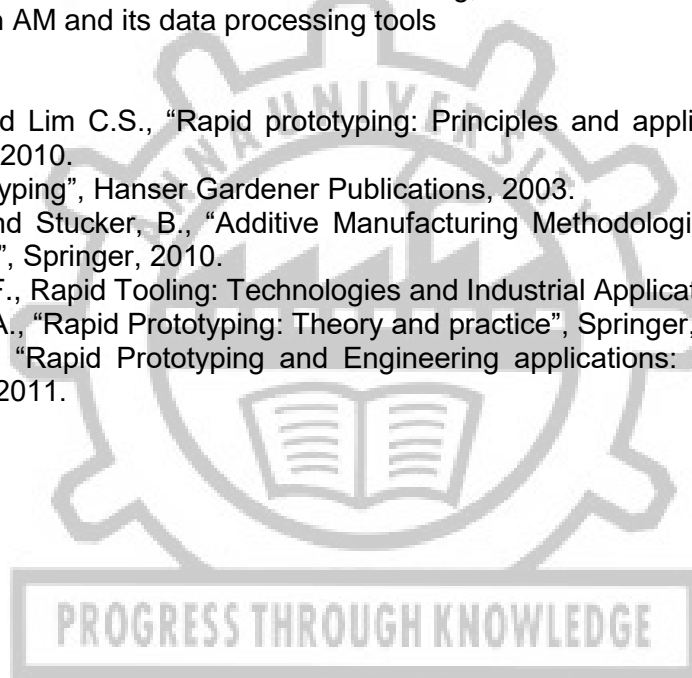
TOTAL: 45 PERIODS

OUTCOMES:

- 1) The students are expected to learn about a variety of Additive Manufacturing (AM) technologies.
- 2) Describe additive manufacturing and explain its advantages and disadvantages
- 3) Explain the processes used in additive manufacturing for a range of materials and applications
- 4) understand the role of additive manufacturing in the design process and their potential to support Design and manufacturing,
- 5) Case studies relevant to mass customized manufacturing, and some of the important research challenges associated with AM and its data processing tools

REFERENCES:

1. Chua, C.K., Leong K.F. and Lim C.S., "Rapid prototyping: Principles and applications", second edition, World Scientific Publishers, 2010.
2. Gebhardt, A., "Rapid prototyping", Hanser Gardener Publications, 2003.
3. Gibson, I., Rosen, D.W. and Stucker, B., "Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing", Springer, 2010.
4. Hilton, P.D. and Jacobs, P.F., Rapid Tooling: Technologies and Industrial Applications, CRC press, 2005.
5. Kamrani, A.K. and Nasr, E.A., "Rapid Prototyping: Theory and practice", Springer, 2006.
6. Liou, L.W. and Liou, F.W., "Rapid Prototyping and Engineering applications: A tool box for prototype development", CRC Press, 2011.



CO-PO Mapping

CO	PO					
	1	2	3	4	5	6
1	2	-	2	-	-	-
2	1	-	-	-	-	2
3	-	-	3	-	2	-
4	-	-	-	3	-	-
5	-	-	-	-	2	3
Avg.	1.5	-	2.5	3	2	2.5

MF4205**FLUID POWER AUTOMATION****L T P C
3 0 0 3****OBJECTIVES:**

- 1) To make the students to learn the basic concepts of hydraulics and pneumatics and their controlling elements in the area of manufacturing process.
- 2) To train the students in designing the hydraulic and pneumatic circuits using various design procedures.
- 3) To understand the concept and principle operation of automation systems and their controls.
- 4) To provide knowledge levels needed for PLC programming and operating
- 5) Ability to implement automation systems in Industry

UNIT I INTRODUCTION**9**

Need for Automation, Hydraulic & Pneumatic Comparison – ISO symbols for fluid power elements, Hydraulic, pneumatics – Selection criteria.

UNIT II FLUID POWER GENERATING/UTILIZING ELEMENTS**9**

Hydraulic pumps and motor gears, vane, piston pumps-motors-selection and specification-Drive characteristics – Linear actuator – Types, mounting details, cushioning – power packs – construction. Reservoir capacity, heat dissipation, accumulators – standard circuit symbols, circuit (flow) analysis.

UNIT III CONTROL AND REGULATION ELEMENTS**9**

Direction flow and pressure control valves-Methods of actuation, types, sizing of ports-pressure and temperature compensation, overlapped and underlapped spool valves-operating characteristics-electro hydraulic servo valves, Digital valves -Different types-characteristics and performance.

UNIT IV CIRCUIT DESIGN**9**

Typical industrial hydraulic circuits-Design methodology – Ladder diagram-cascade, method-truth table-Karnaugh map method-sequencing circuits-combinational and logic circuit.

UNIT V ELECTRO PNEUMATICS & ELECTRONIC CONTROL OF HYDRAULIC AND PNEUMATIC CIRCUITS**AND****9**

Electrical control of pneumatic and hydraulic circuits-use of relays, timers, counters, Ladder diagram. Programmable logic control of Hydraulics Pneumatics circuits, PLC ladder diagram for various circuits, motion controllers, use of field busses in circuits. Electronic drive circuits for various Motors.

TOTAL: 45 PERIODS

OUTCOMES:

- 1) At the end of this course the students are familiarized in the area of hydraulics, pneumatic and fluid power components and its functions.
- 2) Recognize the standard symbols used in fluid power circuits and assess the suitable component for a particular application
- 3) Construct the hydraulic circuits for an industrial application.
- 4) Build a pneumatic circuit and apply them to real life problems.
- 5) Design and develop a PLC controlled pneumatic circuit for industrial application

REFERENCES:

1. Antony Esposito, Fluid Power Systems and control Prentice-Hall, 1988
2. Durbey. A. Peace, Basic Fluid Power, Prentice Hall Inc, 1967.
3. E.C.Fitch and J.B.Suryaatmady. Introduction to fluid logic, McGraw Hill, 1978
4. Herbert R. Merritt, Hydraulic control systems, John Wiley & Sons, Newyork, 1967
5. Peter Rohner, Fluid Power Logic Circuit Design, Mcmelan Prem, 1994.
6. Peter Rohner, Fluid Power logic circuit design. The Macmillan Press Ltd.,London, 1979
7. W.Bolton, Mechatronics, Electronic control systems in Mechanical and Electrical Engineering Pearson Education, 2003.

CO-PO Mapping

CO	PO					
	1	2	3	4	5	6
1	1	-	-	-	-	-
2	1	-	3	-	-	2
3	-	-	3	2	-	-
4	1	-	-	2	3	-
5	-	-	-	-	-	3
Avg.	1	-	3	2	3	2.5

MF4211

AUTOMATION AND METAL FORMING LABORATORY

L T P C

0 0 3 1.5

OBJECTIVES

- 1) To train the students on the basic concepts of metal forming processes
- 2) To determine metal forming parameters for a given shape.
- 3) To learn the automation systems using fluid power control systems
- 4) To learn and use automation studio software
- 5) To learn PLC and its importance in Fluid power applications

EXPERIMENTS

1. Determination of strain hardening exponent
2. Determination of strain rate sensitivity index
3. Construction of formability limit diagram
4. Determination of efficiency in water hammer forming
5. Determination of interface friction factor
6. Determination of extrusion load
7. Study on two high rolling process

AUTOMATION LAB

1. Simulation of single and double acting cylinder circuits
2. Simulation of Hydraulic circuits
3. Simulation of electro pneumatic circuits
4. Simulation of electro hydraulic circuits
5. Simulation of PLC circuits
6. Software simulation of fluid power circuits using Automation studio.

TOTAL: 60 PERIODS

OUTCOMES:

At the end of this course the students are expected

- 1) To impart practical knowledge on bulk metal forming processes
- 2) Know various symbols used in Hydraulic and Pneumatic circuits
- 3) Conduct few sheet metals forming processes and analyse the parameters
- 4) Design hydraulic circuits for industrial applications
- 5) Learnt how to use automation studio

CO-PO Mapping

CO	PO					
	1	2	3	4	5	6
1	-	2	1	2	-	-
2	-	2	-	2	-	-
3	-	2	-	-	3	1
4	-	2	-	-	2	1
5	-	2	-	-	2	1
Avg.	-	2	1	2	2.33	1

MF4212 ADVANCED MANUFACTURING PROCESSES LABORATORY

(Students can do any three sets for this lab out of the given four i.e. I, II, III, IV)

L T P C
0 0 3 1.5

COURSE OBJECTIVES

- (1) To analyses the forces in machining
- (2) To perform modelling and simulation of manufacturing processes
- (3) To develop product using rapid prototyping
- (4) To program a robot for an autonomous movement
- (5) To analyze product Life cycle

I ADVANCED MACHINING PROCESS

- (1) Analysis of cutting forces during turning/drilling process.
- (2) Analysis of temperature during turning/drilling process.
- (3) Study on the effect of process parameters in Electro-Chemical/Electric-Discharge Machining

II PROCESS MODELLING

1. Analysis of stress strain distribution in a structural loading of composite bar using MATLAB codes.
2. Transient heat transfer analysis of a rectangular slab using a FEA package.
3. Modeling & simulation of forging/rolling/machining process using a FEA package.

III RAPID PROTOTYPING

- (1) Selection of Rapid Prototyping Technology.
- (2) Product development activity – Concept design and Detailed design.
- (3) Product development activity – Engineering analysis and Prototype development.

IV ROBOTICS

- (1) Determination of maximum and minimum position of links.
- (2) Verification of transformation (Position and orientation) with respect to gripper and world coordinate system
- (3) Estimation of accuracy, repeatability and resolution.
- (4) Robot programming and simulation for pick and place
- (5) Robot programming and simulation for Color identification
- (6) Robot programming and simulation for Shape identification

COURSE OUTCOMES:

1. Perform modelling and simulation of manufacturing processes
2. Analyze the process using an FEA package
2. Competence to execute product development phases
3. Simple programming for robotic applications
4. Use EDM/ECM for machining different materials

CO-PO Mapping

CO	PO					
	1	2	3	4	5	6
1	1	1	-	2	3	2
2	1	1	-	2	3	-
3	-	1	-	2	-	2
4	-	1	-	2	-	2
5	1	1	3	-	-	2
Avg	1	1	3	2	3	2

MF4311

PROJECT WORK I

L T P C
0 0 12 6

OBJECTIVES:

- (1) To develop knowledge to formulate a real-world problem.
- (2) To break up the goal and evolve procedures
- (3) To use different tools and techniques to arrive at a solution
- (4) To validate the results analytically and experimentally
- (5) To prepare a report and give a presentation

Student shall identify a minor problem related to the field of Manufacturing and carry out a literature survey/case studies/data collection. Student is supposed to formulate Engineering solutions to the problem, methodology to test their hypothesis/solutions and validate it theoretically/practically, planned and executed within the stipulated time

Observations, results and inference should be documented and presented as report in the prescribed format.

TOTAL: 180 PERIODS

OUTCOMES

After successful completion of this course, the students should be able to

- (1) Design and analyze, an identified problem using scientific tools
- (2) Simulation/ Theoretical analysis of a physical system
- (3) Integrate various domain knowledge for a sustainable solution.
- (4) Set Goals, Targets, timeline, plan and execute activities of the project
- (5) Disseminate work both in oral and written format.

CO-PO Mapping

CO	PO					
	1	2	3	4	5	6
1	1	2		3	2	
2	2	2		1		
3	2	2	3	3	2	
4	2	2		3		2
5	-	2	2			2
Avg	1.75	2	2.5	2.5	2	2

MF4411

PROJECT WORK II

L T P C
0 0 24 12

OBJECTIVES:

- (1) To develop knowledge to formulate a real-world problem.
- (2) To break up the goal and evolve procedures
- (3) To use different tools and techniques to arrive at a solution
- (4) To validate the results analytically and experimentally
- (5) To prepare a report and give a presentation

Student shall identify a major/critical problem related to the field of Manufacturing and carry out a literature survey/case studies/data collection. Student supposed to formulate Engineering solutions to set objectives, methodology to test their hypothesis/solutions and validate it theoretically/practically, planned and executed within the stipulated time.

Observations, results and inferences should be documented and presented as report in the prescribed format.

TOTAL: 360 PERIODS

OUTCOMES

After successful completion of this course, the students should be able to

- (1) Design and analyze, an identified problem using scientific tools and research
- (2) simulation/ Theoretical analysis of a physical system
- (3) Integrate various domain knowledge in carrying out experimental work and provide a sustainable solution.
- (4) Set Goals, Targets, timeline, plan and execute activities of the project
- (5) Disseminate work both in oral and written format.

CO-PO Mapping

CO	PO					
	1	2	3	4	5	6
1	1	2		3	2	
2	2	2		1		
3	2	2	3	3	2	
4	2	2		3		2
5	-	2	2			2
Avg	1.75	2	2.5	2.5	2	2

MF4071

DESIGN FOR MANUFACTURE AND ASSEMBLY

L T P C
3 0 0 3

OBJECTIVES:

- (1) To apply various design rules in manufacturing processes
- (2) To evaluate the process by design guidelines for optimum design
- (3) To analyze the rules of concepts of GD& T
- (4) To make the students to learn about tolerance analysis and allocation, geometrical tolerances
- (5) Guidelines for design for manufacturing and assembly with suitable examples.

UNIT I TOLERANCE ANALYSIS 9

Introduction – Concepts, definitions and relationships of tolerancing – Matching design tolerances with appropriate manufacturing process – manufacturing process capability metrics – Worst care, statistical tolerance Analysis – Linear and Non-Linear Analysis – Sensitivity Analysis – Taguchi’s Approach to tolerance design.

UNIT II TOLERANCE ALLOCATION 9

Tolerance synthesis – Computer Aided tolerancing – Traditional cost based analysis – Taguchi’s quality loss function – Application of the Quadratic loss function to Tolerancing – Principles of selective Assembly – Problems.

UNIT III GD&T 9

Fundamentals of geometric dimensioning and tolerancing – Rules and concepts of GD&T – Form controls – Datum systems – Orientation controls – Tolerance of position – Concentricity and symmetry controls – Run out controls – Profile controls.

UNIT IV TOLERANCE CHARTING 9

Nature of the tolerance buildup – structure and setup of the tolerance chart – piece part sketches for tolerance charts – Arithmetic ground rules for tolerance charts – Determination of Required balance dimensions – Determination of Mean working Dimensions – Automatic tolerance charting – Tolerance charting of Angular surfaces.

UNIT V MANUFACTURING GUIDELINES 9

DFM guidelines for casting, weldment design – Formed metal components – Turned parts – Milled, Drilled parts – Non-metallic parts – Computer Aided DFM software – Boothroyd and Dewhurst method of DFMA – DCS – Vis/VSA – 3D Dimensional control – Statistical tolerance Analysis Software – Applications.

TOTAL: 45 PERIODS

OUTCOMES :

At the end of this course the students are expected

- (1) To impart the knowledge about the significance of design for manufacturing and assembly
- (2) To apply the principle of tolerancing in design
- (3) Evaluate the process of GD & T using design guidelines
- (4) Apply tolerance allocation and tolerance charting in design
- (5) Apply guidelines for manufacturing and assembly

REFERENCES:

1. Alex Krulikowski, "Fundamentals GD&T", Delmar Thomson Learning, 1997.
2. C.M. Creveling, "Tolerance Design – A handbook for Developing Optimal Specifications", Addison – Wesley, 1997.
3. James D. Meadows, 'Geometric Dimensioning and Tolerancing", Marcel Dekker Inc., 1995.
4. James G. Bralla, "Handbook of Product Design for Manufacturing", McGraw Hill, 1986.
5. Oliver R. Wade, "Tolerance Control in Design and Manufacturing", Industrial Press, NY, 1967.

CO-PO Mapping

CO	PO					
	1	2	3	4	5	6
1	1	-	-	3	-	-
2	1	1	-	2	2	-
3	-	-	3	2	2	-
4	1	-	-	-	-	-
5	-	-	-	2	2	2
Avg	1	1	3	2.25	2	2

MF4001

MICRO MANUFACTURING

L T P C
3 0 0 3

OBJECTIVES:

- (1) The objective of the course is to acquaint the students with the principles of micro manufacturing
- (2) To learn basic machine tools used in micro manufacturing and developments in the micro manufacturing process
- (3) To familiarize with the research trends in the area of micro manufacturing process.
- (4) To learn various polishing techniques
- (5) To study the various measuring techniques used for micro/nano components

UNIT I MECHANICAL MICRO MACHINING

9

Mechanical Micro machining – Ultra Sonic Micro Machining – Abrasive Jet Micro Machining – Water Jet Micro Machining – Abrasive Water Jet Micro Machining – Micro turning – Chemical and Electro Chemical Micro Machining – Electric discharge micro machining.

UNIT II BEAM ENERGY BASED MICRO MACHINING

9

Electron Beam Micro Machining – Laser Beam Micro Machining – Electric Discharge Micro Machining – Ion Beam Micro Machining – Plasma Beam Micro Machining – Hybrid Micro machining – Electro Discharge Grinding – Electro Chemical spark micro machining – Electrolytic in process Dressing.

UNIT III NANO POLISHING

9

Abrasive Flow finishing – Magnetic Abrasive Finishing – Magneto rheological finishing – Magneto Rheological abrasive flow finishing - Magnetic Float polishing – Elastic Emission Machining – chemo-mechanical Polishing.

UNIT IV MICRO FORMING AND WELDING 9

Micro extrusion – Micro and Nano structured surface development by Nano plastic forming and Roller Imprinting – Micro bending with LASER – LASER micro welding – Electron beam for micro welding.

UNIT V RECENT TRENDS AND APPLICATIONS 9

Metrology for micro machined components – Ductile regime machining– AE based tool wear compensation– Machining of Micro gear, micro nozzle, micro pins – Applications.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course the students are well experienced

- (1) To impart the principles of various basic micro manufacturing process
- (2) To know and perform micro machining
- (3) Research various micro machining process to optimize the process variables
- (4) Attain knowledge about polishing techniques
- (5) Measure and analyse the various parameters of micro machined components

REFERENCES:

1. Bandyopadhyay. A.K., Nano Materials, New age international publishers, New Delhi, 2008, ISBN:8122422578.
2. Bharat Bhushan, Handbook of nanotechnology, springer, Germany, 2010.
3. Jain V.K., 'Introduction to Micro machining' Narosa Publishing House, 2011
4. Jain V.K., Advanced Machining Processes, Allied Publishers, Delhi, 2002
5. Jain V. K., Micro Manufacturing Processes, CRC Press, Taylor & Francis Group, 2012
6. Janocha H., Actuators – Basics and applications, Springer publishers – 2012
7. Mcgeoug.J.A., Micromachining of Engineering Materials, CRC press 2001, ISBN-10:0824706447.
8. www.cmxr.com/industrial/
9. www.sciencemag.org.handbook

CO-PO Mapping

CO	PO					
	1	2	3	4	5	6
1	-	-	3	-	-	-
2	1	-	-	-	2	-
3	3	1	-	-	-	-
4	-	-	-	-	2	2
5	1	-	-	-	2	-
Avg	1.66	1	-	-	2	2

MF4002

QUALITY AND RELIABILITY ENGINEERING

L T P C

3 0 0 3

OBJECTIVES:

To make the students construct the various quality control charts for variables and attributes
 To study the various sampling plans

To make the students design for reliability
To learn different methods of improving reliability
To learn the basics of maintainability.

UNIT I QUALITY & STATISTICAL PROCESS CONTROL 9
Quality – Definition – Quality Assurance – Variation in process – Factors – process capability – control charts – variables X, R and X, - Attributes P, C and U-Chart tolerance design. Establishing and interpreting control charts – charts for variables – Quality rating – Short run SPC.

UNIT II ACCEPTANCE SAMPLING 9
Lot by lot sampling – types – probability of acceptance in single, double, multiple sampling plans – OC curves – Producer's risk and consumer's risk. AQL, LTPD, AOQL, Concepts – standard sampling plans for AQL and LTPD – use of standard sampling plans.

UNIT III EXPERIMENTAL DESIGN AND TAGUCHI METHOD 9
Fundamentals – factorial experiments – random design, Latin square design – Taguchi method – Loss function – experiments – S/N ratio and performance measure – Orthogonal array.

UNIT IV CONCEPT OF RELIABILITY 9
Definition – reliability vs quality, reliability function – MTBF, MTTR, availability, bathtub curve – time dependent failure models – distributions – normal, Weibull, lognormal – Reliability of system and models – serial, parallel and combined configuration – Markov analysis, load sharing systems, standby systems, covariant models, static models, dynamic models.

UNIT V DESIGN FOR RELIABILITY AND MAINTAINABILITY 9
Reliability design process, system effectiveness, economic analysis and life cycle cost, reliability allocation, design methods, parts and material selection, derating, stress-strength and analysis, failure analysis, identification determination of causes, assessments of effects, computation of criticality index, corrective action, system safety – analysis of down-time – the repair time distribution, stochastic point processes system repair time, reliability under preventive maintenance state dependent system with repair. MTTR – mean system down time, repair vs replacement, replacement models, proactive, preventive, predictive maintenance maintainability and availability, optimization techniques for system reliability with redundancy heuristic methods applied to optimal system reliability.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course the students are exposed to the various quality control techniques, to understand the importance and concept of reliability and maintainability in industries.

- (1) Apply control chart techniques in production process
- (2) Understand inspection by sampling techniques
- (3) Able to do reliable design
- (4) Improve the availability of equipment through proper maintenance
- (5) Know how to improve the reliability

REFERENCES:

1. Amata Mitra "Fundamentals of Quality Control and improvement" Pearson Education, 2002.
2. Bester field D.H., "Quality Control" Prentice Hall, 1993.
3. Charles E Ebling, An Introduction to Reliability and Maintainability Engineering, Tata-McGraw Hill, 2000.
4. David J Smith, Reliability, Maintainability and Risk: Practical Methods for Engineers, Butterworth 2002.
5. Dhillon, Engineering Maintainability – How to design for reliability and easy maintenance, PHI, 2008.
6. Patrick D To' corner, Practical Reliability Engineering, John-Wiley and Sons Inc, 2002

CO-PO Mapping

CO	PO					
	1	2	3	4	5	6
1	1	-	3	2	1	1
2	-	-	-	3	-	-
3	-	-	-	2	-	2
4	1	-	3	-	2	-
5	-	-	-	2	-	1
Avg.	1	-	3	2.25	1.5	1.33

MF4003 FINITE ELEMENT METHODS FOR MANUFACTURING ENGINEERING

**L T P C
3 0 0 3**

OBJECTIVES:

- (1) To familiarize the students with fundamentals of finite element method,
- (2) To study the fundamentals of one dimensional and two dimensional problems using FEA in manufacturing.
- (3) Acquaint students with finite element formulations and theories
- (4) Develop the ability to perform finite element analyses and evaluate the results of a select set of manufacturing processes,
- (5) Provide exposure to practical problems and their solutions, through simulations using the finite element software

UNIT I INTRODUCTION

9

Fundamentals – Initial, boundary and eigen value problems – weighted residual, Galerkin and Rayleigh Ritz methods - Integration by parts – Basics of variational formulation – Polynomial and Nodal approximation.

UNIT II ONE DIMENSIONAL ANALYSIS

9

Steps in FEM – Discretization. Interpolation, derivation of elements characteristic matrix, shape function, assembly and imposition of boundary conditions-solution and post processing – One dimensional analysis in solid mechanics and heat transfer.

UNIT III SHAPE FUNCTIONS AND HIGHER ORDER FORMULATIONS

9

Shape functions for one and two dimensional elements- Three noded triangular and four noded quadrilateral element Global and natural co-ordinates—Nonlinear analysis – Isoparametric elements – Jacobian matrices and transformations – Basics of two dimensional, plane stress, plane strain and axisymmetric analysis.

UNIT IV COMPUTER IMPLEMENTATION

9

Pre Processing, mesh generation, elements connecting, boundary conditions, input of material and processing characteristics – Solution and post processing – Overview of application packages – Development of code for one dimensional analysis and validation

UNIT V ANALYSIS OF PRODUCTION PROCESSES

9

FE analysis of metal casting – special considerations, latent heat incorporation, gap element – Time stepping procedures – Crank – Nicholson algorithm – Prediction of grain structure – Basic concepts of plasticity and fracture – Solid and flow formulation – small incremental deformation formulation – Fracture

criteria – FE analysis of metal cutting, chip separation criteria, incorporation of strain rate dependency – FE analysis of welding.

TOTAL: 45 PERIODS

OUTCOMES :

At the end of this course the students are highly confident in

- (1) Fundamentals of Finite Element Methods.
- (2) Perform one dimensional and Two-dimensional analysis using FEA
- (3) Perform finite element formulations to solve problems
- (4) perform finite element analyses and evaluate the results of a select set of manufacturing processes,
- (5) Provide simulations through FE Software

REFERENCES:

1. Bathe, K.J., Finite Element procedures in Engineering Analysis, 1990
2. Kobayash,S, Soo-ik-Oh and Altan,T, Metal Forming and the Finite Element Methods, Oxford University Press, 1989.
3. Lewis R.W. Morgan, K, Thomas, H.R. and Seetharaman, K.N. The Finite Element Method in Heat Transfer Analysis, John Wiley, 1994.
4. Rao, S.S., Finite Element method in engineering, Pergammon press, 2005.
5. Reddy, J.N. An Introduction to the Finite Element Method, McGraw Hill,2005.
6. Seshu P., Textbook of Finite Element Analysis, PHI Learning Pvt. Ltd, 2004.
7. www.pollockeng.com
8. www.tbook.com

CO-PO Mapping

CO	PO					
	1	2	3	4	5	6
1	1	-	-	-	-	2
2	2	-	-	3	-	-
3	-	-	3	2	-	-
4	2	-	-	3	-	-
5	-	-	-	-	2	1
Avg.	1.66	-	3	2.66	2	1.5

MF4004

MATERIALS MANAGEMENT

L T P C

3 0 0 3

OBJECTIVES:

To introduce the students

- (1) the various concepts of materials management
- (2) familiarize them with vendor development and rating
- (3) the various aspects of Logistics and storage
- (4) Planning and Forecasting of the need
- (5) Various aspects of Inventory management

UNIT I INTRODUCTION

9

Introduction to materials management – Objectives – Functions – Operating Cycle – Value analysis – Make or buy decisions.

UNIT II MANAGEMENT OF PURCHASE 9

Purchasing policies and procedures – Selection of sources of supply – Vendor development – Vendor evaluation and rating – Methods of purchasing – Imports – Buyer – Seller relationship – Negotiations.

UNIT III MANAGEMENT OF STORES AND LOGISTICS 9

Stores function – Location – Layout – Stock taking – Materials handling – Transportation – Insurance – Codification – Inventory pricing – stores management – safety – warehousing – Distribution linear programming – Traveling Salesman problems – Network analysis – Logistics Management.

UNIT IV MATERIALS PLANNING 9

Forecasting – Materials requirements planning – Quantity – Periodic – Deterministic models – Finite production.

UNIT V INVENTORY MANAGEMENT 9

ABC analysis – Aggregate planning – Lot size under constraints – Just in Time (JIT) system.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course the students are

- (1) Familiarized with the various concepts and functions of material management
- (2) Able to handle the purchase and stores Independently
- (3) Understand Logistics and inventory pricing
- (4) Materials planning and periodic replenishment of material
- (5) Just in time techniques and inventory management

REFERENCES

1. Dr. R. Kesavan, C.Elanchezian and T.SundarSelwyn, Engineering Management – Eswar Press – 2005.
2. Dr.R. Kesavan, C.Elanchezian and B.Vijaya Ramnath, Production Planning and Control, Anuratha Publications, Chennai, 2008.
3. G. Reghuram, N. Rangaraj, Logistics and supply chain management – cases and concepts, Macmillan India Ltd., 2006.
4. Gopalakrishnan.P, Handbook of Materials Management, Prentice Hall of India, 2005.
5. Guptha P.K. and Heera, Operations Research, Suttan Chand & Sons, 2007.
6. Lamer Lee and Donald W.Dobler, Purchasing and Material Management, Text and cases, Tata McGraw Hill, 2006.

CO-PO Mapping

CO	PO					
	1	2	3	4	5	6
1	1	-	-	-	-	2
2	-	-	3	-	-	-
3	-	-	3	-	-	-
4	-	-	-	2	-	-
5	-	-	-	3	2	2
Avg.	1	-	3	2.5	2	2

OBJECTIVES:

- (1) To introduce the concepts of Ergonomics and to indicate the areas of Applications.
- (2) Identify ergonomic principles
- (3) to increase awareness of the need and role of ergonomics in occupational health
- (4) To inculcate analysing skills among the students with respect to work place design, working postures and lifting tasks.
- (5) To provide thorough knowledge about assessment about occupational exposure to heat stress, noise, vibrations

UNIT I INTRODUCTION**9**

Concepts of human factors engineering and ergonomics – Man – machine system and design philosophy – Physical work – Heat stress – manual lifting – work posture – repetitive motion.

UNIT II ANTHROPOMETRY**9**

Physical dimensions of the human body as a working machine – Motion size relationships – Static and dynamic anthropometry – Anthropometric aids – Design principles – Using anthropometric measures for industrial design – Procedure for anthropometric design.

UNIT III DESIGN OF SYSTEMS**9**

Displays – Controls – Workplace – Seating – Work process – Duration and rest periods – Hand tool design – Design of visual displays – Design for shift work.

UNIT IV ENVIRONMENTAL FACTORS IN DESIGN**9**

Temperature – Humidity – Noise – Illumination –Vibration – Measurement of illumination and contrast – use of photometers – Recommended illumination levels. The ageing eye – Use of indirect (reflected) lighting – cost efficiency of illumination – special purpose lighting for inspection and quality control – Measurement of sound – Noise exposure and hearing loss – Hearing protectors – analysis and reduction of noise – Effects of Noise on performance – annoyance of noise and interference with communication – sources of vibration discomfort.

UNIT V WORK PHYSIOLOGY**9**

Provision of energy for muscular work – Role of oxygen physical exertion – Measurement of energy expenditure Respiration – Pulse rate and blood pressure during physical work – Physical work capacity and its evaluation.

TOTAL: 45 PERIODS**OUTCOMES:**

At the end of this course the students are

- (1) updated with various concepts of Ergonomics
- (2) able to provide appropriate allowances for the jobs under analysis.
- (3) Students will be able to analyse and calculate the level of risk in a job causing stress, fatigue and musculoskeletal disorders and design appropriate work systems.
- (4) Students will be able to assess the occupational environmental factors like heat stress, noise, and vibration and RSPM level in the industry.
- (5) Maintain a comfortable environment in the work place

REFERENCES:

1. E.J. McCormic & Mark S. Sangers, Human factors in engineering design, McGraw Hill 2007
2. Martin Helander, A guide to the ergonomics of manufacturing, East West press, 2007

3. R.S. Bridger Introduction to Ergonomics, McGraw Hill, 1995.

CO-PO Mapping

CO	PO					
	1	2	3	4	5	6
1	2	-	-	-	-	-
2	-	-	-	3	-	1
3	1	-	2	-	-	-
4	-	-	2	3	2	-
5	1	-	1	2	-	2
Avg.	1.33	-	1.66	2.66	2	1.5

MF4006

POLYMERS AND COMPOSITE MATERIALS

L T P C
3 0 0 3

OBJECTIVES:

- (1) To impart knowledge on various polymer processing techniques
- (2) To learn about various fibre, Matrix materials and their properties
- (3) To learn the methods by which Polymer matrix composites are made
- (4) To study about the composites used for High temperature applications
- (5) To study the behaviour of reinforcements in MMC and PMC

UNIT I PROCESSING OF POLYMERS

9

Chemistry and Classification of Polymers – Properties of Thermo plastics – Properties of Thermosetting Plastics - Extrusion – Injection Moulding – Blow Moulding – Compression and Transfer Moulding – Casting – Thermo Forming. General Machining properties of Plastics – Machining Parameters and their effect – Joining of Plastics – Thermal bonding – Applications.

UNIT II FIBERS AND MATRIX MATERIALS

9

Fibers – Fabrication, Structure, properties and applications – Glass fiber, Boron fiber, carbon fiber, organic fiber, ceramic and metallic fibres - whiskers–Fabrication of Matrix materials – polymers, metals and ceramics and their properties – interfaces – Wettability – Types of bonding at the interface – Tests for measuring interfacial strength - Physical and chemical properties.

UNIT III PROCESSING OF POLYMER MATRIX COMPOSITES

9

Thermoset matrix composites: hand layup, spray, filament winding, Pultrusion, resin transfer moulding, autoclave moulding - bag moulding, compression moulding with Bulk Moulding Compound and sheet Moulding Compound – thermoplastic matrix composites – film stacking, diaphragm forming, thermoplastic tape laying, injection moulding – interfaces in PMCs - structure, properties and application of PMCs – recycling of PMCs.

UNIT IV PROCESSING OF METAL MATRIX COMPOSITES

9

Metallic matrices: aluminium, titanium, magnesium, copper alloys – processing of MMCs: liquid state, Solid state, in situ fabrication techniques – diffusion bonding – powder metallurgy techniques- interfaces in MMCs – mechanical properties – machining of MMCs – Applications.

UNIT V PROCESSING OF CERAMIC MATRIX COMPOSITES AND

CARBON-CARBON COMPOSITES

9

Processing of CMCs: cold pressing, sintering, reaction bonding, liquid infiltration, lanxide process – in situ chemical reaction techniques: chemical vapour deposition, chemical vapour impregnation, sol-gel – interfaces in CMCs – mechanical properties and applications of CMCs – Carbon-carbon Composites – applications.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course the students are expected

- To study matrix material, reinforcements of polymer matrix composites, MMC and ceramic matrix composites.
- To develop knowledge on processing, interfacial properties and application of composites.
- To have ability to develop new fibre or reinforcement materials
- To differentiate between the composites used in room temperature and High temperature applications

REFERENCES:

1. ASM Handbook – Composites, Vol-21, 2001, ISBN: 978-0-87170-703-1.
2. Harold Belofsky, Plastics, Product Design and Process Engineering, Hanser Publishers, 2002.
3. Jamal Y. Sheikh-Ahmad, Machining of Polymer Composites, Springer, USA, 2009. ISBN: 978-0-387-35539-9.
4. Krishnan K Chawla, Composite Materials: Science and Engineering, International Edition, Springer, 2012, ISBN:978-0-387-74364-6.
5. Mallick P.K., Fiber Reinforced Composites: Materials, Manufacturing and Design, CRC press, New Delhi, 2010, ISBN:0849342058.
6. Mallick, P.K. and Newman.S., Composite Materials Technology, Hanser Publishers, 2003.
7. Said Jahanmir, Ramulu M. and Philp Koshy, Machining of Ceramics and Composites, Marcel Dekker Inc., New York, 1999, ISBN: 0-8247-0178-x.
8. Seamour, E.B. Modern Plastics Technology, Prentice Hall, 2002

CO-PO Mapping

CO	PO					
	1	2	3	4	5	6
1	1	-	-	3	-	1
2	-	-	1	2	-	-
3	-	-	3	-	2	-
4	1	-	-	-	2	-
5	-	-	1	3	-	1
Avg.	1	-	1.66	2.66	2	1

MF4092

NON-DESTRUCTIVE TESTING

L T P C

3 0 0 3

OBJECTIVES:

- (1) To stress the importance of NDT in Engineering.
- (2) To select the appropriate NDT Technique
- (3) To familiarize with different NDT Technique
- (4) To impart various knowledge to check the weld quality of various structures, pressure vessels
- (5) Compare the merits of various NDT Techniques

UNIT I NON-DESTRUCTIVE TESTING: AN INTRODUCTION, VISUAL INSPECTION & LIQUID PENETRANT TESTING

9

Introduction to various non-destructive methods, Comparison of Destructive and Non-destructive Tests, Visual Inspection, Optical aids used for visual inspection, Applications.

Physical principles, procedure for penetrant testing, Penetrant testing materials, Penetrant testing methods- water washable, Post – Emulsification methods, Applications

UNIT II EDDY CURRENT TESTING & ACOUSTIC EMISSION 9

Principles, Instrumentation for ECT, Absolute, differential probes, Techniques – High sensitivity techniques, Multi frequency, Phased array ECT, Applications.

Principle of AET, Instrumentation, Applications - testing of metal pressure vessels, Fatigue crack detection in aerospace structures.

UNIT III MAGNETIC PARTICLE TESTING & THERMOGRAPHY 9

Principle of MPT, procedure used for testing a component, Equipment used for MPT, Magnetizing techniques, Applications.

Principle of Thermography, Infrared Radiometry, Active thermography measurements, Applications – Imaging entrapped water under an epoxy coating, Detection of carbon fiber contaminants.

UNIT IV ULTRASONIC TESTING 9

Principle, Ultrasonic transducers, Ultrasonic Flaw detection Equipment, Modes of display A- scan, B-Scan, C-Scan, Applications, Inspection Methods - Normal Incident Pulse-Echo Inspection, Normal Incident Through-transmission Testing, Angle Beam Pulse-Echo testing, TOFD Technique, Applications of Normal Beam Inspection in detecting fatigue cracks, Inclusions, Slag, Porosity and Intergranular cracks - Codes, standards, specification and procedures and case studies in ultrasonics test.

UNIT V RADIOGRAPHY 9

Principle of Radiography, x-ray and gamma ray sources- safety procedures and standards, Effect of radiation on Film, Radiographic imaging, Inspection Techniques – Single wall single image, Double wall Penetration, Multiwall Penetration technique, Real Time Radiography - Codes, standards, specification and procedures and case studies in Radiography test.

Case studies on defects in cast, rolled, extruded, welded and heat-treated components - Comparison and selection of various NDT techniques

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course the students

- (1) Realize the importance of various NDT Techniques
- (2) Are expected to have hands on experience on all types of NDT techniques
- (3) Will choose appropriate technique for testing
- (4) Will Compare the merits of various NDT Techniques
- (5) Characterize the flaws and defects and provide solutions

REFERENCES:

1. Baldev Raj, Jeyakumar,T., Thavasimuthu,M., “Practical Non Destructive Testing” Narosa publishing house, New Delhi, 2002
2. Krautkramer. J., “Ultra Sonic Testing of Materials”, 1st Edition, Springer – Verlag Publication, New York, 1996.
3. Peter J. Shull “Non-Destructive Evaluation: Theory, Techniques and Application” Marcel Dekker, Inc., New York, 2002
4. www.ndt.net

CO-PO Mapping

CO	PO					
	1	2	3	4	5	6

1	1	-	-	-	-	-
2	-	-	3	-	-	1
3	-	-	-	2	-	-
4	-	-	-	-	1	-
5	1	-	-	2	-	1
Avg.	1	-	3	2	1	1

MF4007

LEAN MANUFACTURING

L T P C
3 0 0 3

OBJECTIVE:

- (1) To implement lean manufacturing concepts in the factories.
- (2) Understand the distinction between mass and lean production and to be able to assess the difference in a manufacturing environment
- (3) Understand the various elements of Lean systems
- (4) Learn the importance of JIT
- (5) Understand the various Inspection systems and effectively plan for a Lean system

UNIT I INTRODUCTION:

9

The mass production system – Origin of lean production system – Necessity – Lean revolution in Toyota – Systems and systems thinking – Basic image of lean production – Customer focus – Muda (waste).

UNIT II STABILITY OF LEAN SYSTEM:

9

Standards in the lean system – 5S system – Total Productive Maintenance – standardized work – Elements of standardized work – Charts to define standardized work – Man power reduction – Overall efficiency – standardized work and Kaizen – Common layouts.

UNIT III JUST IN TIME

9

Principles of JIT – JIT system – Kanban – Kanban rules – Expanded role of conveyance – Production levelling – Pull systems – Value stream mapping.

UNIT IV JIDOKA (AUTOMATION WITH A HUMAN TOUCH

9

Jidoka concept – Poka-Yoke (mistake proofing) systems – Inspection systems and zone control – Types and use of Poka-Yoke systems – Implementation of Jidoka.

UNIT V WORKER INVOLVEMENT AND SYSTEMATIC PLANNING METHODOLOGY

9

Involvement – Activities to support involvement – Quality circle activity – Kaizen training - Suggestion Programmes – Hoshin Planning System (systematic planning methodology) – Phases of Hoshin Planning – Lean culture

TOTAL: 45 PERIODS

OUTCOMES:

The student will be competent

- (1) To know the necessity for a Lean Manufacturing system
- (2) To Differentiate between the conventional Mass production system with Lean system
- (3) In effectively implement the principles of JIT
- (4) To apply the Inspection tools effectively in the Lean systems
- (5) To apply Hoshin planning system to create a Lean culture in Industry

REFERENCES

1. Dennis P., "Lean Production Simplified: A Plain-Language Guide to the World's Most Powerful Production System", (Second edition), Productivity Press, New York, 2007.
2. Liker, J., "The Toyota Way: Fourteen Management Principles from the World's Greatest Manufacturer", McGraw Hill, 2004.
3. Michael, L.G., "Lean Six SIGMA: Combining Six SIGMA Quality with Lean Production Speed", McGraw Hill, 2002.
4. Ohno, T., "Toyota Production System: Beyond Large-Scale Production", Taylor & Francis, Inc., 1988.
5. Rother, M., and Shook, J., "Learning to See: Value Stream Mapping to Add Value and Eliminate MUDA", Lean Enterprise Institute, 1999.

CO-PO Mapping

CO	PO					
	1	2	3	4	5	6
1	1	-	-	-	-	-
2	-	1	3	-	1	-
3	-	-	3	-	-	-
4	1	-	-	2	-	1
5	1	2	-	-	2	2
Avg.	1	1.5	3	2	1.5	1.5

MF4008

ROBOT DESIGN AND PROGRAMMING

L T P C
3 0 0 3

OBJECTIVES:

- (1) To impart knowledge about different types of robots and configuration
- (2) To gain fundamental knowledge on robot manipulators.
- (3) To provide a brief knowledge on geometry, kinematics, dynamics, motion planning and control
- (4) To impart knowledge in Robot designing and programming
- (5) To familiarize with sensors and actuators used in robots

UNIT I INTRODUCTION

9

Definition, Need Application, Types of robots – Classifications – Configuration, work volume, control loops, controls and intelligence, specifications of robot, degrees of freedoms, end effectors – types, selection applications.

UNIT III ROBOT KINEMATICS

9

Introduction – Matrix representation Homogeneous transformation, forward and inverse – Kinematic equations, Denvit – Hartenbers representations – Inverse Kinematic relations. Fundamental problems with D-H representation, differential motion and velocity of frames – Jacobian, Differential Charges between frames:

UNIT III ROBOT DYNAMICS AND TRAJECTORY PLANNING

9

Lagrangeon mechanics, dynamic equations for sing, double and multiple DOF robots – static force analysis of robots, Trajectory planning – joint space, Cartesian space description and trajectory planning – third order, fifth order - Polynomial trajectory planning, Machine Vision

UNIT IV ROBOT PROGRAMMING & AI TECHNIQUES 9
 Types of Programming – Teach Pendant programming – Basic concepts in A1 techniques – Concept of knowledge representations – Expert system and its components.

UNIT V ROBOT SENSORS AND ACTUATORS 9
 Design of Robots – characteristics of actuating systems, comparison, microprocessors control of electric motors, magnetostrictive actuators, shape memory type metals, sensors, position, velocity, force, temperature, pressure sensors – Contact and non-contact sensors, infrared sensors, RCC, vision sensors.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course the students are expected

- (1) Classify and configure robots
- (2) Apply the kinematic arrangement of robots and its applications in the area of manufacturing sectors
- (3) To select sensors for different application
- (4) To build a robot for any type of application
- (5) To develop and Expert system

REFERENCES:

1. Gordon Mair, 'Industrial Robotics', Prentice Hall (U.K.) 1988
2. Groover.M.P. Industrial Robotics, McGraw – Hill International edition, 1996.
3. Saeed.B. Niku, 'Introduction to Robotics, Analysis, system, Applications', Pearson educations, 2002
4. Wesley E Snyder R, 'Industrial Robots, Computer Interfacing and Control', Prentice Hall International Edition, 1988.

CO-PO Mapping

CO	PO					
	1	2	3	4	5	6
1	1	-	2	-	-	-
2	-	-	-	3	3	-
3	-	-	3	2	-	-
4	1	-	-	2	-	-
5	1	-	2	-	-	2
Avg	1	-	2.33	2.33	3	1

MF4009

MEMS AND NANOTECHNOLOGY

L T P C

3 0 0 3

OBJECTIVES:

- (1) To inspire the students to expect to the trends in manufacturing of micro components
- (2) Familiarise the students with various fabrication techniques for micro components.
- (3) Acquaint them with various sensors and actuators
- (4) Introduce them the various methods of developing nano materials
- (5) Make them understand characterization tools

UNIT I OVER VIEW OF MEMS AND MICROSYSTEMS 9
 Definition – historical development – properties, design and fabrication micro-system, microelectronics, working principle, applications and advantages of micro system. Substrates and wafers, silicon as substrate material, mechanical properties of Si, Silicon Compounds - silicon piezo resistors, Gallium arsenide, quartz, polymers for MEMS, conductive polymers.

UNIT II FABRICATION PROCESSES AND MICRO SYSTEM PACKAGING 9

Photolithography, photo resist applications, light sources, ion implantation, diffusion–Oxidation - thermal oxidation, silicon dioxide, chemical vapour deposition, sputtering - deposition by epitaxy – etching – bulk and surface machining – LIGA process – LASER, Electron beam, Ion beam processes – Mask less lithography. Micro system packaging –packaging design– levels of micro system packaging -die level, device level and system level – interfaces in packaging – packaging technologies- Assembly of Microsystems

UNIT III MICRO DEVICES 9

Sensors – classification – signal conversion ideal characterization of sensors micro actuators, mechanical sensors – measurands - displacement sensors, pressure sensor, flow sensors, Accelerometer, chemical and bio sensor - sensitivity, reliability and response of micro-sensor - micro actuators – applications.

UNIT IV SCIENCE AND SYNTHESIS OF NANO MATERIALS 9

Classification of nano structures – Effects of nano scale dimensions on various properties – structural, thermal, chemical, magnetic, optical and electronic properties fluid dynamics –Effect of nano scale dimensions on mechanical properties - vibration, bending, fracture
Nanoparticles, Sol-Gel Synthesis, Inert Gas Condensation, High energy Ball Milling, Plasma Synthesis, Electro deposition and other techniques. Synthesis of Carbon nanotubes – Solid carbon source-based production techniques – Gaseous carbon source-based production techniques – Diamond like carbon coating. Top down and bottom up processes.

UNIT V CHARACTERIZATION OF NANO MATERIALS 9

Nano-processing systems – Nano measuring systems – characterization – analytical imaging techniques – microscopy techniques, electron microscopy scanning electron microscopy, confocal LASER scanning microscopy - transmission electron microscopy, transmission electron microscopy, scanning tunnelling microscopy, atomic force microscopy, diffraction techniques – spectroscopy techniques – Raman spectroscopy, 3D surface analysis – Mechanical, Magnetic and thermal properties – Nano positioning systems.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course the students are expected

- (1) Realise the need of micro electromechanical systems.
- (2) Develop a knowledge to select a sensor for an application
- (3) Develop a nano material
- (4) characterize the Nano material
- (5) Develop an Electromechanical systems

REFERENCES:

1. Charles P Poole, Frank J Owens, Introduction to Nano technology, John Wiley and Sons, 2003
2. Julian W. Hardner Micro Sensors, Principles and Applications, CRC Press 1993.
3. Mark Madou , Fundamentals of Microfabrication, CRC Press, New York, 1997.
4. Mohamed Gad-el-Hak, MEMS Handbook, CRC press, 2006, ISBN : 8493-9138-5
5. Norio Taniguchi, Nano Technology, Oxford University Press, New York, 2003
6. Sami Franssila, Introduction to Micro fabrication, John Wiley & sons Ltd, 2004. ISBN:470-85106-6
7. Tai – Ran Hsu, MEMS and Microsystems Design and Manufacture, Tata-McGraw Hill, New Delhi, 2002.
8. Waqar Ahmed and Mark J. Jackson, Emerging Nanotechnologies for Manufacturing, Elsevier Inc.,2013,ISBN : 978-93-82291-39-8

CO	PO					
	1	2	3	4	5	6
1	1	-	-	2	-	1
2	1	-	-	2	2	-
3	-	-	3	2	-	-
4	-	-	3	2	-	-

5	-	-	-	2	2	2
Avg	1	-	3	2	2	1.5

CM4091 GREEN MANUFACTURING **L T P C**
3 0 0 3

COURSE OBJECTIVES

1. To expose the students to the basics of environmental sustainability and impact assessment objectives.
2. To incorporate knowledge about the environmental based improvements towards lean manufacturing systems.
3. To analyze various machineries with intent to conserve energy
4. To analyze hazardous and solid wastes with intent to point out areas of adverse environmental impact and how this impact could be minimized or prevented.
5. To impart the knowledge about the need, procedure and benefits of Green-Co rating.

UNIT – I ENVIRONMENTAL SUSTAINABILITY AND IMPACT ASSESSMENT 9
Environmental impact assessment objectives – Legislative development – European community directive – Hungarian directive. Strategic environmental assessment and sustainability appraisal. Regional spatial planning and environmental policy.

UNIT – II LEAN MANUFACTURING AND GREEN ENERGY SYSTEM 9
Conventional Manufacturing versus Lean Manufacturing – Principles of Lean Manufacturing. World energy consumption – Greenhouse effect, Global warming. Energy conservation and measurement principles with their applicability in engineering and process industries.

UNIT – III ENERGY SAVING MACHINERY AND COMPONENTS 9
Electricity Billing: Components and Costs – kVA – Need and Control – Determination of kVA demand and Consumption. Selection of fans, pumps and Compressors – Performance Evaluation – Cause for inefficient operation – scope for energy conservation.

UNIT – IV HAZARDOUS AND SOLID WASTE MANAGEMENT 9
Hazardous waste: definition, terminology, classification and Sources – Need for hazardous waste management: Need, Handling, methods of collection, storage and transport with suitable examples. Solid waste management: Need, Waste prevention and Life cycle assessment. Collection, storage, reuse and recycling of solid waste with suitable examples.

UNIT – V GREEN CO-RATING 9
Ecological Footprint - Need for Green Co-Rating – Green Co-Rating System – Intent – System Approach – Weightage- Assessment Process – Types of Rating – Green Co-Benefits – Case Studies of Green Co-Rating.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

CO1: Understand the Concepts of environmental sustainability and environmental impact assessment objectives

CO2: Apply suitable schemes towards design of green manufacturing requirements.

CO3: Analyze manufacturing processes towards conservation of energy.

CO4: Analyze manufacturing processes towards minimization or prevention of hazardous and solid wastes.

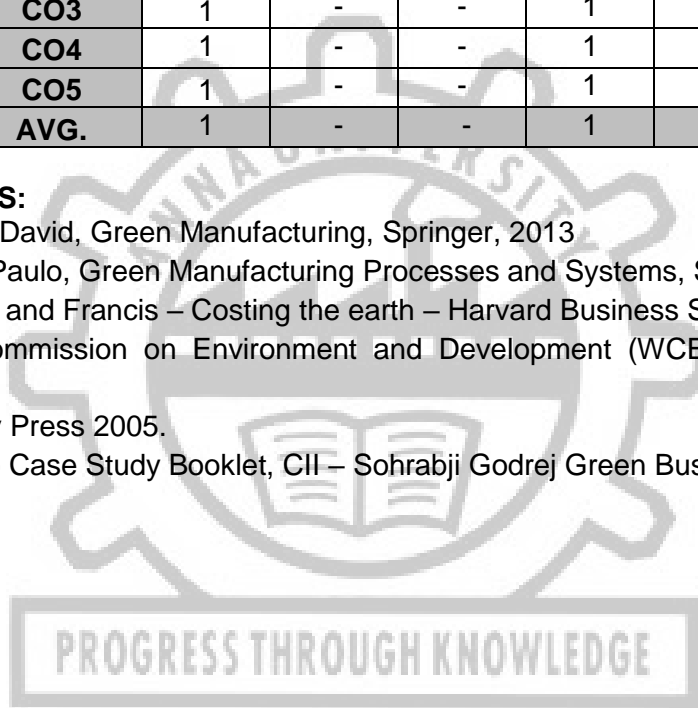
CO5: Acquire Knowledge of green co-rating and its benefits are well known to the students.

CO-PO MAPPING:

Course Outcomes	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	-	-	1	1	1
CO2	1	-	-	1	1	1
CO3	1	-	-	1	1	1
CO4	1	-	-	1	1	1
CO5	1	-	-	1	1	1
AVG.	1	-	-	1	1	1

REFERENCES:

1. Dornfield David, Green Manufacturing, Springer, 2013
2. Davim J Paulo, Green Manufacturing Processes and Systems, Springer, 2013
3. Cairncross and Francis – Costing the earth – Harvard Business School Press – 2009
4. World Commission on Environment and Development (WCED), Our Common Future, Oxford University Press 2005.
5. University Press 2005.
6. Green Co Case Study Booklet, CII – Sohrabji Godrej Green Business Centre, 2015

**MF4010****COMPUTER AIDED PRODUCT DESIGN****L T P C**
3 0 0 3**OBJECTIVES:**

- (1) To Learn the basic concepts of Designing and Drafting.
- (2) To Learn the computer aided modelling and various concepts of product design.
- (3) Integrating CAE, CAD, CAM tools in product design and assess the quality and performance of products.
- (4) To learn reliability and Maintainability concepts.
- (5) To learn the failure analysis tools for improvement

UNIT I**INTRODUCTION****9**

Introduction to Engineering Design – Various phases of systematic design – sequential engineering and concurrent engineering – Computer hardware & Peripherals – software packages for design and drafting.

UNIT II COMPUTER GRAPHICS FUNDAMENTALS AND GEOMETRIC MODEL 9

Computer graphics – applications – principals of interactive computer graphics – 2D 3D transformations – projections – curves - Geometric Modelling – types – Wire frame surface and solid modeling – Boundary Representation, constructive solid geometry – Graphics standards – assembly modeling – use of software packages

UNIT III PRODUCT DESIGN CONCEPTS AND PRODUCT DATA MANAGEMENT 9

Understanding customer needs – Product function modelling – Function trees and function structures – Product tear down methods – Bench marking – Product portfolio – concept generation and selection – Product Data Management – concepts – Collaborative product design– manufacturing planning factor – Customization factor – Product life cycle management.

UNIT IV PRODUCT DESIGN TOOLS & TECHNIQUES 9

Product modeling – types of product models; product development process tools – TRIZ – Altshuller’s inventive principles – Modeling of product metrics – Design for reliability – design for manufacturability – machining, casting, and metal forming – design for assembly and disassembly - Design for environment

UNIT V PRODUCT DESIGN TECHNIQUES 9

FMEA – QFD – Poka Yoke - DOE – Taguchi method of DOE – Quality loss functions – Design for product life cycle.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course the students are expected

- (1) To model a product using CAD software.
- (2) Assess the data for the need for a new product
- (3) To apply the various design concepts and design tools and techniques while designing a product.
- (4) To know the challenges in the product development
- (5) To apply the failure analysis in the product design

REFERENCES:

1. Biren Prasad, “Concurrent Engineering Fundamentals Vol.11”, Prentice Hall, 1997.
2. David F.Rogers.J, Alan Adams, “Mathematical Elements for Computer Graphics”, McGraw Hill, 1990
3. Ibrahim Zeid, “CAD/CAM theory and Practice”, Tata McGraw Hill, 1991.
4. James G.Bralla, “Handbook of Product Design for Manufacturing”, McGraw Hill, 1994
5. Kevin Otto, Kristin Wood, “Product Design”, Pearson Education, 2000

CO-PO Mapping

CO	PO					
	1	2	3	4	5	6
1	1	-	-	-	-	-
2	-	1	-	3	2	1
3	-	-	3	2	2	1
4	-	-	-	2	-	-
5	1	1	-	2	-	2
Avg.	1	1	3	2.25	2	1.33

OBJECTIVES:

- (1) To introduce the process planning concepts and its necessity
- (2) Economical planning of tools and equipment requirement
- (3) Differentiate between cost accounting and cost estimation
- (4) Cost Estimation and analysis
- (4) To estimate time for various machining operations

UNIT I INTRODUCTION TO PROCESS PLANNING**9**

Introduction- methods of process planning-Drawing Interpretation-Material evaluation – steps in process selection, Production equipment and tooling selection

UNIT II PROCESS PLANNING ACTIVITIES**9**

Process parameters calculation for various production processes-Selection jigs and fixtures election of quality assurance methods – Set of documents for process planning-Economics of process planning- case studies

UNIT III INTRODUCTION TO COST ESTIMATION**9**

Importance of costing and estimation –methods of costing-elements of cost estimation –Types of estimates – Estimating procedure- Estimation labor cost, material cost- allocation of overhead charges- Calculation of depreciation cost

UNIT IV PRODUCTION COST ESTIMATION**9**

Estimation of Different Types of Jobs – Estimation of Forging Shop, Estimation of Welding Shop, Estimation of Foundry Shop

UNIT V MACHINING TIME CALCULATION**9**

Estimation of Machining Time – Importance of Machine Time Calculation- Calculation of Machining Time for Different Lathe Operations, Drilling and Boring – Machining Time Calculation for Milling, Shaping and Planning -Machining Time Calculation for Grinding

TOTAL: 45 PERIODS

OUTCOMES:

- (1) Explain the concept of selection and steps in process planning, tooling, equipment selection and material evaluation
- (2) Calculate process parameters and select Jig, Fixtures and quality assurance methods
- (3) Apply the methods of costing and to explain the concept of estimation.
- (4) Compute the cost of the product in various shops of production.
- (5) Calculate the machining time for various operation

REFERENCES:

1. Chitale A.V. and Gupta R.C., "Product Design and Manufacturing", 2nd Edition, PHI, 2002.
2. Ostwalal P.F. and Munez J., "Manufacturing Processes and systems", 9th Edition, John Wiley, 1998.
3. Peter scalon, "Process planning, Design/Manufacture Interface", Elsevier science technology Books, Dec 2002.
4. Russell R.S and Tailor B.W, "Operations Management", 4th Edition, PHI, 2003.

CO-PO Mapping

CO	PO					
	1	2	3	4	5	6
1	1	-	2	-	-	1
2	2	-	-	3	-	2
3	-	1	2	-	-	-
4	1	-	3	2	1	2
5	1	1	-	3	-	3
Avg.	1.66	1	2.33	2.66	1	2

MF4091**MANUFACTURING MANAGEMENT**

L	T	P	C
3	0	0	3

OBJECTIVES

1. Students will be able to study the concepts in facility planning.
2. Students will be able to study types of plant layout and capacity planning methods.
3. Students will be able to study the concepts of Project management.
4. Students will be able to study the concepts and methods in production planning and control.
5. Students will be able to study the concepts in Inventory and maintenance management.

UNIT-I FACILITY PLANNING**9**

Facility planning – Factors affecting selection of plant location, Factor rating analysis: Break – even analysis, Load distance model, closeness ratings – case study

UNIT-II CAPACITY & LAYOUT PLANNING**9**

Types of plant layout, criteria for good layout, Process layout, Assembly line balancing. Computer based solutions to layout problems such as CRAFT, ALDEP, CORELAP and PREP. Capacity planning – Analysis of designed capacity, installed capacity, commissioned capacity, utilized capacity, factors affecting productivity and capacity expansion strategies.

UNIT-III PROJECT MANAGEMENT**9**

Demand forecasting – Quantitative and qualitative techniques, measurement of forecasting errors, Project management – its role in functional areas of management, network representation of a project, CPM and PERT techniques – case study

UNIT-IV PRODUCTION PLANNING & CONTROL 9

Aggregate production planning, production planning strategies, Disaggregating the aggregate plan, Materials Requirement Planning (MRP), MRP-II, Supply chain management, Operation scheduling, prioritization.

UNIT-V INVENTORY AND MAINTENANCE MANAGEMENT 9

Introduction to EOQ models, Inventory control techniques – ABC, FSN, VED etc. Types of inventory control – Perpetual, two-bin and periodic inventory system – JIT, SMED, Kanban, Zero inventory, Maintenance strategies and planning, Maintenance economics: quantitative analysis, optimal number of machines, Replacement strategies and policies – economic service life, opportunity cost, replacement analysis using specific time period.

TOTAL =45 PERIODS

COURSE OUTCOMES:

On Completion of the course the student will be able to

1. Able to acquire knowledge on facility, and problems associated with it.
2. Ability to learn the various capacity and layout planning models
3. Understand the concepts of demand forecasting and project management with relevant case studies.
4. Able to understand the concepts of production planning and scheduling.
5. Understand the various inventory and maintenance management techniques.

	PO					
	1	2	3	4	5	6
CO1	2	1			1	
CO2	2	1			1	
CO3	2	1			1	
CO4	2	1				
CO5	2	1				
Avg	(10/5)=2	(5/5)=1			(3/3)=1	

REFERENCES:

1. Chary, SN, "Production and Operations Management", 4th Edition, SIE, TMH, 2009.
2. Chase. RB, N. J. Aquilano, & F. R. Jacobs, "Operations Management – For Competitive Advantage", 11th Edition, SIE, TMH, 2007.
3. James. B. Dilworth, "Operations Management – Design, Planning and Control for Manufacturing and Services", McGraw Hill Inc. Management Series, 1992.
4. KanishkaBedi, "Production and Operations Management", 2 nd Edition, Oxford Higher Education, 2007
5. Lee. J. Krajewski, L. P. Ritzman, & M. K. Malhotra, "Operations Management – Process and Value Chains", 8th Edition, PHI/Pearson Education, 2007.
6. MelnykDenzler, "Operations Management – A Value Driven Approach", Irwin McGraw Hill 1996.
7. Pannererselvam, R "Production and Operations Management", 3rd Edition, PHI, 2012.

MF4012

NANOTECHNOLOGY

3 0 0 3

L T P C

OBJECTIVES:

The course is aimed to

- (1) Offer an overview on properties of Nanomaterials in their design and fabrication.
- (2) Inculcate insight of the nano defects and doping effects of Nanomaterials in their design fabrication.
- (3) Educate them on various nano structuring processes and recent trends
- (4) Provide them with knowledge of nanostructure classification and various synthetic approaches.
- (5) Make them understand various Nanomaterial characterization techniques

UNIT I OVER VIEW OF NANOTECHNOLOGY

9

Definition – historical development – properties, design and fabrication Nanosystems, working principle ,applications and advantages of nano system. Nanomaterials – ordered oxides – Nano arrays – potential health effects

UNIT II NANODEFECTS, NANO PARTICLES AND NANOLAYERS

9

Nano defects in crystals – applications – Nuclear Track nano defects. Fabrication of nano particles – LASER ablation – sol gels – precipitation of quantum dots. Nano layers – PVD, CVD, Epitaxy and ion implantation – formation of Silicon oxide- chemical composition – doping properties – optical properties

UNIT III NANOSTRUCTURING

9

Nanophotolithography – introduction – techniques – optical – electron beam – ion beam – X-ray and Synchrotron – nanolithography for microelectronic industry – nano-polishing of Diamond – Etching of Nano structures – Nano imprinting technology – Focused ion beams - LASER interference Lithography nanoarrays –Near-Field Optics - case studies and Trends

UNIT IV SCIENCE AND SYNTHESIS OF NANO MATERIALS**9**

Classification of nano structures – Effects of nano scale dimensions on various properties – structural, thermal, chemical, magnetic, optical and electronic properties fluid dynamics –Effect of nano scale dimensions on mechanical properties - vibration, bending, fracture

Nanoparticles, Sol-Gel Synthesis, Inert Gas Condensation, High energy Ball Milling, Plasma Synthesis, Electro deposition and other techniques. Synthesis of Carbon nanotubes – Solid carbon source-based production techniques – Gaseous carbon source-based production techniques – Diamond like carbon coating. Top down and bottom up processes.

UNIT V CHARACTERIZATION OF NANO MATERIALS**9**

Nano-processing systems – Nano measuring systems – characterization – analytical imaging techniques – microscopy techniques, electron microscopy scanning electron microscopy, confocal LASER scanning microscopy - transmission electron microscopy, transmission electron microscopy, scanning tunnelling microscopy, atomic force microscopy, diffraction techniques – spectroscopy techniques – Raman spectroscopy, 3D surface analysis – Mechanical, Magnetic and thermal properties – Nano positioning systems.

TOTAL: 45 PERIODS**OUTCOMES:**

At the end of this course the students are expected

- (1) Obtain the knowledge on Nano systems and its applications.
- (2) Gain the fundamentals of nano defects and properties.
- (3) Acquire knowledge about nano structuring and fabrication techniques
- (4) Apply the concepts and techniques to design various nanomaterial-based devices
- (5) Aware of various morphological techniques and selecting appropriate tools for their future research.

REFERENCES:

1. Charles P Poole, Frank J Owens, Introduction to Nano technology, John Wiley and Sons, 2003
2. Fahrner W.R., Nanotechnology and Nanoelectronics, Springer (India) Private Ltd., 2011.
3. Julian W. Hardner Micro Sensors, Principles and Applications, CRC Press 1993.
4. Mark Madou , Fundamentals of Microfabrication, CRC Press, New York, 1997.
5. Mohamed Gad-el-Hak, MEMS Handbook, CRC press, 2006, ISBN: 8493-9138-5
6. Norio Taniguchi, Nano Technology, Oxford University Press, New York, 2003
7. Sami Franssila, Introduction to Micro fabrication, John Wiley & sons Ltd, 2004. ISBN:470-85106-6
8. Tai – Ran Hsu, MEMS and Microsystems Design and Manufacture, Tata-McGraw Hill, New Delhi, 2002.
9. Waqar Ahmed and Mark J. Jackson, Emerging Nanotechnologies for Manufacturing, Elsevier Inc.,2013, ISBN: 978-93-82291-39-8

CO-PO Mapping

CO	PO					
	1	2	3	4	5	6
1	1	-	-	-	-	1
2	1	-	2	-	-	-
3	2	-	3	2	2	-
4	1	-	-	-	2	1
5	1	1	-	-	3	2
Avg.	1.2	1	2.5	2	2.33	1.33

MF4013 MATERIALS TESTING AND CHARACTERIZATION TECHNIQUES L T P C 3 0 0 3

OBJECTIVE:

- (1) Make them acquainted with microscopic techniques to analyse crystal structures
- (2) Acquire an understanding on the electron microscopic techniques for characterization
- (3) Gain a fundamental on chemical and thermal analysis
- (4) Provide the knowledge on various static methods to characterize materials
- (5) Study the failure of materials under stress

UNIT I MICRO AND CRYSTAL STRUCTURE ANALYSIS 9

Principles of Optical Microscopy – Specimen Preparation Techniques – Polishing and Etching – Polarization Techniques – Quantitative Metallography – Estimation of grain size – ASTM grain size numbers – Microstructure of Engineering Materials - Elements of Crystallography – X- ray Diffraction – Bragg’s law – Techniques of X-ray Crystallography – Debye – Scherer camera – Geiger Diffractometer – analysis of Diffraction patterns – Inter planer spacing – Identification of Crystal Structure, Elements of Electron Diffraction.

UNIT II ELECTRON MICROSCOPY 9

Interaction of Electron Beam with Materials – Transmission Electron Microscopy – Specimen Preparation – Imaging Techniques – BF & DF – SAD – Electron Probe Microanalysis – Scanning Electron Microscopy – Construction & working of SEM – various Imaging Techniques – Applications- Atomic Force Microscopy- Construction & working of AFM - Applications.

UNIT III CHEMICAL AND THERMAL ANALYSIS 9

Basic Principles, Practice and Applications of X-Ray Spectrometry, Wave Dispersive X-Ray Spectrometry, Auger Spectroscopy, Secondary Ion Mass Spectroscopy, Fourier Transform Infra-Red Spectroscopy (FTIR)- Proton Induced X-Ray Emission Spectroscopy, Differential Thermal Analysis, Differential Scanning Calorimetry (DSC) And Thermo Gravimetric Analysis (TGA)

UNIT IV MECHANICAL TESTING – STATIC TESTS 9

Hardness – Brinell, Vickers, Rockwell and Micro Hardness Test – Tensile Test – Stress – Strain plot – Proof Stress – Torsion Test - Ductility Measurement – Impact Test – Charpy & Izod – DWTT - Fracture Toughness Test, Codes and standards for testing metallic and composite materials.

UNIT V MECHANICAL TESTING – DYNAMIC TESTS 9

Fatigue – Low & High Cycle Fatigues – Rotating Beam & Plate Bending HCF tests – S-N curve – LCF tests – Crack Growth studies – Creep Tests – LM parameters – AE Tests-modal analysis - Applications of Dynamic Tests.

TOTAL: 45 PERIODS

OUTCOMES:

- 1) At the end of this course the students are expected
- 2) to be knowledgeable in microstructure evaluation, crystal structure analysis,
- 3) to take images in electron microscopy and process those images,
- 4) to do Chemical Thermal Analysis,
- 5) Analyse the results of static and dynamic mechanical testing.

REFERENCES:

1. ASM Hand book-Materials characterization, Vol – 10, 2004.
2. Culity B.D., Stock S.R& Stock S., Elements of X ray Diffraction, (3rd Edition). Prentice Hall, 2001.
3. Davis J. R., Tensile Testing, 2nd Edition, ASM International, 2004.
4. Davis, H.E., Hauck G. & Troxell G.E., The Testing of engineering Materials, (4th Edition), McGraw Hill, College Divn., 1982.
5. Dieter G.E., Mechanical Metallurgy, (3rd Edition), ISBN: 0070168938, McGraw Hill, 1988.
6. Goldsten,I.J., Dale.E., Echin.N.P.& Joy D.C., Scanning Electron Microscopy & X ray- Micro Analysis, (2nd Edition), ISBN – 0306441756, Plenum Publishing Corp., 2000.
7. Grundy P.J. and Jones G.A., Electron Microscopy in the Study of Materials, Edward Arnold Limited, 1976.
8. Morita.S, Wiesendanger.R, and Meyer.E, “Non-contact Atomic Force Microscopy” Springer, 2002,
9. Newby J., Metals Hand Book- Metallography & Micro Structures, (9th Edition), ASM International, 1989.
10. Suryanarayana A. V. K., Testing of metallic materials, (2nd Edition), BS publications, 2007.

CO-PO Mapping

CO	PO					
	1	2	3	4	5	6
1	-	1	-	-	-	1
2	1	-	3	2	-	-
3	1	-	-	-	2	3
4	1	2	-	-	-	-
5	1	2	3	-	-	1
Avg.	1	1.66	3	2	2	1.66

OBJECTIVES:

- (1) Understand key elements of Mechatronics system, representation into block diagram
- (2) It gives the frame work of knowledge that allows engineers and technicians to develop an interdisciplinary understanding and integrated approach to engineering.
- (3) Understand principles of sensors, its characteristics, interfacing with DAQ microcontroller
- (4) Understand the concept of PLC system and its ladder programming, and significance of PLC systems in industrial application
- (5) Understand the PLC used in home appliances

UNIT I INTRODUCTION**9**

Introduction to Mechatronics-systems – Mechatronics approach to modern engineering and design – Need of Mechatronics – Emerging areas of Mechatronics – Classification of Mechatronics – Mechatronics elements.

UNIT II SENSORS AND TRANSDUCERS**9**

Introduction – Performance Terminology – Potentiometers – Strain gauges – I VDT – Eddy current sensor – Hall effect sensor – Capacitance sensors – Digital transducers – Temperature sensors – Optical sensors – Piezo electric sensor-ultrasonic sensors – Proximity sensors – Signal processing techniques.

UNIT III MICROPROCESSORS AND MICROCONTROLLERS**9**

Introduction – Architectures of 8 – bit microcontrollers (8051) series, PIC Microcontrollers (16f xxx) series – Assembly language programming instruction format, addressing modes, instruction sets, Basic program examples interface of keypads, LEDs, A/D and D/A Converters, RS 232 serial communication interface, classification of memories.

UNIT IV ACTUATORS**9**

Switching Devices, Classification of actuators – Electrical actuators – Solid state relays, solenoids, D.C. motors, Servo motors, Stepper motors – Interfacing with microcontroller through H-bridge Circuits – Piezoelectric actuators.

UNIT V MECHATRONIC SYSTEMS**9**

Design process-stages of design process – Traditional and Mechatronics design concepts – Case studies – Engine management system, Automatic camera, Automatic washing machine, Pick and place robots.

TOTAL: 45 PERIODS

OUTCOMES:

The student will be able to

- (1) Identify the key elements of mechatronics system and its representation in terms of block diagram.
- (2) Understand the concept of signal processing and use of interfacing systems such as ADC, DAC, digital I/O
- (3) Interfacing of Sensors, Actuators using appropriate DAQ micro-controller
- (4) Differentiate between traditional design and Mechatronics design
- (5) Apply the mechatronics concepts in home appliances

REFERENCES:

1. Devadas shetty, Richard A. Kolk, "Mechatronics System Design", PWS Publishing Company, 2001.
2. M.A. Mazidi & J.G. Mazidi, 8051 Micrcontroller and embedded systems, 2002
3. R.K.Rajput.A Text Book of Mechatronics, Chand &Co, 2007
4. W.Bolton, "MICHATRONICS" Pearson Education Limited, 2004

CO-PO Mapping

CO	PO					
	1	2	3	4	5	6
1	1	-	-	2	-	-
2	1	-	3	2	1	-
3	1	-	3	3	-	2
4	1	-	-	2	-	1
5	1	-	-	-	-	3
Avg.	1	-	3	1.75	1	2

MR4071**INTERNET OF THINGS FOR MANUFACTURING**
L T P C
3 0 0 3
COURSE OBJECTIVES:

1. To understand the basics of IoT, Opportunities and challenges in IoT
2. To design a IoT solution
3. To develop an IoT protype
4. To explain the various protocols used in IoT and Localization
5. To examine the applications of IoT in Manufacturing

UNIT I INTRODUCTION**9**

Technology of the IoT and applications,. IoT data management requirements, Architecture of IoT, Security issues Opportunities for IoT -Issues in implementing IoT. Technological challenges, RFID and the Electronic Product Code (EPC) network, the web of things.

UNIT II DESIGN OF IoT**9**

Design challenges in IoT -Standardization, Security and privacy, Infrastructure, Analytics. Design steps for implementing IoT.

UNIT III PROTOTYPING OF IoT**9**

Design principles for connected devices -Embedded devices, physical design, online components, embedded coding system. Informed Manufacturing plant – Elements, IoT implementation in Transportation and logistics, Energy and utilities, Automotive Connected supply chain, Plant floor control automation, remote monitoring, Management of critical assets, Energy management and resource optimization, proactive maintenance.

UNIT IV PREREQUISITES FOR IoT**9**

IOT Technologies Wireless protocols low-power design (Bluetooth Low Energy), range extension techniques (data mining and mesh networking), and data-intensive IoT for continuous recognition applications Data storage and analysis Localization algorithms Localization for mobile systems

UNIT V APPLICATION IN MANUFACTURING**9**

Applications HCI and IoT world - Multilingual interactions Robotics and Autonomous Vehicles Sensing and data processing-Simultaneous mapping and localization-Levels of autonomy, Smart factories, Future research challenges

TOTAL : 45 PERIODS**COURSE OUTCOME:**

On completion of the course, the students will be able to

CO1: Identify the Opportunities and challenges in IoT

CO2: Propose a suitable IoT design

CO3: Develop an optimized IoT prototype

CO4: Understand the various protocols used in IoT and Localization

CO5: Understand the applications of IoT in Manufacturing

REFERENCES:

1. Adrian McEwan and Hakim Cassimally, "Designing the internet of things", Wiley, 2013
2. Code Halos: How the Digital Lives of People, Things, and Organizations are Changing the Rules of Business, by Malcolm Frank, Paul Roehrig and Ben Pring, published by John Wiley & Sons.
3. Internet of Things: A Hands-On Approach by Vijay Madisetti, Arshdeep Bahga, VPT; 1st edition 2014.
4. Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stamatis Karnouskos, Stefan Avesand, David Boyle, "From Machine-to-Machine to the Internet of Things -Introduction to a New Age of Intelligence" Elsevier
5. Meta Products -Building the Internet of Things by Wimer Hazenberg, Menno Huisman, BIS Publishers 2014.

CO	PO					
	1	2	3	4	5	6
1	1		2	1		
2	1		2			3
3	1		2			3
4	1		2			3
5	1		2			3
Avg	(5/5)=1		(10/5)=2	(1/1)=1		(12/4)=3

COURSE OBJECTIVES:

1. Recognize the importance of data analytics
2. Exhibit competence on data analytics packages
3. Apply solution methodologies for industrial problems.

UNIT I INTRODUCTION 9

Introduction to Multivariate Statistics-Degree of Relationship among Variables-Review of Univariate and Bivariate Statistics-Screening Data Prior to Analysis-Missing Data, Outliers, Normality, Linearity, and Homoscedasticity.

UNIT II MULTIPLE REGRESSION 9

Multiple Regression- Linear and Nonlinear techniques- Backward-Forward-Stepwise Hierarchical regression-Testing interactions (2way interaction) - Analysis of Variance and Covariance (ANOVA & ANCOVA) - Multivariate Analysis of Variance and Covariance (MANOVA & MANCOVA).

UNIT III LOGISTIC REGRESSION 9

Regression with binary dependent variable -Simple Discriminant Analysis Multiple Discriminant analysis-Assessing classification accuracy- Conjoint analysis (Full profile method).

UNIT IV PRINCIPAL COMPONENT ANALYSIS 9

Principal Component Analysis -Factor Analysis- Orthogonal and Oblique Rotation-Factor Score Estimation-Multidimensional Scaling-Perceptual Map-Cluster Analysis (Hierarchical Vs Nonhierarchical Clustering).

UNIT V LATENT VARIABLE MODELS 9

Latent Variable Models an Introduction to Factor, Path, and Structural Equation Analysis- Time series data analysis (ARIMA model) – Decision tree analysis (CHAID, CART) - Introduction to Big Data Management.

TOTAL: 45 PERIODS**COURSE OUTCOMES:**

On completion of the course, the student will be able to:

- To recognize the importance of data analytics
- To Exhibit competence on data analytics packages
- To apply solution methodologies for industrial problems.

REFERENCES:

1. Hair, J. F., Black, W. C., Babin, B. J., Anderson, R. E., & Tatham, R. L. "Multivariate data analysis", (7th edition). Pearson India. 2015
2. Tabachnick, B. G., & Fidell, L. S., "Using multivariate statistics", (5th edition). Pearson Prentice Hall, 2001
3. Gujarati, D. N. , "Basic econometrics", Tata McGraw-Hill Education, 2012
4. Malhotra, N. K., " Marketing research: An applied orientation", 5/e. Pearson Education India, 2008
5. Cohen, J., Cohen, P., West, S. G., & Aiken, L. S. " Applied multiple regression/correlation analysis for the behavioral sciences", Routledge., 2013
6. Han, J., Kamber, M., & Pei, J. "Data mining: concepts and techniques: concepts and techniques", Elsevier, 2011.

CO	PO					
	1	2	3	4	5	6
1	1	1	1	1	1	1

2	1	1	1	1	1	1
3	1	1	1	1	1	1
AVG	1	1	1	1	1	1

1-low, 2-medium, 3-high, ‘-‘- no correlation

CM4071

MANUFACTURING SYSTEM SIMULATION

L T P C
3 0 0 3

OBJECTIVES:

- To discuss the importance and advantages of applying simulation and modelling techniques
- To teach various random number generation techniques, its use in simulation
- To explain the applications of random probability distributions in real time environments.
- To train students to solve discrete event problems using software.
- To train students on Simulation models using a simulation software.

UNIT I INTRODUCTION 9

Systems and its types, Types of Modelling, Principles used in Modeling, simulation as a decision making tool, types of simulation, Advantages and disadvantages of simulation, Steps in simulation model building - statistical models in simulation -discrete and continuous system

UNIT II RANDOM NUMBERS 9

Random number generation -Properties of Random Numbers –Generation of Pseudo Random Numbers – Techniques –Tests for Random Numbers

UNIT III RANDOM VARIATES 9

Random variate generation-Inverse Transform Technique –Direct Transform Techniques Convolution Method Acceptance Rejection Technique– Routines for Random Variate Generation, Testing -Analysis of simulation data.

UNIT IV ANALYSIS OF SIMULATION DATA 9

Input modelling-Fitness tests – verification and validation of simulation models – output analysis for a single model, Comparison and evaluation of alternate system design, Optimization using simulation.

UNIT V SIMULATION LANGUAGES AND CASE STUDIES 9

Simulation languages and packages-Case studies in WITNESS; FLEXSIM, ARENA, SIMQUICK- Simulation based optimization-Modelling and Simulation with Petrinets -Case studies in manufacturing and material handling system- Monte Carlo Simulation. Simulation of Single Server Queuing System. Simulation of manufacturing shop Simulation of Inventory System

TOTAL: 45 PERIODS

OUTCOMES

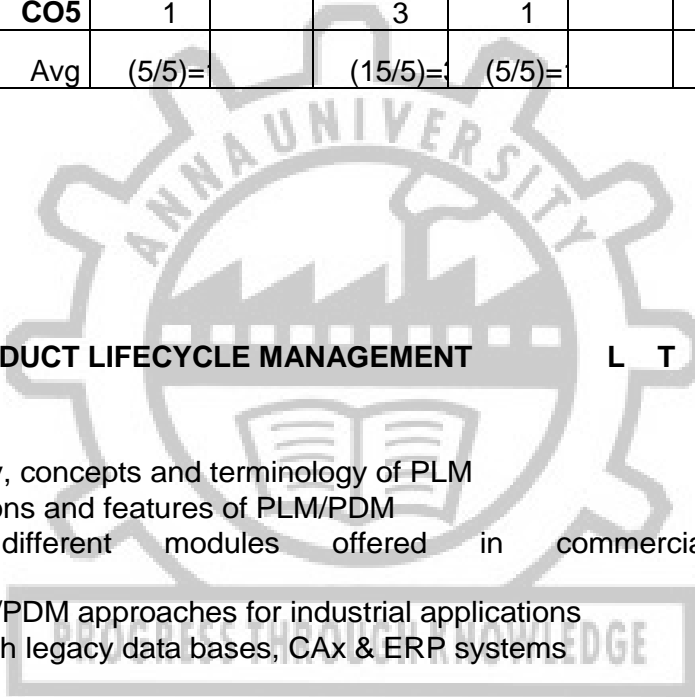
- CO1: Explain the Manufacturing Models of Discrete event systems
CO2: Develop the Uncertainty using Random numbers and Random Variates
CO3: Analyze the verification & validation of Models and Optimization

CO4: Demonstrate the concepts of modeling layers of society's critical infrastructure networks
 CO5: Make use of tools to view and control simulations

REFERENCES

1. Geoffrey Gordon, "System Simulation", 2nd Edition, Prentice Hall, India, 2020.
2. Jerry Banks & John S.Carson, Barry L Nelson, "Discrete event system simulation", Prentice Hall,2000.
3. Law A.M, "Simulation Modelling and Analysis",Fifth edition, Tata Mc Graw Hill,2014.
4. NarsinghDeo, "System Simulation with Digital Computer",Fifth edition, Prentice Hall,2014.
5. Pidd, M, "Computer Simulation in Management Science", Fifth edition,John Wiley & Sons, Inc,2016.

	PO					
	1	2	3	4	5	6
CO1	1		3	1		
CO2	1		3	1		
CO3	1		3	1		
CO4	1		3	1		
CO5	1		3	1		
Avg	(5/5)=		(15/5)=	(5/5)=		



PD4391 PRODUCT LIFECYCLE MANAGEMENT L T P C 3 0 0 3

OBJECTIVES:

1. To understand history, concepts and terminology of PLM
2. To understand functions and features of PLM/PDM
3. To understand different modules offered in commercial PLM/PDM tools
4. To demonstrate PLM/PDM approaches for industrial applications
5. To Use PLM/PDM with legacy data bases, CAx & ERP systems

UNIT I HISTORY, CONCEPTS AND TERMINOLOGY OF PLM 9

Introduction to PLM, Need for PLM, opportunities of PLM, Different views of PLM - Engineering Data Management (EDM), Product Data Management (PDM), Collaborative Product Definition Management (cPDM), Collaborative Product Commerce (CPC), Product Lifecycle Management (PLM).PLM/PDM Infrastructure – Network and Communications, Data Management, Heterogeneous data sources and applications.

UNIT II PLM/PDM FUNCTIONS AND FEATURES 9

User Functions – Data Vault and Document Management, Workflow and Process Management, Product Structure Management, Product Classification and Programme Management. Utility Functions – Communication and Notification, data transport, data translation, image services, system administration and application integration.

UNIT III DETAILS OF MODULES IN APDM/PLM SOFTWARE 9

Case studies based on top few commercial PLM/PDM tools

UNIT IV ROLE OF PLM IN INDUSTRIES**9**

Case studies on PLM selection and implementation (like auto, aero, electronic) - other possible sectors, PLM visioning, PLM strategy, PLM feasibility study, change management for PLM, financial justification of PLM, barriers to PLM implementation, ten step approach to PLM, benefits of PLM for–business, organization, users, product or service, process performance.

UNIT V BASICS ON CUSTOMISATION/INTEGRATION OF PDM/PLM SOFTWARE**9**

PLM Customization, use of EAI technology (Middleware), Integration with legacy data base, CAD, SLM and ERP

TOTAL:45 PERIODS**OUTCOMES:**

The students will be able to

1. Summarize the history, concepts and terminology of PLM
2. Use the functions and features of PLM/PDM
3. Use different modules offered in commercial PLM/PDM tools.
4. Implement PLM/PDM approaches for industrial applications.
5. Integrate PLM/PDM with legacy data bases, CAx& ERP systems.

	PO					
	1	2	3	4	5	6
1	1	2	2	1	-	-
2	2	2	2	1	-	-
3	2	1	2	1	-	-
4	1	1	3	1	-	-
5	1	1	1	1	-	-
Avg	1.4	1.4	2	1	-	-

REFERENCES

1. Antti Saaksvuori and Anselmi Immonen, “Product Lifecycle Management”, Springer Publisher, 2008 (3rd Edition).
2. International Journal of Product Lifecycle Management, Inderscience Publishers
3. Ivica Crnkovic, Ulf Asklund and Annita Persson Dahlqvist, “Implementing and Integrating Product Data Management and Software Configuration Management”, Artech House Publishers, 2003.
4. John Stark, “Global Product: Strategy, Product Lifecycle Management and the Billion Customer Question”, Springer Publisher, 2007.
5. John Stark, “Product Lifecycle Management: 21st Century Paradigm for Product Realisation”, Springer Publisher, 2011 (2nd Edition).
6. Michael Grieves, “Product Life Cycle Management”, Tata McGraw Hill, 2006.

OBJECTIVE:

- (1) Learn to know the necessity for a New Product by analysing the market trend
- (2) Select methodology and process for development
- (3) Generate detailed specifications for the given architecture
- (4) Integrating CAE, CAD, CAM tools in product design and assess the quality and performance of products
- (5) Make a prototype of a problem adhering to design principles to enhance manufacturability

UNIT I PRODUCT DEVELOPMENT AND CONCEPT SELECTION 9

Product development process – Product development organizations- Identifying the customer needs – Establishing the product specifications – concept generation – Concept selection.

UNIT II PRODUCT ARCHITECTURE 9

Product architecture – Implication of the architecture – Establishing the architecture – Related system level design issues.

UNIT III INDUSTRIAL AND MANUFACTURING DESIGN 9

Need for industrial design – Impact of industrial design – Industrial design process. Assessing the quality of industrial design- Human Engineering consideration - Estimate the manufacturing cost – Reduce the component cost – Reduce the assembly cost – Reduce the support cost – Impact of DFM decisions on other factors

UNIT IV PROTOTYPING AND ECONOMIC ANALYSIS 9

Principles of prototyping – Planning for prototypes - Elements of economic analysis – Base case financial model – Sensitivity analysis – Influence of the quantitative factors

UNIT V MANAGING PRODUCT DEVELOPMENT PROJECTS 9

Sequential, parallel and coupled tasks - Baseline project planning – Project Budget Project execution – Project evaluation- patents- patent search-patent laws International code for patents.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course the students are expected to

- (1) Identify the need for a New Product
- (2) design and develop various products
- (3) Work out the cost of developing a product
- (4) Will be able to prototype the product
- (5) Know how to patent the new design or the product

REFERENCES:

1. Charles Gevartz, Developing New products with TQM, McGraw – Hill International editions, 1994
2. Karal .T. Ulrich, Steven D.Eppinger, Product Design and Development, McGRAW- HILL International Editions.2003.
3. S.Rosenthal, Effective product design and development, Irwin 1992.

CO-PO Mapping

CO	PO					
	1	2	3	4	5	6
1	2	-	-	3	-	1
2	1	-	3	1	1	1
3	-	-	-	2	2	1
4	1	-	3	3	2	1
5	1	-	-	-	2	2
Avg.	1.25	-	3	2.25	1.75	1.2

MF4016

ENTREPRENEURSHIP DEVELOPMENT

L T P C
3 0 0 3

OBJECTIVE:

- (1) To develop and strengthen entrepreneurial quality and motivation in students.
- (2) To impart knowledge on the competencies necessary to establish new ventures
- (3) To inculcate strategic thinking, budgeting and ethical behaviour which are vital to enhance entrepreneurial skills
- (4) To establish start-ups and small businesses
- (5) To evaluate the business and monitor

UNIT I ENTREPRENEURIAL COMPETENCE 9

Entrepreneurship concept – Entrepreneurship as a Career – Entrepreneurial Personality - Characteristics of Successful, Entrepreneur – Knowledge and Skills of Entrepreneur.

UNIT II ENTREPRENEURIAL ENVIRONMENT 9

Business Environment - Role of Family and Society - Entrepreneurship Development Training and Other Support Organisational Services - Central and State Government Industrial Policies and Regulations - International Business.

UNIT III BUSINESS PLAN PREPARATION 9

Sources of Product for Business - Prefeasibility Study - Criteria for Selection of Product - Ownership - Capital - Budgeting Project Profile Preparation - Matching Entrepreneur with the Project - Feasibility Report Preparation and Evaluation Criteria.

UNIT IV LAUNCHING OF SMALL BUSINESS 9

Finance and Human Resource Mobilization Operations Planning - Market and Channel Selection - Growth Strategies - Product Launching – Incubation, Venture capital, IT startups.

UNIT V MANAGEMENT OF SMALL BUSINESS 9

Monitoring and Evaluation of Business - Preventing Sickness and Rehabilitation of Business Units- Effective Management of small Business.

TOTAL: 45 PERIODS

COURSE OUTCOME:

Students will

- (1) Gain knowledge and skills needed to run a business.
- (2) Innovate and solve challenges in business
- (3) Determine risks in the trade and respond effectively
- (4) Utilize tools and develop strategies to manage business
- (5) Establish start-ups and Evaluate the business

REFERENCES:

1. Hisrich, Entrepreneurship, Edition 9, Tata McGraw Hill, New Delhi, 2014
2. S.S.Khanka, Entrepreneurial Development, S.Chand and Company Limited, New Delhi, (Revised Edition) 2013.
3. Mathew Manimala, Entrepreneurship Theory at the Crossroads, Paradigms & Praxis, Biztrantra, 2nd Edition ,2005
4. Prasanna Chandra, Projects – Planning, Analysis, Selection, Implementation and Reviews, Tata McGraw-Hill, 1996.
5. P.Saravanavel, Entrepreneurial Development, Ess Pee kay Publishing House, Chennai 1997.
6. Arya Kumar. Entrepreneurship. Pearson, 2012.
7. Donald F Kuratko, T.V Rao. Entrepreneurship: A South Asian perspective. Cengage, 2012

CO-PO Mapping

CO	PO					
	1	2	3	4	5	6
1	1	-	2	1	-	-
2	1	1	-	2	1	1
3	1	-	3	2	-	-
4	-	-	-	2	2	3
5	1	1	-	-	2	2
Avg.	1	1	2.5	1.75	1.66	2

MF4020

INDUSTRIAL SAFETY

L T P C
3 0 0 3

OBJECTIVES:

- (1) To develop and strengthen the safety ideas and motivate the students to impart basic safety skills
- (2) To know about Industrial safety programs, Industrial laws, regulations and source models
- (3) To understand about fire and explosion, preventive methods, relief and its sizing methods
- (4) To assess the safety of human beings from toxic substances
- (5) To analyse industrial hazards and its risk assessment.

UNIT I OPERATIONAL SAFETY

9

Hot metal operation, boiler, pressure vessels – heat treatment shop – gas furnace operation – electroplating – hot bending pipes – safety in welding and cutting, Cold – metal operation – safety in machine shop – cold bending and chamfering of pipes metal cutting – shot blasting, grinding, painting – power press and other machines. Management of toxic gases and chemicals – industrial fires and prevention – road safety – highway and urban safety – safety of sewage disposal and cleaning – control of environmental pollution – managing emergencies in industries – planning security and risk assessments, on – site and off site. Control of major industrial hazards.

UNIT II SAFETY APPRAISAL AND ANALYSIS

9

Human side of safety – personal protective equipment – causes and cost of accidents. Accidents prevention program – specific hazard control strategies – HAZOP training and development of employees – first aid – fire fight devices – accident reporting, investigation. Measurement of safety performance, accident reporting and investigation – plant safety inspection, job safety analysis – safety permit procedures. Product safety – plant safety rules and procedures – safety sampling – safety inventory systems. Determining the cost effectiveness of safety measurement.

UNIT III OCCUPATIONAL HEALTH

9

Concept and spectrum of health functional units and activities of operational health service – occupational and related disease – levels of prevention of diseases – notifiable occupational diseases Toxicology Lead – Nickel, chromium and manganese toxicity – gas poisoning (such as CO, Ammonia Chlorise, So₂, H₂s.) their effects and prevention – effects of ultra violet radiation and infrared radiation on human system.

UNIT IV SAFETY AND HEALTH REGULATIONS

9

Safety and health standards – industrial hygiene – occupational diseases prevention welfare facilities. The object of factories act 1948 with special reference to safety provisions, model rules 123a, history of legislations related to safety – pressure vessel act – Indian boiler act – the environmental protection act – electricity act – explosive act.

UNIT V SAFETY MANAGEMENT

9

Evaluation of modern safety concepts – safety management functions – safety organization, safety department- safety committee, safety audit – performance measurements and motivation – employee participation in safety - safety and productivity.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course the students are

- (1) Expected to gain knowledge and skills needed to run an industry with utmost safety precautions.
- (2) Understand the industrial laws, regulations and source models.
- (3) Apply the methods of prevention of fire and explosions.
- (4) Analyse the effect of release of toxic substances
- (5) Understand the methods of hazard identification and preventive measures.

REFERENCES:

1. John V Grimaldi, Safety Management. AITB publishers, 2003.
2. John.V Grimaldi and Rollin. H Simonds, "Safety Management", All India traveller book seller, New Delhi – 1989.
3. Krishnan N.V, "Safety in Industry", Jaico Publisher House, 1996.
4. Singh, U.K and Dewan, J.M., "Safety, Security And Risk Management", APH publishing company, New Delhi, 1996.

CO-PO Mapping

CO	PO					
	1	2	3	4	5	6
1	1	-	-	2	1	1
2	-	-	3	2	1	-
3	1	1	-	2	2	2
4	1	1	-	2	-	2
5	-	1	-	2	1	2
Avg.	1	1	3	2	1.25	1.75

MF4017

ADVANCES IN MATERIALS

L T P C
3 0 0 3

COURSE OBJECTIVES

- (1) Understand major types of special steels such as HSLA, TRIP, Dual and Tool steels and cast-irons
- (2) To study the polymer behaviour and develop polymer composites
- (3) To study energy conversion materials
- (4) To learn about various materials used for bio implants
- (5) To understand the advantage of materials at Nano scale

UNIT I METALLIC MATERIALS

9

Classification of metallic materials - Ferrous and nonferrous.

Ferrous metals and alloys-Introduction to specifications – types of steels, alloy steels, tool steels; stainless steels, HSLA, TRIP steels, TWIP steels. Shape memory alloys – Intermetallic – Superalloys- Titanium and Magnesium alloys – Bulk metallic glass –high entropy alloys- metamaterials –topological materials

UNIT II POLYMERS AND COMPOSITES

9

Structure of polymers, characterization and applications of polymers: mechanical behavior of polymers, strengthening of polymers, crystallization and glass transition phenomenon and types of polymers.

Composites: Particle reinforced composites, fiber reinforced composites – influence of fiber length, orientation and concentration. Fiber phase, matrix phase, metal matrix composites, polymer matrix composites, ceramic matrix composites, carbon – carbon composites, hybrid composites and structural composites.

UNIT III ENERGY MATERIALS

9

Need for high performance energy materials - carbon nanostructure based energy conversion and storage materials - nanomaterials for solar cell applications - next generation energy storage materials – Li and Ni based batteries, fuel cells.

UNIT IV BIO MATERIALS

9

Introduction to biomaterials; need for biomaterials; Salient properties of important material classes; Property requirement of biomaterials; Metallic implant materials, ceramic implant materials, polymeric implant materials, composites as biomaterials; Orthopedic, dental and other applications.

Biomaterials preparation and characterization; Processing and properties of different bio ceramic materials; Mechanical and physical properties evaluation of biomaterials; New and novel materials for biomedical applications. Design concept of developing new materials for bio-implant applications; Nanomaterials and nanocomposites for medical applications

UNIT V NANO MATERIALS

9

Concept of nano materials – scale / dimensional aspects, Top-down and bottom-up approaches for preparing nano materials Advantages and limitations at the nano level – thermodynamic aspects at the nano level, health and environmental issues.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students would be able to:

- (1) Understand the various ferrous alloys and their applications
- (2) Understand different types of composite materials and polymers
- (3) Understand Solar materials
- (4) Understand the properties of different biomaterials
- (5) Understand the structure and behavior of Nano materials

REFERENCES

- 1. Avner S. H., 'Introduction to Physical Metallurgy', 2nd Edition, McGraw Hill, 1974
- 2. Leslie W. C., 'The Physical Metallurgy of Steels', McGraw Hill, 1982
- 3. Pickering P. B., 'Physical Metallurgy and the Design of Steels', Applied Science Publishers, 1983
- 4. Hench L. Larry, and Jones J., (Editors), Biomaterials, Artificial organs and Tissue Engineering, Woodhead Publishing Limited, 2005.
- 5. Gunter Schmid, "Nanoparticles: From Theory to Applications", Wiley-VCH Verlag GmbH & Co., 2004.
- 6. Brick R. M., Gordon R. B, Phillips A., 'Structure and Properties of Alloys', McGraw Hill, 1965
- 7. Hench L. Larry, & Wilson J., (Editors), An Introduction to Bio ceramics, World Scientific, 1994.
- 8. Charles P. Poole, Jr., Frank J. Owens, "Introduction to nano technology", Wiley, 2003.

CO-PO Mapping

CO	PO					
	1	2	3	4	5	6
1	1	-	-	2	2	-
2	1	-	3	-	-	-
3	1	-	3	-	-	2
4	1	-	-	-	2	1
5	1	-	-	-	2	1
Avg	1	-	3	2	2	1.33

MF4018

ARTIFICIAL INTELLIGENCE

L T P C
3 0 0 3

OBJECTIVES:

The objective of this course is to enable the students to

- (1) Understand the basic concepts of intelligent agents
- (2) Develop general-purpose problem-solving agents, logical reasoning agents, and agents that reason under uncertainty
- (3) To learn to represent knowledge in solving AI problems

- (4) To understand the different ways of designing software agents
- (5) Employ AI techniques to solve some of today's real-world problems.

UNIT I INTELLIGENT AGENTS 9
 Introduction to AI –Agents and Environments –Concept of rationality –Nature of environments
 –Structure of agents Problem solving agents –search algorithms –uninformed search strategies

UNIT II PROBLEM SOLVING 9
 Heuristic search strategies –heuristic functions Local search and optimization problems –local search in continuous space –search with non-deterministic actions –search in partially observable environments
 –online search agents and unknown environments

UNIT III GAME PLAYING AND CSP 9
 Game theory –optimal decisions in games –alpha-beta search –monte-carlo tree search –stochastic games –partially observable games Constraint satisfaction problems –constraint propagation –backtracking search for CSP –local search for CSP –structure of CSP

UNIT IV LOGICAL AGENTS 9
 Knowledge-based agents –propositional logic –propositional theorem proving –propositional model checking –agents based on propositional logic First-order logic –syntax and semantics –knowledge representation and engineering –inferences in first-order logic –forward chaining –backward chaining --resolution

UNIT V KNOWLEDGE REPRESENTATION AND PLANNING 9
 Ontological engineering –categories and objects –events –mental objects and modal logic – reasoning systems for categories –reasoning with default information Classical planning –algorithms for classical planning –heuristics for planning –hierarchical planning –non deterministic domains –time, schedule, and resources --analysis

TOTAL :45 PERIODS

COURSE OUTCOMES:

- On successful completion of this course, the students will be able to
1. Explain autonomous agents that make effective decisions in fully informed, partially observable, and adversarial settings
 2. Choose appropriate algorithms for solving given AI problems
 3. Design and implement logical reasoning agents
 4. Design and implement agents that can reason under uncertainty
 5. Apply AI for real world problems

TEXT BOOKS:

1. S. Russell and P. Norvig, "Artificial Intelligence: A Modern Approach", Prentice Hall, Third Edition, 2009.
2. I. Bratko, —Prolog: Programming for Artificial Intelligence, Fourth edition, Addison-Wesley Educational Publishers Inc., 2011.

REFERENCES

1. M. Tim Jones, —Artificial Intelligence: A Systems Approach (Computer Science) II, Jones and Bartlett Publishers, Inc.; First Edition, 2008
2. Nils J. Nilsson, —The Quest for Artificial Intelligence, Cambridge University Press, 2009.

3. William F. Clocksin and Christopher S. Mellish, II Programming in Prolog: Using the ISO StandardII, Fifth Edition, Springer, 2003.
4. Gerhard Weiss, —Multi Agent SystemsII, Second Edition, MIT Press, 2013.
5. David L. Poole and Alan K. Mackworth, —Artificial Intelligence: Foundations of Computational AgentsII, Cambridge University Press, 2010.

CO-PO Mapping

CO	PO					
	1	2	3	4	5	6
1	1	-	-	2	2	-
2	-	-	-	3	2	-
3	1	-	2	-	-	-
4	-	-	-	3	2	-
5	1	-	-	-	-	2
Avg	1	-	2	2.66	2	2

MF4019

SMART MANUFACTURING

L T P C
3 0 0 3

COURSE OBJECTIVES

- (1) To introduce students to fundamentals of Manufacturing
- (2) To familiarize with selection of sensors for various application
- (3) To learn the basics of agent-based manufacturing
- (4) Understand Cyber physical systems
- (5) Provide brief understanding about industry 4.0 concepts in Manufacturing systems

UNIT I SENSORS SMART MANUFACTURING

9

Introduction – Role of sensors in manufacturing automation – operation principles of different sensors – electrical, optical, acoustic, pneumatic, magnetic, electro-optical and vision sensors. Condition monitoring of manufacturing systems – principles – sensors for monitoring force, vibration and noise, selection of sensors and monitoring techniques. Automatic identification techniques for shop floor control – optical character and machine vision sensors – smart / intelligent sensors – integrated sensors, Robot sensors, Micro sensors, Nano sensors.

UNIT II DATA ANALYTICS

9

Introduction to Data and Analytics in a Digital Context (Internet of Things), Product Data Management for Design and Manufacturing (PLM Tools), Typical data challenges (data quality, enrichment, integration of ERP & PLM data), Preparing data for analytics (techniques to improve data quality, integration - ETL)
Advances in data visualization & related tools-Statistical Techniques for Analytics, Descriptive Statistics Inferential statistics, Regression and ANOVA

UNIT II CYBER PHYSICAL SYSTEMS

9

Concept of Cyber Physical Systems (CPS) and Cyber Physical Production System (CPPS), System Architecture for implementation of CPPS, Components for CPPS, Communication for CPPS

UNIT IV E- MANUFACTURING

9

Introduction of Agent based manufacturing- agent based Manufacturing, Cloud Based Manufacturing Information technology-based Supply chain, Concept of agile manufacturing and E-manufacturing.

UNIT V INDUSTRY 4.0**9**

Evaluation of industries, Introduction to Industry 4.0, Challenges in industry 4.0, Impact of Industry 4.0, Case studies on industry 4.0, Introduction to Internet of Things (IoT) and its applications, Smart supply chain and Case studies.

TOTAL :45 PERIODS**COURSE OUTCOMES**

The students are expected to appreciate:

- (1) Appreciate concepts and basic framework necessary for smart manufacturing
- (2) current trends at system level in manufacturing organizations
- (3) Use of Sensors and Selection of sensors for various applications
- (4) IoT based manufacturing systems
- (5) The importance of industry 4.0 concepts at manufacturing systems

TEXT BOOKS:

1. Bahga and V. Madiseti, Internet of Things, A hands-on approach, Create Space Independent Publishing Platform, 1st edition, 2014, ISBN: 978-0996025515
2. Bahga and V. Madiseti, Cloud Computing, A hands-on approach, Create Space Independent Publishing Platform, 1st edition, 2013, ISBN: 978-1494435141
3. M. Skilton and F. Hovsepian, The 4th Industrial Revolution: Responding to the Impact of Artificial Intelligence on Business, Springer Nature, 2017, ISBN: 978-3-319-62479-2
4. M. P. Grover "Automation, Production Systems and Computer-Integrated Manufacturing" Pearson Education, 4th Edition, 2016, ISBN: 978-0133499612
5. M. P. Groover, Mitchell Weis, Roger, N. Nagel, Nicholas and G. Odrey, Industrial Robotics Technology, Programming and Applications, McGraw Hill, 2nd Edition, 2017 ISBN: 978-1259006210

Reference books:

1. Gilchirst, Industry 4.0: The Industrial Internet of Things, Apress (Springer), 1st Edition, 2016, ISBN: 978-1-4842-2046-7
2. S. Jeschke, C. Brecher, H. Song, and D. B. Rawat, Industrial Internet of Things: Cyber manufacturing Systems, Springer, 1st edition, 2017, ISBN: 978-3319425580
3. T. Erl, Z. Mahmood, and R. Puttini, Cloud Computing: Concepts, Technology & Architecture, Prentice Hall, 1st edition, 2013, ISBN: 978-0133387520.
4. N. Viswanandham, Y. Narhari "Performance Modeling of Automated Manufacturing Systems" Prentice-Hall, 1st Edition, 1994, ISBN: 978-8120308701
5. S. K. Saha, Introduction to Robotics, Tata Mcgraw Hill Education Private Limited, 2nd Edition, ISBN: 978-9332902800

CO-PO Mapping

CO	PO					
	1	2	3	4	5	6
1	1	-	-	-	2	-
2	1	-	-	2	2	-
3	-	-	3	-	2	-
4	-	-	-	3	2	-
5	1	-	3	-	-	2
Avg	1	-	3	2.5	2	2



AUDIT COURSES

AX4091

ENGLISH FOR RESEARCH PAPER WRITING

**L T P C
2 0 0 0**

COURSE OBJECTIVES

- Teach how to improve writing skills and level of readability
- Tell about what to write in each section
- Summarize the skills needed when writing a Title
- Infer the skills needed when writing the Conclusion
- Ensure the quality of paper at very first-time submission

UNIT I

INTRODUCTION TO RESEARCH PAPER WRITING

6

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

UNIT II PRESENTATION SKILLS 6

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction

UNIT III TITLE WRITING SKILLS 6

Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check

UNIT IV RESULT WRITING SKILLS 6

Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions

UNIT V VERIFICATION SKILLS 6

Useful phrases, checking Plagiarism, how to ensure paper is as good as it could possibly be the first-time submission

TOTAL: 30 PERIODS

COURSE OUTCOMES

CO1 – Understand that how to improve your writing skills and level of readability

CO2 – Learn about what to write in each section

CO3 – Understand the skills needed when writing a Title

CO4 – Understand the skills needed when writing the Conclusion

CO5 – Ensure the good quality of paper at very first-time submission

REFERENCES

1. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011
2. Day R How to Write and Publish a Scientific Paper, Cambridge University Press 2006
3. Goldbort R Writing for Science, Yale University Press (available on Google Books) 2006
4. Highman N, Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book 1998.

AX4092

DISASTER MANAGEMENT

**L T P C
2 0 0 0**

COURSE OBJECTIVES

- Summarize basics of disaster
- Explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- Illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- Describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
- Develop the strengths and weaknesses of disaster management approaches

UNIT I INTRODUCTION

6

Disaster: Definition, Factors and Significance; Difference between Hazard And Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

UNIT II REPERCUSSIONS OF DISASTERS AND HAZARDS 6

Economic Damage, Loss of Human and Animal Life, Destruction of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

UNIT III DISASTER PRONE AREAS IN INDIA 6

Study of Seismic Zones; Areas Prone To Floods and Droughts, Landslides And Avalanches; Areas Prone To Cyclonic and Coastal Hazards with Special Reference To Tsunami; Post-Disaster Diseases and Epidemics

UNIT IV DISASTER PREPAREDNESS AND MANAGEMENT 6

Preparedness: Monitoring Of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological And Other Agencies, Media Reports: Governmental and Community Preparedness.

UNIT V RISK ASSESSMENT 6

Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival

TOTAL : 30 PERIODS

COURSE OUTCOMES

- CO1: Ability to summarize basics of disaster
- CO2: Ability to explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- CO3: Ability to illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- CO4: Ability to describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
- CO5: Ability to develop the strengths and weaknesses of disaster management approaches

REFERENCES

1. Goel S. L., Disaster Administration And Management Text And Case Studies”,Deep & Deep Publication Pvt. Ltd., New Delhi,2009.
2. NishithaRai, Singh AK, “Disaster Management in India: Perspectives, issues and strategies “New Royal book Company,2007.
3. Sahni, PardeepEt.Al. ,” Disaster Mitigation Experiences And Reflections”, Prentice Hall OfIndia, New Delhi, 2001.

AX4093

CONSTITUTION OF INDIA

**L T P C
2 0 0 0**

OBJECTIVES

Students will be able to:

- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional Role and entitlement to civil and economic rights as well as the emergence nation hood in the early years of Indian nationalism.
- To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.

UNIT I HISTORY OF MAKING OF THE INDIAN CONSTITUTION

History, Drafting Committee, (Composition & Working)

UNIT II PHILOSOPHY OF THE INDIAN CONSTITUTION

Preamble, Salient Features

UNIT III CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES

Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

UNIT IV ORGANS OF GOVERNANCE

Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.

UNIT V LOCAL ADMINISTRATION

District's Administration head: Role and Importance, □ Municipalities: Introduction, Mayor and role of Elected Representative, CEO, Municipal Corporation. Pachayati raj: Introduction, PRI: Zila Pachayat. Elected officials and their roles, CEO Zila Pachayat: Position and role. Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy.

UNIT VI ELECTION COMMISSION

Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners - Institute and Bodies for the welfare of SC/ST/OBC and women.

PROGRESS THROUGH KNOWLEDGE

TOTAL: 30 PERIODS

OUTCOMES

Students will be able to:

- Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
- Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
- Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
- Discuss the passage of the Hindu Code Bill of 1956.

SUGGESTED READING

- The Constitution of India, 1950 (Bare Act), Government Publication.
- Dr. S.N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.

- M.P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.
- D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

AX4094
P C

நற்றமிழ் இலக்கியம்

L T

2 0

0 0

UNIT I
6

சங்க இலக்கியம்

1. தமிழின் துவக்க நூல் தொல்காப்பியம்
- எழுத்து, சொல், பொருள்
2. அகநானூறு (82)
- இயற்கை இன்னிசை அரங்கம்
3. குறிஞ்சிப் பாட்டின் மலர்க்காட்சி
4. புறநானூறு (95,195)
- போரை நிறுத்திய ஔவையார்

UNIT II
6

அறநெறித் தமிழ்

1. அறநெறி வகுத்த திருவள்ளுவர்
- அறம் வலியுறுத்தல், அன்புடைமை, ஒப்புரவறிதல், ஈகை, புகழ்
2. பிற அறநூல்கள் - இலக்கிய மருந்து
- ஏலாதி, சிறுபஞ்சமூலம், திரிகடுகம், ஆசாரக்கோவை
(தூய்மையை வலியுறுத்தும் நூல்)

UNIT III
6

இரட்டைக் காப்பியங்கள்

1. கண்ணகியின் புரட்சி
- சிலப்பதிகார வழக்குரை காதை
சமூகசேவை இலக்கியம் மணிமேகலை
- சிறைக்கோட்டம் அறக்கோட்டமாகிய காதை

UNIT IV
6

அருள்நெறித் தமிழ்

1. சிறுபாணாற்றுப்படை
- பாரி முல்லைக்குத் தேர் கொடுத்தது, பேகன் மயிலுக்குத்
போர்வை கொடுத்தது, அதியமான் ஔவைக்கு நெல்லிக்கனி
கொடுத்தது, அரசர் பண்புகள்
2. நற்றிணை
- அன்னைக்குரிய புன்னை சிறப்பு
3. திருமந்திரம் (617, 618)

- இயமம் நியமம் விதிகள்
 - 4. தர்மச்சாலையை நிறுவிய வள்ளலார்
 - 5. புறநானூறு
 - சிறுவனே வள்ளலானான்
 - 6. அகநானூறு (4) - வண்டு
 - நற்றிணை (11) - நண்டு
 - கலித்தொகை (11) - யானை, புறா
 - ஐந்திணை 50 (27) - மான்
- ஆகியவை பற்றிய செய்திகள்

UNIT V 6 நவீன தமிழ் இலக்கியம்

1. உரைநடைத் தமிழ்,
 - தமிழின் முதல் புதினம்,
 - தமிழின் முதல் சிறுகதை,
 - கட்டுரை இலக்கியம்,
 - பயண இலக்கியம்,
 - நாடகம்,
2. நாட்டு விடுதலை போராட்டமும் தமிழ் இலக்கியமும்,
3. சமுதாய விடுதலையும் தமிழ் இலக்கியமும்,
4. பெண் விடுதலையும் விளிம்பு நிலையினரின் மேம்பாட்டில் தமிழ் இலக்கியமும்,
5. அறிவியல் தமிழ்,
6. இணையத்தில் தமிழ்,
7. சுற்றுச்சூழல் மேம்பாட்டில் தமிழ் இலக்கியம்.

TOTAL: 30 PERIODS

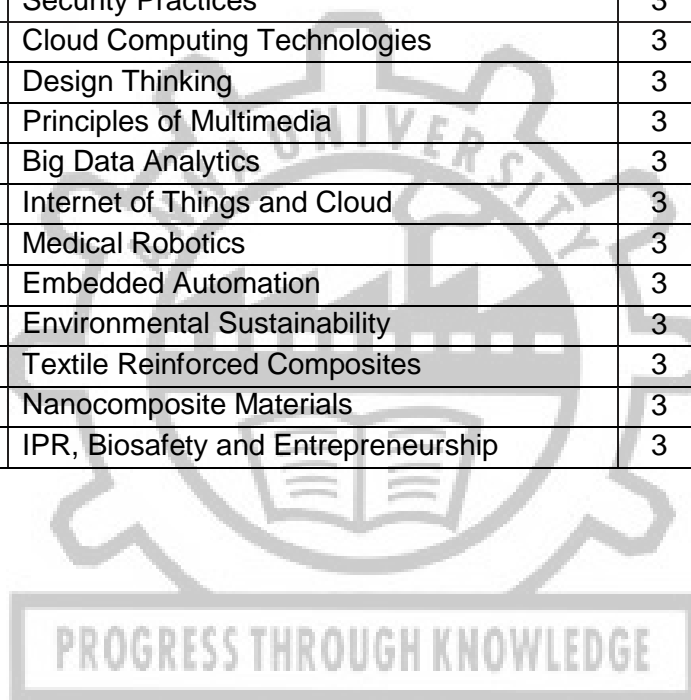
தமிழ் இலக்கிய வெளியீடுகள் / புத்தகங்கள்

1. தமிழ் இணைய கல்விக்கழகம் (Tamil Virtual University) - www.tamilvu.org
2. தமிழ் விக்கிப்பீடியா (Tamil Wikipedia) - <https://ta.wikipedia.org>
3. தர்மபுர ஆதீன வெளியீடு
4. வாழ்வியல் களஞ்சியம் - தமிழ்ப் பல்கலைக்கழகம், தஞ்சாவூர்
5. தமிழ்கலைக் களஞ்சியம் - தமிழ் வளர்ச்சித் துறை (thamilvalarchithurai.com)
6. அறிவியல் களஞ்சியம் - தமிழ்ப் பல்கலைக்கழகம், தஞ்சாவூர்

LIST OF OPEN ELECTIVES FOR PG PROGRAMMES

SL. NO.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS
			L	T	P	
27.	OCE431	Integrated Water Resources Management	3	0	0	3

28.	OCE432	Water, Sanitation and Health	3	0	0	3
29.	OCE433	Principles of Sustainable Development	3	0	0	3
30.	OCE434	Environmental Impact Assessment	3	0	0	3
31.	OIC431	Blockchain Technologies	3	0	0	3
32.	OIC432	Deep Learning	3	0	0	3
33.	OBA431	Sustainable Management	3	0	0	3
34.	OBA432	Micro and Small Business Management	3	0	0	3
35.	OBA433	Intellectual Property Rights	3	0	0	3
36.	OBA434	Ethical Management	3	0	0	3
37.	ET4251	IoT for Smart Systems	3	0	0	3
38.	ET4072	Machine Learning and Deep Learning	3	0	0	3
39.	PX4012	Renewable Energy Technology	3	0	0	3
40.	PS4093	Smart Grid	3	0	0	3
41.	CP4391	Security Practices	3	0	0	3
42.	MP4251	Cloud Computing Technologies	3	0	0	3
43.	IF4072	Design Thinking	3	0	0	3
44.	MU4153	Principles of Multimedia	3	0	0	3
45.	DS4015	Big Data Analytics	3	0	0	3
46.	NC4201	Internet of Things and Cloud	3	0	0	3
47.	MX4073	Medical Robotics	3	0	0	3
48.	VE4202	Embedded Automation	3	0	0	3
49.	CX4016	Environmental Sustainability	3	0	0	3
50.	TX4092	Textile Reinforced Composites	3	0	0	3
51.	NT4002	Nanocomposite Materials	3	0	0	3
52.	BY4016	IPR, Biosafety and Entrepreneurship	3	0	0	3



OBJECTIVE

- Students will be introduced to the concepts and principles of IWRM, which is inclusive of the economics, public-private partnership, water & health, water & food security and legal & regulatory settings.

UNIT I CONTEXT FOR IWRM**9**

Water as a global issue: key challenges – Definition of IWRM within the broader context of development – Key elements of IWRM - Principles – Paradigm shift in water management - Complexity of the IWRM process – UN World Water Assessment - SDGs.

UNIT II WATER ECONOMICS**9**

Economic view of water issues: economic characteristics of water good and services – Non-market monetary valuation methods – Water economic instruments – Private sector involvement in water resources management: PPP objectives, PPP models, PPP processes, PPP experiences through case studies.

UNIT III LEGAL AND REGULATORY SETTINGS**9**

Basic notion of law and governance: principles of international and national law in the area of water management - Understanding UN law on non-navigable uses of international water courses – International law for groundwater management – World Water Forums – Global Water Partnerships - Development of IWRM in line with legal and regulatory framework.

UNIT IV WATER AND HEALTH WITHIN THE IWRM CONTEXT**9**

Links between water and health: options to include water management interventions for health – Health protection and promotion in the context of IWRM – Global burden of Diseases - Health impact assessment of water resources development projects – Case studies.

UNIT V AGRICULTURE IN THE CONCEPT OF IWRM**9**

Water for food production: 'blue' versus 'green' water debate – Water foot print - Virtual water trade for achieving global water and food security – Irrigation efficiencies, irrigation methods - current water pricing policy– scope to relook pricing.

TOTAL: 45 PERIODS**OUTCOMES**

- On completion of the course, the student is expected to be able to

CO1	Describe the context and principles of IWRM; Compare the conventional and integrated ways water management.
CO2	Select the best economic option among the alternatives; illustrate the pros and cons of PPP through case studies.
CO3	Apply law and governance in the context of IWRM.
CO4	Discuss the linkages between water-health; develop a HIA framework.
CO5	Analyse how the virtual water concept pave way to alternate policy options.

REFERENCES:

1. Cech Thomas V., Principles of water resources: history, development, management and policy. John Wiley and Sons Inc., New York. 2003.
2. Mollinga .P. etal “ Integrated Water Resources Management”, Water in South Asia Volume I, Sage Publications, 2006.
3. Technical Advisory Committee, Integrated Water Resources management, Technical Advisory Committee Background Paper No: 4. Global water partnership, Stockholm, Sweden. 2002.
4. Technical Advisory Committee, Dublin principles for water as reflected in comparative assessment of institutional and legal arrangements for Integrated Water Resources Management, Technical Advisory Committee Background paper No: 3. Global water partnership, Stockholm, Sweden. 1999.
5. Technical Advisory Committee, Effective Water Governance”. Technical Advisory Committee Background paper No: 7. Global water partnership, Stockholm, Sweden, 2003.

CO – PO Mapping - INTEGRATED WATER RESOURCES MANAGEMENT

POs/PSOs		Course Outcome					Overall Correlation of COs to POs
		CO1	CO2	CO3	CO4	CO5	
PO1	Knowledge of Engineering Sciences	3	2	2	2	2	2
PO2	Problem analysis	1	3	2	2	2	2
PO3	Design / development of solutions		2	2	2	2	2
PO4	Investigation	1	2			1	1
PO5	Modern Tool Usage	1	1	2	1	1	1
PO6	Individual and Team work		2	2			2
PO7	Communication		2	2			2
PO8	Engineer and Society	2	2	3	2	3	3
PO9	Ethics		2	3	2	2	2
PO10	Environment and Sustainability	3	3	3	3	3	3
PO11	Project Management and Finance	1	1	1		1	1
PO12	Life Long Learning		2	2	2	2	2
PSO1	Knowledge of field research methodology, gender, legal and environmental aspects in the context of integrated water resources management	3	2	2	2	2	2
PSO2	Formulate, analyze and comprehend the differences in social and environmental variability in South Indian context with their peers and strive to work towards sustainability	2	2	2	2	2	2
PSO3	Produce and publish professional reports, peer-reviewed journal, on contemporary and state of the art research in integrated water resources management	2	2	2	2	2	2

OBJECTIVES:

- Understand the accelerating health impacts due to the present managerial aspects and initiatives in water and sanitation and health sectors in the developing scenario

UNIT I FUNDAMENTALS WASH 9

Meanings and Definition: Safe Water- Health, Nexus: Water- Sanitation - Health and Hygiene – Equity issues-Water security - Food Security. Sanitation And Hygiene (WASH) and Integrated Water Resources Management (IWRM) - Need and Importance of WASH

UNIT II MANAGERIAL IMPLICATIONS AND IMPACT 9

Third World Scenario – Poor and Multidimensional Deprivation--Health Burden in Developing Scenario - Factors contribute to water, sanitation and hygiene related diseases-Social: Social Stratification and Literacy Demography: Population and Migration- Fertility - Mortality- Environment: Water Borne-Water Washed and Water Based Diseases - Economic: Wage - Water and Health Budgeting -Psychological: Non-compliance - Disease Relapse - Political: Political Will.

UNIT III CHALLENGES IN MANAGEMENT AND DEVELOPMENT 9

Common Challenges in WASH - Bureaucracy and Users- Water Utilities -Sectoral Allocation:- Infrastructure- Service Delivery: Health services: Macro and Micro- level: Community and Gender Issues- Equity Issues - Paradigm Shift: Democratization of Reforms and Initiatives.

UNIT IV GOVERNANCE 9

Public health -Community Health Assessment and Improvement Planning (CHA/CHIP)-Infrastructure and Investments on Water, (WASH) - Cost Benefit Analysis – Institutional Intervention-Public Private Partnership - Policy Directives - Social Insurance -Political Will vs Participatory Governance -

UNIT V INITIATIVES 9

Management vs Development -Accelerating Development- Development Indicators -Inclusive Development-Global and Local- Millennium Development Goal (MDG) and Targets - Five Year Plans - Implementation - Capacity Building - Case studies on WASH.

TOTAL: 45 PERIODS

OUTCOMES:

C0	Capture to fundamental concepts and terms which are to be applied and understood through the study.
C0	Comprehend the various factors affecting water sanitation and health through the lens of the world scenario.
C0	Critically analyse and articulate the underlying common challenges in water, sanitation and health.
C0	Acquire knowledge on the attributes of governance and its say on water sanitation and health.
C0	Gain an overarching insight in to the aspects of sustainable resource management in the absence of a clear level playing field in the developmental aspects.

REFERENCES

1. Bonitha R., Beaglehole R., Kjellstrom, 2006, "Basic Epidemiology", 2nd Edition, World Health Organization.
2. Van Note Chism, N. and Bickford, D. J. (2002), Improving the environment for learning: An expanded agenda. *New Directions for Teaching and Learning*, 2002: 91–98. doi: 10.1002/tl.831 Improving the Environment for learning: An Expanded Agenda
3. National Research Council. *Global Issues in Water, Sanitation, and Health: Workshop Summary*. Washington, DC: The National Academies Press, 2009.
4. Sen, Amartya 1997. *On Economic Inequality*. Enlarged edition, with annex by James Foster and Amartya Sen, Oxford: Clarendon Press, 1997.
5. *Intersectoral Water Allocation Planning and Management*, 2000, World Bank Publishers www.Amazon.com
6. Third World Network.org (www.twn.org).

CO PO MAPPING : WATER, SANITATION AND HEALTH

PO/PSO		Course Outcome					Overall Correlation of COs to POs
		CO1	CO2	CO3	CO4	CO5	
PO1	Knowledge of Engineering Sciences	1	1		M	1	1
PO2	Problem analysis	2	2		2	2	2
PO3	Design / development of solutions		2		1	2	2
PO4	Investigation	2	3		3	3	3
PO5	Modern Tool Usage				1		1
PO6	Individual and Team work	2	2		1	2	2
PO7	Communication				2	2	2
PO8	Engineer and Society	3	3		3	3	3
PO9	Ethics		1		2	2	2
PO10	Environment and Sustainability	3				3	3
PO11	Project Management and Finance					1	1
PO12	Life Long Learning	2	3	2	3	3	3
PSO1	Explain the concepts of water management, field research methodology, gender, legal and environmental aspects in the context of integrated water resources management		3	3		3	3
PSO2	Formulate, analyse and comprehend the differences in social and economic variability in South Asian context with their peers and strive to work towards sustainability.		3	2		3	3
PSO3	Produce and publish professional reports, peer reviewed journal on contemporary and state of art research in water resources Engineering.		3	3		3	2

OBJECTIVES:

- To impart knowledge on environmental, social and economic dimensions of sustainability and the principles evolved through landmark events so as to develop an action mindset for sustainable development.

UNIT I SUSTAINABILITY AND DEVELOPMENT CHALLENGES 9

Definition of sustainability – environmental, economical and social dimensions of sustainability - sustainable development models – strong and weak sustainability – defining development- millennium development goals – mindsets for sustainability: earthly, analytical, precautionary, action and collaborative– syndromes of global change: utilisation syndromes, development syndromes, and sink syndromes – core problems and cross cutting Issues of the 21 century - global, regional and local environmental issues – social insecurity - resource degradation –climate change – desertification.

UNIT II PRINCIPLES AND FRAME WORK 9

History and emergence of the concept of sustainable development - our common future - Stockholm to Rio plus 20– Rio Principles of sustainable development – Agenda 21 natural step- peoples earth charter – business charter for sustainable development –UN Global Compact - Role of civil society, business and government – United Nations' 2030 Agenda for sustainable development – 17 sustainable development goals and targets, indicators and intervention areas

UNIT III SUSTAINABLE DEVELOPMENT AND WELLBEING 9

The Unjust World and inequities - Quality of Life - Poverty, Population and Pollution - Combating Poverty - Demographic dynamics of sustainability - Strategies to end Rural and Urban Poverty and Hunger – Sustainable Livelihood Framework- Health, Education and Empowerment of Women, Children, Youth, Indigenous People, Non-Governmental Organizations, Local Authorities and Industry for Prevention, Precaution , Preservation and Public participation.

UNIT IV SUSTAINABLE SOCIO-ECONOMIC SYSTEMS 10

Sustainable Development Goals and Linkage to Sustainable Consumption and Production – Investing in Natural Capital- Agriculture, Forests, Fisheries - Food security and nutrition and sustainable agriculture- Water and sanitation - Biodiversity conservation and Ecosystem integrity –Ecotourism - Sustainable Cities – Sustainable Habitats- Green Buildings - Sustainable Transportation — Sustainable Mining - Sustainable Energy– Climate Change –Mitigation and Adaptation - Safeguarding Marine Resources - Financial Resources and Mechanisms

UNIT V ASSESSING PROGRESS AND WAY FORWARD 8

Nature of sustainable development strategies and current practice- Sustainability in global, regional and national context –Approaches to measuring and analysing sustainability– limitations of GDP- Ecological Footprint- Human Development Index- Human Development Report – National initiatives for Sustainable Development - Hurdles to Sustainability - Science and Technology for sustainable development – Performance indicators of sustainability and Assessment mechanism – Inclusive Green Growth and Green

OUTCOMES:

- On completion of the course, the student is expected to be able to

CO1	Explain and evaluate current challenges to sustainability, including modern world social, environmental, and economic structures and crises.
CO2	Identify and critically analyze the social environmental, and economic dimensions of sustainability in terms of UN Sustainable development goals
CO3	Develop a fair understanding of the social, economic and ecological linkage of Human well being, production and consumption
CO4	Evaluate sustainability issues and solutions using a holistic approach that focuses on connections between complex human and natural systems.
CO5	Integrate knowledge from multiple sources and perspectives to understand environmental limits governing human societies and economies and social justice dimensions of sustainability.

REFERENCES:

- Tom Theis and Jonathan Tomkin, Sustainability: A Comprehensive Foundation, Rice University, Houston, Texas, 2012
- A guide to SDG interactions:from science to implementation, International Council for Science, Paris,2017
- Karel Mulder, Sustainable Development for Engineers - A Handbook and Resource Guide, Roulledge Taylor and Francis, 2017.
- The New Global Frontier - Urbanization, Poverty and Environmentin the 21st Century - *George Martine,Gordon McGranahan,Mark Montgomery and Rogelio Fernández-Castilla*, IIED and UNFPA, Earthscan, UK, 2008
- Nolberto Munier, Introduction to Sustainability: Road to a Better Future, Springer, 2006
- Barry Dalal Clayton and Stephen Bass, Sustainable Development Strategies- a resource book”, Earthscan Publications Ltd, London, 2002.

CO – PO Mapping –Principles of Sustainable Development

PO/PSO		Course Outcome					Overall Correlation o COs to POs
		CO1	CO2	CO3	CO4	CO5	
PO1	Knowledge of Engineering Science						
PO2	Problem analysis	3	3				3
PO3	Design / development of solutions				3	3	3
PO4	Investigation		2	2	2	2	2
PO5	Modern Tool Usage						
PO6	Individual and Team work		2	2			2
PO7	Communication					1	1
PO8	Engineer and Society	3			3		3
PO9	Ethics				2	2	2
PO10	Environment and Sustainability	3	3	3	3	3	3
PO11	Project Management and Finance						
PO12	Life Long Learning					1	1
PSO1	Knowledge of Environmental Management discipline	3	3	3	3		3
PSO2	Environmental Performance Evaluation and coordination						

PSO3	Conceptualization of Environmental Management Systems						
------	---	--	--	--	--	--	--

OCE434

ENVIRONMENTAL IMPACT ASSESSMENT

L T P C
3 0 0 3

OBJECTIVES:

- To make the students to understand environmental clearance, its legal requirements and to provide knowledge on overall methodology of EIA, prediction tools and models, environmental management plan and case studies.

UNIT I INTRODUCTION

9

Historical development of Environmental Impact Assessment (EIA). Environmental Clearance- EIA in project cycle. legal and regulatory aspects in India – types and limitations of EIA –EIA process- screening – scoping - terms of reference in EIA- setting – analysis – mitigation. Cross sectoral issues –public hearing in EIA- EIA consultant accreditation.

UNIT II IMPACT IDENTIFICATION AND PREDICTION

10

Matrices – networks – checklists – cost benefit analysis – analysis of alternatives – expert systems in EIA. prediction tools for EIA – mathematical modeling for impact prediction – assessment of impacts – air – water – soil – noise – biological — cumulative impact assessment

UNIT III SOCIO-ECONOMIC IMPACT ASSESSMENT

8

Socio-economic impact assessment - relationship between social impacts and change in community and institutional arrangements. factors and methodologies- individual and family level impacts. communities in transition-rehabilitation

UNIT IV EIA DOCUMENTATION AND ENVIRONMENTAL MANAGEMENT PLAN

9

Environmental management plan - preparation, implementation and review – mitigation and rehabilitation plans – policy and guidelines for planning and monitoring programmes – post project audit – documentation of EIA findings – ethical and quality aspects of environmental impact assessment

UNIT V CASE STUDIES

9

Mining, power plants, cement plants, highways, petroleum refining industry, storage & handling of hazardous chemicals, common hazardous waste facilities, CETPs, CMSWMF, building and construction projects

TOTAL: 45 PERIODS

OUTCOMES:

- On completion of the course, the student is expected to be able to

CO1	Understand need for environmental clearance, its legal procedure, need of EIA, types, stakeholders and their roles
CO2	Understand various impact identification methodologies, prediction techniques a model of impacts on various environments
CO3	Understand relationship between social impacts and change in community due development activities and rehabilitation methods
CO4	Document the EIA findings and prepare environmental management and monitoring plan
CO5	Identify, predict and assess impacts of similar projects based on case studies

REFERENCES:

1. EIA Notification 2006 including recent amendments, by Ministry of Environment, Forest and Climate Change, Government of India
2. Sectoral Guidelines under EIA Notification by Ministry of Environment, Forest and Climate Change, Government of India
3. Canter, L.W., Environmental Impact Assessment, McGraw Hill, New York. 1996
4. Lawrence, D.P., Environmental Impact Assessment – Practical solutions to recurrent problems, Wiley-Interscience, New Jersey. 2003
5. Lee N. and George C. 2000. Environmental Assessment in Developing and Transitional Countries. Chichester: Willey
6. World Bank –Source book on EIA ,1999
7. Sam Mannan, Lees' Loss Prevention in the Process Industries, Hazard Identification Assessment and Control, 4th Edition, Butterworth Heineman, 2012.

CO – PO Mapping- ENVIRONMENTAL IMPACT ASSESSMENT

PO/PSO		Course Outcome					Overall Correlation of COs to Pos
		CO1	CO2	CO3	CO4	CO5	
PO1	Knowledge of Engineering Sciences		3			3	3
PO2	Problem analysis		2	2			2
PO3	Design / development of solutions		3	3	3		3
PO4	Investigation		2	2		2	2
PO5	Modern Tool Usage		2	2	3		2
PO6	Individual and Team work		2	2	2		2
PO7	Communication				1		1
PO8	Engineer and Society	2			2		2
PO9	Ethics	3	3	3	2	2	3
PO10	Environment and Sustainability	3			2		2
PO11	Project Management and Finance				1		L
PO12	Life Long Learning		1	1			L
PSO1	Knowledge of Environmental Engineering discipline	2					2
PSO2	Environmental Performance Evaluation and coordination		2	2	2		2
PSO3	Conceptualization of Environmental Engineering Systems		2		2		2

OIC431

BLOCKCHAIN TECHNOLOGIES

**L T P C
3 0 0 3**

COURSE OBJECTIVES:

- This course is intended to study the basics of Blockchain technology.
- During this course the learner will explore various aspects of Blockchain technology like application in various domains.
- By implementing, learners will have idea about private and public Blockchain, and smart contract.

UNIT I INTRODUCTION OF CRYPTOGRAPHY AND BLOCKCHAIN 9
 Introduction to Blockchain, Blockchain Technology Mechanisms & Networks, Blockchain Origins, Objective of Blockchain, Blockchain Challenges, Transactions and Blocks, P2P Systems, Keys as Identity, Digital Signatures, Hashing, and public key cryptosystems, private vs. public Blockchain.

UNIT II BITCOIN AND CRYPTOCURRENCY 9
 Introduction to Bitcoin, The Bitcoin Network, The Bitcoin Mining Process, Mining Developments, Bitcoin Wallets, Decentralization and Hard Forks, Ethereum Virtual Machine (EVM), Merkle Tree, Double-Spend Problem, Blockchain and Digital Currency, Transactional Blocks, Impact of Blockchain Technology on Cryptocurrency.

UNIT III INTRODUCTION TO ETHEREUM 9
 Introduction to Ethereum, Consensus Mechanisms, Metamask Setup, Ethereum Accounts, , Transactions, Receiving Ethers, Smart Contracts.

UNIT-IV INTRODUCTION TO HYPERLEDGER AND SOLIDITY PROGRAMMING 10
 Introduction to Hyperledger, Distributed Ledger Technology & its Challenges, Hyperledger & Distributed Ledger Technology, Hyperledger Fabric, Hyperledger Composer. Solidity - Language of Smart Contracts, Installing Solidity & Ethereum Wallet, Basics of Solidity, Layout of a Solidity Source File & Structure of Smart Contracts, General Value Types.

UNIT V BLOCKCHAIN APPLICATIONS 8
 Internet of Things, Medical Record Management System, Domain Name Service and Future of Blockchain, Alt Coins.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After the completion of this course, student will be able to

- CO1:** Understand and explore the working of Blockchain technology
- CO2:** Analyze the working of Smart Contracts
- CO3:** Understand and analyze the working of Hyperledger
- CO4:** Apply the learning of solidity to build de-centralized apps on Ethereum
- CO5:** Develop applications on Blockchain

REFERENCES:

1. Imran Bashir, “Mastering Blockchain: Distributed Ledger Technology, Decentralization, and Smart Contracts Explained”, Second Edition, Packt Publishing, 2018.
2. Narayanan, J. Bonneau, E. Felten, A. Miller, S. Goldfeder, “Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction” Princeton University Press, 2016
3. Antonopoulos, Mastering Bitcoin, O’Reilly Publishing, 2014. .
4. Antonopoulos and G. Wood, “Mastering Ethereum: Building Smart Contracts and Dapps”, O’Reilly Publishing, 2018.
5. D. Drescher, Blockchain Basics. Apress, 2017.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	2	1	3	2	2	3
2	2	1	2	3	2	2
3	2	1	3	1	2	1
4	2	1	2	3	2	2
5						
Avg	2.00	1.00	2.50	2.25	2.00	2.00

COURSE OBJECTIVES:

- Develop and Train Deep Neural Networks.
- Develop a CNN, R-CNN, Fast R-CNN, Faster-R-CNN, Mask-RCNN for detection and recognition
- Build and train RNNs, work with NLP and Word Embeddings
- The internal structure of LSTM and GRU and the differences between them
- The Auto Encoders for Image Processing

UNIT I DEEP LEARNING CONCEPTS

Fundamentals about Deep Learning. Perception Learning Algorithms. Probabilistic modelling. Early Neural Networks. How Deep Learning different from Machine Learning. Scalars. Vectors. Matrixes, Higher Dimensional Tensors. Manipulating Tensors. Vector Data. Time Series Data. Image Data. Video Data.

UNIT II NEURAL NETWORKS

About Neural Network. Building Blocks of Neural Network. Optimizers. Activation Functions. Loss Functions. Data Pre-processing for neural networks, Feature Engineering. Overfitting and Underfitting. Hyperparameters.

UNIT III CONVOLUTIONAL NEURAL NETWORK

About CNN. Linear Time Invariant. Image Processing Filtering. Building a convolutional neural network. Input Layers, Convolution Layers. Pooling Layers. Dense Layers. Backpropagation Through the Convolutional Layer. Filters and Feature Maps. Backpropagation Through the Pooling Layers. Dropout Layers and Regularization. Batch Normalization. Various Activation Functions. Various Optimizers. LeNet, AlexNet, VGG16, ResNet. Transfer Learning with Image Data. Transfer Learning using Inception Oxford VGG Model, Google Inception Model, Microsoft ResNet Model. R-CNN, Fast R-CNN, Faster R-CNN, Mask-RCNN, YOLO

UNIT VI NATURAL LANGUAGE PROCESSING USING RNN

About NLP & its Toolkits. Language Modeling . Vector Space Model (VSM). Continuous Bag of Words (CBOW). Skip-Gram Model for Word Embedding. Part of Speech (PoS) Global Co-occurrence Statistics–based Word Vectors. Transfer Learning. Word2Vec. Global Vectors for Word Representation GloVe. Backpropagation Through Time. Bidirectional RNNs (BRNN) . Long Short Term Memory (LSTM). Bi-directional LSTM. Sequence-to-Sequence Models (Seq2Seq). Gated recurrent unit GRU.

UNIT V DEEP REINFORCEMENT & UNSUPERVISED LEARNING

About Deep Reinforcement Learning. Q-Learning. Deep Q-Network (DQN). Policy Gradient Methods. Actor-Critic Algorithm. About Autoencoding. Convolutional Auto Encoding. Variational Auto Encoding. Generative Adversarial Networks. Autoencoders for Feature Extraction. Auto Encoders for Classification. Denoising Autoencoders. Sparse Autoencoders

COURSE OUTCOMES:

CO1: Feature Extraction from Image and Video Data

CO2: Implement Image Segmentation and Instance Segmentation in Images

CO3: Implement image recognition and image classification using a pretrained network (Transfer Learning)

CO4: Traffic Information analysis using Twitter Data

CO5: Autoencoder for Classification & Feature Extraction

TOTAL : 45 PERIODS

REFERENCES

1. Deep Learning A Practitioner's Approach Josh Patterson and Adam Gibson O'Reilly Media, Inc.2017
2. Learn Keras for Deep Neural Networks, Jojo Moolayil, Apress,2018
3. Deep Learning Projects Using TensorFlow 2, Vinita Silaparasetty, Apress, 2020
4. Deep Learning with Python, FRANÇOIS CHOLLET, MANNING SHELTER ISLAND,2017
5. Pro Deep Learning with TensorFlow, Santanu Pattanayak, Apress,2017

OBA431

SUSTAINABLE MANAGEMENT

LT P C
3 0 0 3

COURSE OBJECTIVES:

- To provide students with fundamental knowledge of the notion of corporate sustainability.
- To determine how organizations impacts on the environment and socio-technical systems, the relationship between social and environmental performance and competitiveness, the approaches and methods.

UNIT I MANAGEMENT OF SUSTAINABILITY

9

Management of sustainability -rationale and political trends: An introduction to sustainability management, International and European policies on sustainable development, theoretical pillars in sustainability management studies.

UNIT II CORPORATE SUSTAINABILITY AND RESPONSIBILITY

9

Corporate sustainability parameter, corporate sustainability institutional framework, integration of sustainability into strategic planning and regular business practices, fundamentals of stakeholder engagement.

UNIT III SUSTAINABILITY MANAGEMENT: STRATEGIES AND APPROACHES

9

Corporate sustainability management and competitiveness: Sustainability-oriented corporate strategies, markets and competitiveness, Green Management between theory and practice, Sustainable Consumption and Green Marketing strategies, Environmental regulation and strategic postures; Green Management approaches and tools; Green engineering: clean technologies and innovation processes; Sustainable Supply Chain Management and Procurement.

UNIT IV SUSTAINABILITY AND INNOVATION

9

Socio-technical transitions and sustainability, Sustainable entrepreneurship, Sustainable pioneers in green market niches, Smart communities and smart specializations.

UNIT V SUSTAINABLE MANAGEMENT OF RESOURCES, COMMODITIES AND COMMONS

9

Energy management, Water management, Waste management, Wild Life Conservation, Emerging trends in sustainable management, Case Studies.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- CO1: An understanding of sustainability management as an approach to aid in evaluating and minimizing environmental impacts while achieving the expected social impact.
- CO2: An understanding of corporate sustainability and responsible Business Practices
- CO3: Knowledge and skills to understand, to measure and interpret sustainability performances.

CO4: Knowledge of innovative practices in sustainable business and community management

CO5: Deep understanding of sustainable management of resources and commodities

REFERENCES:

1. Daddi, T., Iraldo, F., Testa, Environmental Certification for Organizations and Products: Management, 2015
2. Christian N. Madu, Handbook of Sustainability Management 2012
3. Petra Molthan-Hill, The Business Student's Guide to Sustainable Management: Principles and Practice, 2014
4. Margaret Robertson, Sustainability Principles and Practice, 2014
5. Peter Rogers, An Introduction to Sustainable Development, 2006

MAPPING OF POs AND COs:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	1	2	2
CO2	3	2	2	2	1	2
CO3	3	3	1	2	2	3
CO4	3	3	2	1	1	2
CO5	3	3	2	1	2	2

OBA432

MICRO AND SMALL BUSINESS MANAGEMENT

**L T P C
3 0 0 3**

COURSE OBJECTIVES

- To familiarize students with the theory and practice of small business management.
- To learn the legal issues faced by small business and how they impact operations.

UNIT I INTRODUCTION TO SMALL BUSINESS

9

Creation, Innovation, entrepreneurship and small business - Defining Small Business –Role of Owner – Manager – government policy towards small business sector –elements of entrepreneurship –evolution of entrepreneurship –Types of Entrepreneurship – social, civic, corporate - Business life cycle - barriers and triggers to new venture creation – process to assist start ups – small business and family business.

UNIT II SCREENING THE BUSINESS OPPORTUNITY AND FORMULATING THE BUSINESS PLAN

9

Concepts of opportunity recognition; Key factors leading to new venture failure; New venture screening process; Applying new venture screening process to the early stage small firm Role planning in small business – importance of strategy formulation – management skills for small business creation and development.

UNIT III BUILDING THE RIGHT TEAM AND MARKETING STRATEGY

9

Management and Leadership – employee assessments – Tuckman’s stages of group development - The entrepreneurial process model - Delegation and team building - Comparison of HR management in small and large firms - Importance of coaching and how to apply a coaching model.

Marketing within the small business - success strategies for small business marketing - customer delight and business generating systems, - market research, - assessing market performance- sales management and strategy - the marketing mix and marketing strategy.

UNIT IV FINANCING SMALL BUSINESS 9

Main sources of entrepreneurial capital; Nature of 'bootstrap' financing - Difference between cash and profit - Nature of bank financing and equity financing - Funding-equity gap for small firms. Importance of working capital cycle - Calculation of break-even point - Power of gross profit margin- Pricing for profit - Credit policy issues and relating these to cash flow management and profitability.

UNIT V VALUING SMALL BUSINESS AND CRISIS MANAGEMENT 9

Causes of small business failure - Danger signals of impending trouble - Characteristics of poorly performing firms - Turnaround strategies - Concept of business valuation - Different valuation measurements - Nature of goodwill and how to measure it - Advantages and disadvantages of buying an established small firm - Process of preparing a business for sale.

TOTAL: 45 PERIODS

COURSE OUTCOMES

- CO1. Familiarise the students with the concept of small business
- CO2. In depth knowledge on small business opportunities and challenges
- CO3. Ability to devise plans for small business by building the right skills and marketing strategies
- CO4. Identify the funding source for small start ups
- CO5. Business evaluation for buying and selling of small firms

REFERENCES

1. Hankinson,A.(2000). "The key factors in the profile of small firm owner-managers that influence business performance. The South Coast Small Firms Survey, 1997-2000." Industrial and Commercial Training 32(3):94-98.
2. Parker,R.(2000). "Small is not necessarily beautiful: An evaluation of policy support for small and medium-sized enterprise in Australia." Australian Journal of Political Science 35(2):239-253.
3. Journal articles on SME's.

MAPPING OF POs AND COs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	1	1	-	-
CO2	3	3	3	3	2	3
CO3	3	3	2	2	3	3
CO4	3	2	2	2	1	1
CO5	3	2	2	3	2	1

**OBA433 INTELLECTUAL PROPERTY RIGHTS L T P C
3 0 0 3**

COURSE OBJECTIVE

- To understand intellectual property rights and its valuation.

UNIT I INTRODUCTION 9

Intellectual property rights - Introduction, Basic concepts, Patents, Copyrights, Trademarks, Trade Secrets, Geographic Indicators; Nature of Intellectual Property, Technological Research, Inventions and Innovations, History - the way from WTO to WIPO, TRIPS.

UNIT II PROCESS**9**

New Developments in IPR, Procedure for grant of Patents, TM, GIs, Patenting under Patent Cooperation Treaty, Administration of Patent system in India, Patenting in foreign countries.

UNIT III STATUTES**9**

International Treaties and conventions on IPRs, The TRIPs Agreement, PCT Agreement, The Patent Act of India, Patent Amendment Act (2005), Design Act, Trademark Act, Geographical Indication Act, Bayh-Dole Act and Issues of Academic Entrepreneurship.

UNIT IV STRATEGIES IN INTELLECTUAL PROPERTY**9**

Strategies for investing in R&D, Patent Information and databases, IPR strength in India, Traditional Knowledge, Case studies.

UNIT V MODELS**9**

The technologies Know-how, concept of ownership, Significance of IP in Value Creation, IP Valuation and IP Valuation Models, Application of Real Option Model in Strategic Decision Making, Transfer and Licensing.

TOTAL: 45 PERIODS**COURSE OUTCOMES**

CO1: Understanding of intellectual property and appreciation of the need to protect it

CO2: Awareness about the process of patenting

CO3: Understanding of the statutes related to IPR

CO4: Ability to apply strategies to protect intellectual property

CO5: Ability to apply models for making strategic decisions related to IPR

REFERENCES

1. V. Sople Vinod, Managing Intellectual Property by (Prentice hall of India Pvt.Ltd), 2006.
2. Intellectual Property rights and copyrights, EssEss Publications.
3. Primer, R. Anita Rao and Bhanoji Rao, Intellectual Property Rights, Lastain Book company.
4. Edited by Derek Bosworth and Elizabeth Webster, The Management of Intellectual Property, Edward Elgar Publishing Ltd., 2006.
5. WIPO Intellectual Property Hand book.

MAPPING OF POs AND COs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	3	2	3
CO2	3	3	2	3	1	3
CO3	3	3	3	3	2	3
CO4	3	3	3	2	1	3
CO5	3	3	3	2	2	3

OBA434**ETHICAL MANAGEMENT****L T P C****3 0 0 3****COURSE OBJECTIVE**

➤ To help students develop knowledge and competence in ethical management and decision making in organizational contexts.

UNIT I ETHICS AND SOCIETY**9**

Ethical Management- Definition, Motivation, Advantages-Practical implications of ethical management. Managerial ethics, professional ethics, and social Responsibility-Role of culture and society's expectations- Individual and organizational responsibility to society and the community.

UNIT II ETHICAL DECISION MAKING AND MANAGEMENT IN A CRISIS**9**

Managing in an ethical crisis, the nature of a crisis, ethics in crisis management, discuss case studies, analyze real-world scenarios, develop ethical management skills, knowledge, and competencies. Proactive crisis management.

UNIT III STAKEHOLDERS IN ETHICAL MANAGEMENT**9**

Stakeholders in ethical management, identifying internal and external stakeholders, nature of stakeholders, ethical management of various kinds of stakeholders: customers (product and service issues), employees (leadership, fairness, justice, diversity) suppliers, collaborators, business, community, the natural environment (the sustainability imperative, green management, Contemporary issues).

UNIT IV INDIVIDUAL VARIABLES IN ETHICAL MANAGEMENT**9**

Understanding individual variables in ethics, managerial ethics, concepts in ethical psychology- ethical awareness, ethical courage, ethical judgment, ethical foundations, ethical emotions/intuitions/intensity. Utilization of these concepts and competencies for ethical decision-making and management.

UNIT V PRACTICAL FIELD-GUIDE, TECHNIQUES AND SKILLS**9**

Ethical management in practice, development of techniques and skills, navigating challenges and dilemmas, resolving issues and preventing unethical management proactively. Role modelling and creating a culture of ethical management and human flourishing.

TOTAL: 45 PERIODS**COURSE OUTCOMES**

- CO1: Role modelling and influencing the ethical and cultural context.
- CO2: Respond to ethical crises and proactively address potential crises situations.
- CO3: Understand and implement stakeholder management decisions.
- CO4: Develop the ability, knowledge, and skills for ethical management.
- CO5: Develop practical skills to navigate, resolve and thrive in management situations

REFERENCES

1. Brad Agle, Aaron Miller, Bill O' Rourke, The Business Ethics Field Guide: the essential companion to leading your career and your company, 2016.
2. Steiner & Steiner, Business, Government & Society: A managerial Perspective, 2011.
3. Lawrence & Weber, Business and Society: Stakeholders, Ethics, Public Policy, 2020.

MAPPING OF POs AND COs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	3	2	3
CO2		3	2	3	1	3
CO3	3	3	3	3	2	3
CO4	3	3	3	2	1	3
CO5	3	3	3	2	2	3

COURSE OBJECTIVES:

1. To study about **Internet of Things** technologies and its role in real time applications.
2. To introduce the infrastructure required for IoT
3. To familiarize the accessories and communication techniques for IoT.
4. To provide insight about the embedded processor and sensors required for IoT
5. To familiarize the different platforms and Attributes for IoT

UNIT I INTRODUCTION TO INTERNET OF THINGS**9**

Overview, Hardware and software requirements for IOT, Sensor and actuators, Technology drivers, Business drivers, Typical IoT applications, Trends and implications.

UNIT II IOT ARCHITECTURE**9**

IoT reference model and architecture -Node Structure - Sensing, Processing, Communication, Powering, Networking - Topologies, Layer/Stack architecture, IoT standards, Cloud computing for IoT, Bluetooth, Bluetooth Low Energy beacons.

UNIT III PROTOCOLS AND WIRELESS TECHNOLOGIES FOR IOT**9****PROTOCOLS:**

NFC, SCADA and RFID, Zigbee MIPI, M-PHY, UniPro, SPMI, SPI, M-PCIe GSM, CDMA, LTE, GPRS, small cell.

Wireless technologies for IoT: WiFi (IEEE 802.11), Bluetooth/Bluetooth Smart, ZigBee/ZigBee Smart, UWB (IEEE 802.15.4), 6LoWPAN, Proprietary systems-Recent trends.

UNIT IV IOT PROCESSORS**9**

Services/Attributes: Big-Data Analytics for IOT, Dependability, Interoperability, Security, Maintainability.

Embedded processors for IOT : Introduction to Python programming -Building IOT with RASPERRY PI and Arduino.

UNIT V CASE STUDIES**9**

Industrial IoT, Home Automation, smart cities, Smart Grid, connected vehicles, electric vehicle charging, Environment, Agriculture, Productivity Applications, IOT Defense

TOTAL: 45 PERIODS**COURSE OUTCOMES:**

At the end of this course, the students will have the ability to

CO1: Analyze the concepts of IoT and its present developments.

CO2: Compare and contrast different platforms and infrastructures available for IoT

CO3: Explain different protocols and communication technologies used in IoT

CO4: Analyze the big data analytic and programming of IoT

CO5: Implement IoT solutions for smart applications

CO	PO					
	1	2	3	4	5	6
1	1	2	1	-	-	-
2	-	2	-	-	-	-
3	1	2	-	1	3	-
4	2		3	3	3	3
5	3	2	3	3	3	3
Avg.	1.75	2	2.33	2.33	3	2

REFERENCES:

1. ArshdeepBahga and VijaiMadiseti : A Hands-on Approach “Internet of Things”,Universities Press 2015.
2. Oliver Hersent , David Boswarthick and Omar Elloumi “ The Internet of Things”, Wiley,2016.
3. Samuel Greengard, “ The Internet of Things”, The MIT press, 2015.
4. Adrian McEwen and Hakim Cassimally“Designing the Internet of Things “Wiley,2014.
5. Jean- Philippe Vasseur, Adam Dunkels, “Interconnecting Smart Objects with IP: The Next Internet” Morgan Kuffmann Publishers, 2010.
6. Adrian McEwen and Hakim Cassimally, “Designing the Internet of Things”, John Wiley and sons, 2014.
7. Lingyang Song/DusitNiyato/ Zhu Han/ Ekram Hossain,” Wireless Device-to-Device Communications and Networks, CAMBRIDGE UNIVERSITY PRESS,2015.
8. OvidiuVermesan and Peter Friess (Editors), “Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems”, River Publishers Series in Communication, 2013.
9. Vijay Madiseti , ArshdeepBahga, “Internet of Things (A Hands on-Approach)”, 2014.
10. Zach Shelby, Carsten Bormann, “6LoWPAN: The Wireless Embedded Internet”, John Wiley and sons, 2009.
11. Lars T.Berger and Krzysztof Iniewski, “Smart Grid applications, communications and security”, Wiley, 2015.
12. JanakaEkanayake, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama and Nick Jenkins, “ Smart Grid Technology and Applications”, Wiley, 2015.
13. UpenaDalal,”Wireless Communications & Networks,Oxford,2015.

ET4072

MACHINE LEARNING AND DEEP LEARNING

L T P C

3 0 0 3

COURSE OBJECTIVES:

The course is aimed at

1. Understanding about the learning problem and algorithms
2. Providing insight about neural networks
3. Introducing the machine learning fundamentals and significance
4. Enabling the students to acquire knowledge about pattern recognition.
5. Motivating the students to apply deep learning algorithms for solving real life problems.

UNIT I LEARNING PROBLEMS AND ALGORITHMS **9**
 Various paradigms of learning problems, Supervised, Semi-supervised and Unsupervised algorithms

UNIT II NEURAL NETWORKS **9**
 Differences between Biological and Artificial Neural Networks - Typical Architecture, Common Activation Functions, Multi-layer neural network, Linear Separability, Hebb Net, Perceptron, Adaline, Standard Back propagation Training Algorithms for Pattern Association - Hebb rule and Delta rule, Hetero associative, Auto associative, Kohonen Self Organising Maps, Examples of Feature Maps, Learning Vector Quantization, Gradient descent, Boltzmann Machine Learning.

UNIT III MACHINE LEARNING – FUNDAMENTALS & FEATURE SELECTIONS & CLASSIFICATIONS **9**
 Classifying Samples: The confusion matrix, Accuracy, Precision, Recall, F1- Score, the curse of dimensionality, training, testing, validation, cross validation, overfitting, under-fitting the data, early stopping, regularization, bias and variance. Feature Selection, normalization, dimensionality reduction, Classifiers: KNN, SVM, Decision trees, Naïve Bayes, Binary classification, multi class classification, clustering.

UNIT IV DEEP LEARNING: CONVOLUTIONAL NEURAL NETWORKS **9**
 Feed forward networks, Activation functions, back propagation in CNN, optimizers, batch normalization, convolution layers, pooling layers, fully connected layers, dropout, Examples of CNNs.

UNIT V DEEP LEARNING: RNNs, AUTOENCODERS AND GANS **9**
 State, Structure of RNN Cell, LSTM and GRU, Time distributed layers, Generating Text, Autoencoders: Convolutional Autoencoders, Denoising autoencoders, Variational autoencoders, GANs: The discriminator, generator, DCGANs

TOTAL : 45 PERIODS

COURSE OUTCOMES (CO):

At the end of the course the student will be able to

CO1 : Illustrate the categorization of machine learning algorithms.

CO2: Compare and contrast the types of neural network architectures, activation functions

CO3: Acquaint with the pattern association using neural networks

CO4: Elaborate various terminologies related with pattern recognition and architectures of convolutional neural networks

CO5: Construct different feature selection and classification techniques and advanced neural network architectures such as RNN, Autoencoders, and GANs.

CO	PO					
	1	2	3	4	5	6
1	1	3	1	-	-	-
2	2	3	2	-	-	-
3	3	-	3	-	3	-
4	2	3	3	-	-	-
5	3	3	3	-	3	-
6	3	3	3	-	3	-
7	3	3	3	-	3	-
Avg.	2.42	3	2.57	-	3	-

REFERENCES:

1. J. S. R. Jang, C. T. Sun, E. Mizutani, Neuro Fuzzy and Soft Computing - A Computational Approach to Learning and Machine Intelligence, 2012, PHI learning
2. Deep Learning, Ian Good fellow, YoshuaBengio and Aaron Courville, MIT Press, ISBN: 9780262035613, 2016.
3. The Elements of Statistical Learning. Trevor Hastie, Robert Tibshirani and Jerome Friedman. Second Edition. 2009.
4. Pattern Recognition and Machine Learning. Christopher Bishop. Springer. 2006.
5. Understanding Machine Learning. Shai Shalev-Shwartz and Shai Ben-David. Cambridge University Press. 2017.

PX4012

RENEWABLE ENERGY TECHNOLOGY

L T P C
3 0 0 3

OBJECTIVES:

To impart knowledge on

- Different types of renewable energy technologies
- Standalone operation, grid connected operation of renewable energy systems

UNIT I INTRODUCTION 9

Classification of energy sources – Co₂ Emission - Features of Renewable energy - Renewable energy scenario in India -Environmental aspects of electric energy conversion: impacts of renewable energy generation on environment Per Capital Consumption - CO₂ Emission - importance of renewable energy sources, Potentials – Achievements– Applications.

UNIT II SOLAR PHOTOVOLTAICS 9

Solar Energy: Sun and Earth-Basic Characteristics of solar radiation- angle of sunrays on solar collector-Estimating Solar Radiation Empirically - Equivalent circuit of PV Cell- Photovoltaic cell characteristics: P-V and I-V curve of cell-Impact of Temperature and Insolation on I-V characteristic Shading Impacts on I-V characteristics-Bypass diode -Blocking diode.

UNIT III PHOTOVOLTAIC SYSTEM DESIGN 9

Block diagram of solar photovoltaic system : Line commutated converters (inversion mode) - Buck and buck-boost converters - selection of inverter, battery sizing, array sizing - PV system classification- standalone PV systems - Grid tied and grid interactive inverters- grid connection issues

UNIT IV WIND ENERGY CONVERSION SYSTEMS 9

Origin of Winds: Global and Local Winds- Aerodynamics of Wind turbine-Derivation of Betz's limit Power available in wind-Classification of wind turbine: Horizontal Axis wind turbine and Vertical axis wind turbine- Aerodynamic Efficiency-Tip Speed-Tip Speed Ratio-Solidity-Blade Count-Power curve wind turbine - Configurations of wind energy conversion systems: Type A, Type B, Type C and Type D Configurations- Grid connection Issues - Grid integrated SCIG and PMSG based WECS.

UNIT V OTHER RENEWABLE ENERGY SOURCES 9

Qualitative study of different renewable energy resources: ocean, Biomass, Hydrogen energy systems, Fuel cells, Ocean Thermal Energy Conversion (OTEC), Tidal and wave energy, Geothermal Energy Resources.

TOTAL : 45 PERIODS

OUTCOMES:

After completion of this course, the student will be able to:

- CO1: Demonstrate the need for renewable energy sources.
- CO2: Develop a stand-alone photo voltaic system and implement a maximum power po tracking in the PV system.
- CO3: Design a stand-alone and Grid connected PV system.
- CO4: Analyze the different configurations of the wind energy conversion systems.
- CO5: Realize the basic of various available renewable energy sources

REFERENCES:

1. S.N.Bhadra, D. Kastha, & S. Banerjee "Wind Electrical Systems", Oxford University Press 2009.
2. Rai. G.D, "Non conventional energy sources", Khanna publishes, 1993.
3. Rai. G.D," Solar energy utilization", Khanna publishes, 1993.
4. Chetan Singh Solanki, "Solar Photovoltaics: Fundamentals, Technologies and Application: PHI Learning Private Limited, 2012.
5. John Twideu and Tony Weir, "Renewal Energy Resources" BSP Publications, 2006
6. Gray, L. Johnson, "Wind energy system", prentice hall of India, 1995.
7. B.H.Khan, " Non-conventional Energy sources", , McGraw-hill, 2nd Edition, 2009.
8. Fang Lin Luo Hong Ye, " Renewable Energy systems", Taylor & Francis Group,2013.

CO-PO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3		2	2	2	1
CO2	3		2	3	3	3
CO3	3		2	3	3	3
CO4	3		2	3	3	2
CO5	3		2	2	2	2

PS4093**SMART GRID****L T P C****3 0 0 3****COURSE OBJECTIVES**

- To Study about Smart Grid technologies, different smart meters and advanced metering infrastructure.
- To know about the function of smart grid.
- To familiarize the power quality management issues in Smart Grid.
- To familiarize the high performance computing for Smart Grid applications
- To get familiarized with the communication networks for Smart Grid applications

UNIT I INTRODUCTION TO SMART GRID**9**

Evolution of Electric Grid, Concept, Definitions and Need for Smart Grid, Smart grid drivers, functions, opportunities, challenges and benefits, Difference between conventional & Smart Grid, Comparison of Micro grid and Smart grid, Present development & International policies in Smart Grid, Smart Grid Initiative for Power Distribution Utility in India – Case Study.

UNIT II SMART GRID TECHNOLOGIES 9

Technology Drivers, Smart Integration of energy resources, Smart substations, Substation Automation, Feeder Automation, Transmission systems: EMS, FACTS and HVDC, Wide area monitoring, Protection and control, Distribution systems: DMS, Volt/Var control, Fault Detection, Isolation and service restoration, Outage management, High-Efficiency Distribution Transformers, Phase Shifting Transformers, Plug in Hybrid Electric Vehicles (PHEV) – Grid to Vehicle and Vehicle to Grid charging concepts.

UNIT III SMART METERS AND ADVANCED METERING INFRASTRUCTURE 9

Introduction to Smart Meters, Advanced Metering infrastructure (AMI) drivers and benefits, AMI protocols, standards and initiatives, AMI needs in the smart grid, Phasor Measurement Unit (PMU) & their application for monitoring & protection. Demand side management and demand response programs, Demand pricing and Time of Use, Real Time Pricing, Peak Time Pricing.

UNIT IV POWER QUALITY MANAGEMENT IN SMART GRID 9

Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring, Power Quality Audit.

Unit V HIGH PERFORMANCE COMPUTING FOR SMART GRID APPLICATIONS 9

Architecture and Standards -Local Area Network (LAN), House Area Network (HAN), Wide Area Network (WAN), Broadband over Power line (BPL), PLC, Zigbee, GSM, IP based Protocols, Basics of Web Service and CLOUD Computing, Cyber Security for Smart Grid.

TOTAL : 45 PERIODS

COURSE OUTCOME:

Students able to

- CO1: Relate with the smart resources, smart meters and other smart devices.
- CO2: Explain the function of Smart Grid.
- CO3: Experiment the issues of Power Quality in Smart Grid.
- CO4: Analyze the performance of Smart Grid.
- CO5: Recommend suitable communication networks for smart grid applications

REFERENCES

1. Stuart Borlase 'Smart Grid: Infrastructure, Technology and Solutions', CRC Press 2012.
2. JanakaEkanayake, Nick Jenkins, KithsiriLiyanaage, Jianzhong Wu, Akihiko Yokoyama, 'Smart Grid: Technology and Applications', Wiley, 2012.
3. Mini S. Thomas, John D McDonald, 'Power System SCADA and Smart Grids', CRC Press, 2015
4. Kenneth C.Budka, Jayant G. Deshpande, Marina Thottan, 'Communication Networks for Smart Grids', Springer, 2014
5. SMART GRID Fundamentals of Design and Analysis, James Momoh, IEEE press, A John Wiley & Sons, Inc., Publication.

MAPPING OF CO'S WITH PO'S

CO	PO					
	1	2	3	4	5	6
1	3	2	-	2	2	2
2	3	-	2	2	-	2
3	2	-	1	-	-	-
4	1	-	-	3	3	1
5	-	2	2	2	2	3
AVG	2.25	2	1.66	2.25	2.3	2

COURSE OBJECTIVES:

- To learn the core fundamentals of system and web security concepts
- To have thorough understanding in the security concepts related to networks
- To deploy the security essentials in IT Sector
- To be exposed to the concepts of Cyber Security and cloud security
- To perform a detailed study of Privacy and Storage security and related Issues

UNIT I SYSTEM SECURITY 9

Model of network security – Security attacks, services and mechanisms – OSI security architecture -A Cryptography primer- Intrusion detection system- Intrusion Prevention system - Security web applications- Case study: OWASP - Top 10 Web Application Security Risks.

UNIT II NETWORK SECURITY 9

Internet Security - Intranet security- Local Area Network Security - Wireless Network Security - Wireless Sensor Network Security- Cellular Network Security - Mobile security - IOT security - Case Study - Kali Linux.

UNIT III SECURITY MANAGEMENT 9

Information security essentials for IT Managers- Security Management System - Policy Driven System Management- IT Security - Online Identity and User Management System. Case study: Metasploit

UNIT IV CYBER SECURITY AND CLOUD SECURITY 9

Cyber Forensics- Disk Forensics – Network Forensics – Wireless Forensics – Database Forensics – Malware Forensics – Mobile Forensics – Email Forensics- Best security practices for automate Cloud infrastructure management – Establishing trust in IaaS, PaaS, and SaaS Cloud types. Case study: DVWA

UNIT V PRIVACY AND STORAGE SECURITY 9

Privacy on the Internet - Privacy Enhancing Technologies - Personal privacy Policies - Detection of Conflicts in security policies- privacy and security in environment monitoring systems. Storage Area Network Security - Storage Area Network Security Devices - Risk management - Physical Security Essentials.

TOTAL: 45 PERIODS**COURSE OUTCOMES:**

- CO1:** Understand the core fundamentals of system security
CO2: Apply the security concepts to wired and wireless networks
CO3: Implement and Manage the security essentials in IT Sector
CO4: Explain the concepts of Cyber Security and Cyber forensics
CO5: Be aware of Privacy and Storage security Issues.

REFERENCES

1. John R. Vacca, Computer and Information Security Handbook, Third Edition, Elsevier 2017
2. Michael E. Whitman, Herbert J. Mattord, Principles of Information Security, Seventh Edition, Cengage Learning, 2022
3. Richard E. Smith, Elementary Information Security, Third Edition, Jones and Bartlett Learning, 2019

4. Mayor, K.K.Mookhey, Jacopo Cervini, Fairuzan Roslan, Kevin Beaver, Metasploit Toolkit for Penetration Testing, Exploit Development and Vulnerability Research, Syngress publications, Elsevier, 2007. ISBN : 978-1-59749-074-0
5. John Sammons, "The Basics of Digital Forensics- The Primer for Getting Started in Digital Forensics", Syngress, 2012
6. Cory Altheide and Harlan Carvey, "Digital Forensics with Open Source Tools",2011 Syngress, ISBN: 9781597495875.
7. Siani Pearson, George Yee "Privacy and Security for Cloud Computing" Computer Communications and Networks, Springer, 2013.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	1	2	1	1	2	1
2	2	1	3	1	1	2
3			2	3	3	3
4	2	2	1	2	1	3
5	1		1	1	2	3
Avg	1.50	1.67	1.60	1.60	1.80	2.40

MP4251

CLOUD COMPUTING TECHNOLOGIES

L T P C
3 0 0 3

COURSE OBJECTIVES:

- To gain expertise in Virtualization, Virtual Machines and deploy practical virtualization solution
- To understand the architecture, infrastructure and delivery models of cloud computing.
- To explore the roster of AWS services and illustrate the way to make applications in AWS
- To gain knowledge in the working of Windows Azure and Storage services offered by Windows Azure
- To develop the cloud application using various programming model of Hadoop and Aneka

UNIT I VIRTUALIZATION AND VIRTUALIZATION INFRASTRUCTURE

Basics of Virtual Machines - Process Virtual Machines – System Virtual Machines –Emulation Interpretation – Binary Translation - Taxonomy of Virtual Machines. Virtualization –Managem Virtualization — Hardware Maximization – Architectures – Virtualization Management – Stora Virtualization – Network Virtualization- Implementation levels of virtualization – virtualization structure virtualization of CPU, Memory and I/O devices – virtual clusters and Resource Management Virtualization for data center automation

UNIT II CLOUD PLATFORM ARCHITECTURE

Cloud Computing: Definition, Characteristics - Cloud deployment models: public, private, hybr community – Categories of cloud computing: Everything as a service: Infrastructure, platform, software- Generic Cloud Architecture Design – Layered cloud Architectural Development – Architectural Desi Challenges

UNIT III AWS CLOUD PLATFORM - IAAS

Amazon Web Services: AWS Infrastructure- AWS API- AWS Management Console - Setting up AV Storage - Stretching out with Elastic Compute Cloud - Elastic Container Service for Kubernetes- AV Developer Tools: AWS Code Commit, AWS Code Build, AWS Code Deploy, AWS Code Pipeline, AV

code Star - AWS Management Tools: Cloud Watch, AWS Auto Scaling, AWS control Tower, CloudFormation, Cloud Trail, AWS License Manager

UNIT IV PAAS CLOUD PLATFORM

Windows Azure: Origin of Windows Azure, Features, The Fabric Controller – First Cloud APP in Windows Azure- Service Model and Managing Services: Definition and Configuration, Service runtime API- Windows Azure Developer Portal- Service Management API- Windows Azure Storage Characteristics-Storage Services- REST API- Blobs

UNIT V PROGRAMMING MODEL

Introduction to Hadoop Framework - Mapreduce, Input splitting, map and reduce functions, specifying input and output parameters, configuring and running a job –Developing Map Reduce Applications - Design of Hadoop file system –Setting up Hadoop Cluster- Aneka: Cloud Application Platform, Thread Programming, Task Programming and Map-Reduce Programming in Aneka

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- CO1:** Employ the concepts of virtualization in the cloud computing
- CO2:** Identify the architecture, infrastructure and delivery models of cloud computing
- CO3:** Develop the Cloud Application in AWS platform
- CO4:** Apply the concepts of Windows Azure to design Cloud Application
- CO5:** Develop services using various Cloud computing programming models.

REFERENCES

1. Bernard Golden, Amazon Web Service for Dummies, John Wiley & Sons, 2013.
2. Raoul Alongi, AWS: The Most Complete Guide to Amazon Web Service from Beginner to Advanced Level, Amazon Asia- Pacific Holdings Private Limited, 2019.
3. Sriram Krishnan, Programming: Windows Azure, O'Reilly, 2010.
4. Rajkumar Buyya, Christian Vacchiola, S.Thamarai Selvi, Mastering Cloud Computing , McGraw Hill Education (India) Pvt. Ltd., 2013.
5. Danielle Ruest, Nelson Ruest, –Virtualization: A Beginner's Guidell, McGraw-Hill Osborne Media, 2009.
6. Jim Smith, Ravi Nair , "Virtual Machines: Versatile Platforms for Systems and Processes", Elsevier/Morgan Kaufmann, 2005.
7. John W.Rittinghouse and James F.Ransome, "Cloud Computing: Implementation, Management, and Security", CRC Press, 2010.
8. Toby Velte, Anthony Velte, Robert Elsenpeter, "Cloud Computing, A Practical Approach", McGraw-Hill Osborne Media, 2009.
9. Tom White, "Hadoop: The Definitive Guide", Yahoo Press, 2012.

IF4072

DESIGN THINKING

L T P C
3 0 0 3

COURSE OBJECTIVES:

- To provide a sound knowledge in UI & UX
- To understand the need for UI and UX
- Research Methods used in Design
- Tools used in UI & UX
- Creating a wireframe and prototype

REFERENCES

1. UX for Developers: How to Integrate User-Centered Design Principles Into Your Day-to-Day Development Work, Westley Knight. Apress, 2018
2. The UX Book: Process and Guidelines for Ensuring a Quality User Experience, Rex Hartson, Pardha Pyla. Morgan Kaufmann, 2012
3. UX Fundamentals for Non-UX Professionals: User Experience Principles for Managers, Writers, Designers, and Developers, Edward Stull. Apress, 2018
4. Lean UX: Designing Great Products with Agile Teams, Gothelf, Jeff, Seiden, and Josh. O'Reilly Media, 2016
5. Designing UX: Prototyping: Because Modern Design is Never Static, Ben Coleman, and Dan Goodwin. SitePoint, 2017

MU4153

PRINCIPLES OF MULTIMEDIA

L T P C
3 0 0 3

COURSE OBJECTIVES:

- To get familiarity with gamut of multimedia and its significance
- To acquire knowledge in multimedia components.
- To acquire knowledge about multimedia tools and authoring.
- To acquire knowledge in the development of multimedia applications.
- To explore the latest trends and technologies in multimedia

UNIT I INTRODUCTION

9

Introduction to Multimedia – Characteristics of Multimedia Presentation – Multimedia Components – Promotion of Multimedia Based Components – Digital Representation – Media and Data Streams – Multimedia Architecture – Multimedia Documents, Multimedia Tasks and Concerns, Production, sharing and distribution, Hypermedia, WWW and Internet, Authoring, Multimedia over wireless and mobile networks.

Suggested Activities:

1. Flipped classroom on media Components.
2. External learning – Interactive presentation.

Suggested Evaluation Methods:

1. Tutorial – Handling media components
2. Quizzes on different types of data presentation.

UNIT II ELEMENTS OF MULTIMEDIA

9

Text-Types, Font, Unicode Standard, File Formats, Graphics and Image data representations – data types, file formats, color models; video – color models in video, analog video, digital video, file formats, video display interfaces, 3D video and TV: Audio – Digitization, SNR, SQNR, quantization, audio quality, file formats, MIDI; Animation- Key Frames and Tweening, other Techniques, 2D and 3D Animation.

Suggested Activities:

1. Flipped classroom on different file formats of various media elements.
2. External learning – Adobe after effects, Adobe Media Encoder, Adobe Audition.

Suggested Evaluation Methods:

1. Demonstration on after effects animations.
2. Quizzes on file formats and color models.

UNIT III MULTIMEDIA TOOLS

9

Authoring Tools – Features and Types – Card and Page Based Tools – Icon and Object Based Tools – Time Based Tools – Cross Platform Authoring Tools – Editing Tools – Painting and Drawing Tools – 3D Modeling and Animation Tools – Image Editing Tools – Sound Editing Tools – Digital Movie Tools.

Suggested Activities:

1. Flipped classroom on multimedia tools.
2. External learning – Comparison of various authoring tools.

Suggested Evaluation Methods:

1. Tutorial – Audio editing tool.
2. Quizzes on animation tools.

UNIT IV MULTIMEDIA SYSTEMS

9

Compression Types and Techniques: CODEC, Text Compression: GIF Coding Standards, JPEG standard – JPEG 2000, basic audio compression – ADPCM, MPEG Psychoacoustics, basic Video compression techniques – MPEG, H.26X – Multimedia Database System – User Interfaces – OS Multimedia Support – Hardware Support – Real Time Protocols – Play Back Architectures – Synchronization – Document Architecture – Hypermedia Concepts: Hypermedia Design – Digital Copyrights, Content analysis.

Suggested Activities:

1. Flipped classroom on concepts of multimedia hardware architectures.
2. External learning – Digital repositories and hypermedia design.

Suggested Evaluation Methods:

1. Quizzes on multimedia hardware and compression techniques.
2. Tutorial – Hypermedia design.

UNIT V MULTIMEDIA APPLICATIONS FOR THE WEB AND MOBILE PLATFORMS

9

ADDIE Model – Conceptualization – Content Collection – Storyboard–Script Authoring Metaphors – Testing – Report Writing – Documentation. Multimedia for the web and mobile platforms. Virtual Reality, Internet multimedia content distribution, Multimedia Information sharing – social media sharing, cloud computing for multimedia services, interactive cloud gaming. Multimedia information retrieval.

Suggested Activities:

1. External learning – Game consoles.
2. External learning – VRML scripting languages.

Suggested Evaluation Methods:

1. Demonstration of simple interactive games.
2. Tutorial – Simple VRML program.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

CO1:Handle the multimedia elements effectively.

CO2:Articulate the concepts and techniques used in multimedia applications.

CO3:Develop effective strategies to deliver Quality of Experience in multimedia applications.

CO4:Design and implement algorithms and techniques applied to multimedia objects.

CO5:Design and develop multimedia applications following software engineering models.

REFERENCES:

1. Li, Ze-Nian, Drew, Mark, Liu, Jiangchuan, “Fundamentals of Multimedia”, Springer, Third Edition, 2021.
2. Prabhat K.Andleigh, Kiran Thakrar, “MULTIMEDIA SYSTEMS DESIGN”, Pearson Education, 2015.

3. Gerald Friedland, Ramesh Jain, "Multimedia Computing", Cambridge University Press, 2018. (digital book)
4. Ranjan Parekh, "Principles of Multimedia", Second Edition, McGraw-Hill Education, 2017

DS4015

BIG DATA ANALYTICS

**L T P C
3 0 0 3**

COURSE OBJECTIVES:

- To understand the basics of big data analytics
- To understand the search methods and visualization
- To learn mining data streams
- To learn frameworks
- To gain knowledge on R language

UNIT I INTRODUCTION TO BIG DATA

9

Introduction to Big Data Platform – Challenges of Conventional Systems - Intelligent data analysis – Nature of Data - Analytic Processes and Tools - Analysis Vs Reporting - Modern Data Analytic Tools- Statistical Concepts: Sampling Distributions - Re-Sampling - Statistical Inference - Prediction Error.

UNIT II SEARCH METHODS AND VISUALIZATION

9

Search by simulated Annealing – Stochastic, Adaptive search by Evaluation – Evaluation Strategies Genetic Algorithm – Genetic Programming – Visualization – Classification of Visual Data Analysis Techniques – Data Types – Visualization Techniques – Interaction techniques – Specific Visual data analysis Techniques

UNIT III MINING DATA STREAMS

9

Introduction To Streams Concepts – Stream Data Model and Architecture - Stream Computing -Sampling Data in a Stream – Filtering Streams – Counting Distinct Elements in a Stream – Estimating Moments Counting Oneness in a Window – Decaying Window - Real time Analytics Platform(RTAP) Applications: Case Studies - Real Time Sentiment Analysis, Stock Market Predictions

UNIT IV FRAMEWORKS

9

MapReduce – Hadoop, Hive, MapR – Sharding – NoSQL Databases - S3 - Hadoop Distributed File Systems – Case Study- Preventing Private Information Inference Attacks on Social Networks- Grand Challenge: Applying Regulatory Science and Big Data to Improve Medical Device Innovation

UNIT V R LANGUAGE

9

Overview, Programming structures: Control statements -Operators -Functions -Environment and scope issues -Recursion -Replacement functions, R data structures: Vectors -Matrices and arrays -Lists -Data frames -Classes, Input/output, String manipulations

COURSE OUTCOMES:

- CO1: understand the basics of big data analytics
- CO2: Ability to use Hadoop, Map Reduce Framework.
- CO3: Ability to identify the areas for applying big data analytics for increasing the business outcome.
- CO4: gain knowledge on R language
- CO5: Contextually integrate and correlate large amounts of information to gain faster insights.

TOTAL:45 PERIODS

REFERENCE:

1. Michael Berthold, David J. Hand, Intelligent Data Analysis, Springer, 2007.
2. Anand Rajaraman and Jeffrey David Ullman, Mining of Massive Datasets, Cambridge University Press, 3rd edition 2020.
3. Norman Matloff, The Art of R Programming: A Tour of Statistical Software Design, No Starch Press, USA, 2011.
4. Bill Franks, Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics, John Wiley & sons, 2012.
5. Glenn J. Myatt, Making Sense of Data, John Wiley & Sons, 2007.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	3	3	3	3	2	1
2	3	3	3	3	2	1
3	3	3	3	3	2	1
4	3	3	3	3	2	1
5	3	3	3	3	2	1
Avg	3	3	3	3	2	1

NC4201

INTERNET OF THINGS AND CLOUD

L T P C
3 0 0 3

COURSE OBJECTIVES:

- To understand Smart Objects and IoT Architectures
- To learn about various IOT-related protocols
- To build simple IoT Systems using Arduino and Raspberry Pi.
- To understand data analytics and cloud in the context of IoT
- To develop IoT infrastructure for popular applications

UNIT I FUNDAMENTALS OF IoT

9

Introduction to IoT – IoT definition – Characteristics – IoT Complete Architectural Stack – IoT enabling Technologies – IoT Challenges. Sensors and Hardware for IoT – Hardware Platforms – Arduino, Raspberry Pi, Node MCU. A Case study with any one of the boards and data acquisition from sensors.

UNIT II PROTOCOLS FOR IoT

9

Infrastructure protocol (IPV4/V6/RPL), Identification (URIs), Transport (Wifi, Lifi, BLE), Discovery, Data Protocols, Device Management Protocols. – A Case Study with MQTT/CoAP usage-IoT privacy, security and vulnerability solutions.

UNIT III CASE STUDIES/INDUSTRIAL APPLICATIONS 9
 Case studies with architectural analysis: IoT applications – Smart City – Smart Water – Smart Agriculture – Smart Energy – Smart Healthcare – Smart Transportation – Smart Retail – Smart waste management.

UNIT IV CLOUD COMPUTING INTRODUCTION 9
 Introduction to Cloud Computing - Service Model – Deployment Model- Virtualization Concepts – Cloud Platforms – Amazon AWS – Microsoft Azure – Google APIs.

UNIT V IoT AND CLOUD 9
 IoT and the Cloud - Role of Cloud Computing in IoT - AWS Components - S3 – Lambda - AWS IoT Core - Connecting a web application to AWS IoT using MQTT- AWS IoT Examples. Security Concerns, Risk Issues, and Legal Aspects of Cloud Computing- Cloud Data Security

TOTAL:45 PERIODS

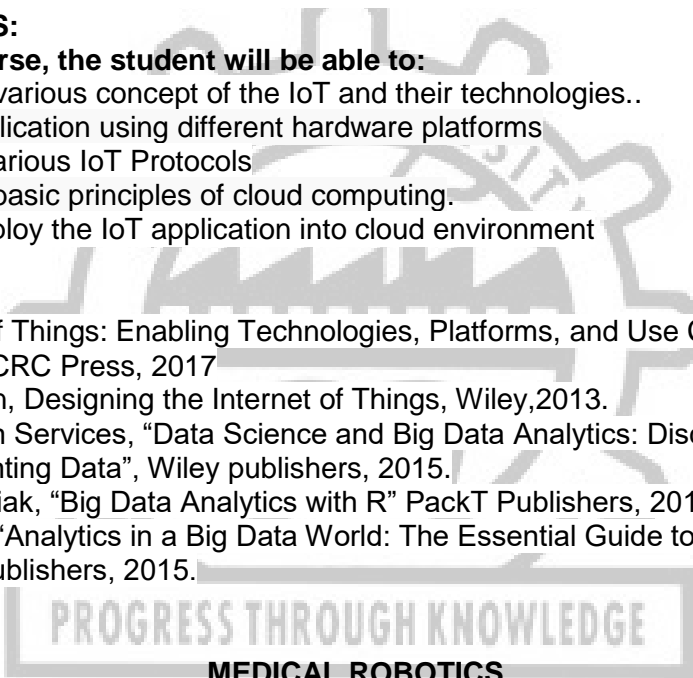
COURSE OUTCOMES:

At the end of the course, the student will be able to:

- CO1:** Understand the various concept of the IoT and their technologies..
- CO2:** Develop IoT application using different hardware platforms
- CO3:** Implement the various IoT Protocols
- CO4:** Understand the basic principles of cloud computing.
- CO5:** Develop and deploy the IoT application into cloud environment

REFERENCES

1. "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", by Pethuru Raj and Anupama C. Raman ,CRC Press, 2017
2. Adrian McEwen, Designing the Internet of Things, Wiley,2013.
3. EMC Education Services, "Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data", Wiley publishers, 2015.
4. Simon Walkowiak, "Big Data Analytics with R" PackT Publishers, 2016
5. Bart Baesens, "Analytics in a Big Data World: The Essential Guide to Data Science and its Applications", Wiley Publishers, 2015.



MX4073

MEDICAL ROBOTICS

**L T P
3 0 0**

COURSE OBJECTIVES:

- To explain the basic concepts of robots and types of robots
- To discuss the designing procedure of manipulators, actuators and grippers
- To impart knowledge on various types of sensors and power sources
- To explore various applications of Robots in Medicine
- To impart knowledge on wearable robots

UNIT I INTRODUCTION TO ROBOTICS

Introduction to Robotics, Overview of robot subsystems, Degrees of freedom, configurations a concept of workspace, Dynamic Stabilization

Sensors and Actuators

Sensors and controllers, Internal and external sensors, position, velocity and acceleration sensor Proximity sensors, force sensors Pneumatic and hydraulic actuators, Stepper motor control circuit End effectors, Various types of Grippers, PD and PID feedback actuator models

UNIT II MANIPULATORS & BASIC KINEMATICS

Construction of Manipulators, Manipulator Dynamic and Force Control, Electronic and pneumatic manipulator, Forward Kinematic Problems, Inverse Kinematic Problems, Solutions of Inverse Kinematic problems

Navigation and Treatment Planning

Variable speed arrangements, Path determination – Machinery vision, Ranging – Laser – Acoustic Magnetic, fiber optic and Tactile sensor

UNIT III SURGICAL ROBOTS

Da Vinci Surgical System, Image guided robotic systems for focal ultrasound based surgical applications, System concept for robotic Tele-surgical system for off-pump, CABG surgery, Urologic applications, Cardiac surgery, Neuro-surgery, Pediatric and General Surgery, Gynecologic Surgery, General Surgery and Nanorobotics. Case Study

UNIT IV REHABILITATION AND ASSISTIVE ROBOTS

Pediatric Rehabilitation, Robotic Therapy for the Upper Extremity and Walking, Clinical-Based Gait Rehabilitation Robots, Motion Correlation and Tracking, Motion Prediction, Motion Replication, Portable Robot for Tele rehabilitation, Robotic Exoskeletons – Design considerations, Hybrid assistive limb. Case Study

UNIT V WEARABLE ROBOTS

Augmented Reality, Kinematics and Dynamics for Wearable Robots, Wearable Robot technology, Sensors, Actuators, Portable Energy Storage, Human-robot cognitive interaction (cHRI), Human-robot physical interaction (pHRI), Wearable Robotic Communication - case study

TOTAL:45 PERIODS

COURSE OUTCOMES:

- CO1:** Describe the configuration, applications of robots and the concept of grippers and actuators
- CO2:** Explain the functions of manipulators and basic kinematics
- CO3:** Describe the application of robots in various surgeries
- CO4:** Design and analyze the robotic systems for rehabilitation
- CO5:** Design the wearable robots

REFERENCES

1. Nagrath and Mittal, "Robotics and Control", Tata McGraw Hill, First edition, 2003
2. Spong and Vidhyasagar, "Robot Dynamics and Control", John Wiley and Sons, First edition, 2008
3. Fu.K.S, Gonzalez. R.C., Lee, C.S.G, "Robotics, control", sensing, Vision and Intelligent Systems, Tata McGraw Hill International, First edition, 2008
4. Bruno Siciliano, Oussama Khatib, Springer Handbook of Robotics, 1st Edition, Springer, 2008
5. Shane (S.Q.) Xie, Advanced Robotics for Medical Rehabilitation - Current State of the Art and Recent Advances, Springer, 2016
6. Sashi S Kommu, Rehabilitation Robotics, I-Tech Education and Publishing, 2007
7. Jose L. Pons, Wearable Robots: Biomechatronic Exoskeletons, John Wiley & Sons Ltd, England, 2008
8. Howie Choset, Kevin Lynch, Seth Hutchinson, "Principles of Robot Motion: Theory, Algorithms, and Implementations", Prentice Hall of India, First edition, 2005
9. Philippe Coiffet, Michel Chirouze, "An Introduction to Robot Technology", Tata McGraw Hill, First Edition, 1983
10. Jacob Rosen, Blake Hannaford & Richard M Satava, "Surgical Robotics: System Applications & Visions", Springer 2011

11. Jocelyn Troccaz, Medical Robotics, Wiley, 2012
12. Achim Schweikard, Floris Ernst, Medical Robotics, Springer, 2015

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1				1		
2				2		
3	2		2	2	2	2
4	2		2	2	3	2
5	2		2	2	3	3
Avg	2		2	1.8	2.6	2.3

VE4202

EMBEDDED AUTOMATION

L T P C
3 0 0 3

COURSE OBJECTIVES:

- To learn about the process involved in the design and development of real-time embedded system
- To develop the embedded C programming skills on 8-bit microcontroller
- To study about the interfacing mechanism of peripheral devices with 8-bit microcontrollers
- To learn about the tools, firmware related to microcontroller programming
- To build a home automation system

UNIT - I INTRODUCTION TO EMBEDDED C PROGRAMMING 9

C Overview and Program Structure - C Types, Operators and Expressions - C Control Flow - C Functions and Program Structures - C Pointers And Arrays - FIFO and LIFO - C Structures - Development Tools

UNIT - II AVR MICROCONTROLLER 9

ATMEGA 16 Architecture - Nonvolatile and Data Memories - Port System - Peripheral Features : Time Base, Timing Subsystem, Pulse Width Modulation, USART, SPI, Two Wire Serial Interface, ADC, Interrupts - Physical and Operating Parameters

UNIT – III HARDWARE AND SOFTWARE INTERFACING WITH 8-BIT SERIES CONTROLLERS 9

Lights and Switches - Stack Operation - Implementing Combinational Logic - Expanding I/O - Interfacing Analog To Digital Convertors - Interfacing Digital To Analog Convertors - LED Displays : Seven Segment Displays, Dot Matrix Displays - LCD Displays - Driving Relays - Stepper Motor Interface - Serial EEPROM - Real Time Clock - Accessing Constants Table - Arbitrary Waveform Generation - Communication Links - System Development Tools

UNIT – IV VISION SYSTEM 9

Fundamentals of Image Processing - Filtering - Morphological Operations - Feature Detection and Matching - Blurring and Sharpening - Segmentation - Thresholding - Contours - Advanced Contour Properties - Gradient - Canny Edge Detector - Object Detection - Background Subtraction

UNIT – V HOME AUTOMATION 9

Home Automation - Requirements - Water Level Notifier - Electric Guard Dog - Tweeting Bird Feeder - Package Delivery Detector - Web Enabled Light Switch - Curtain Automation - Android Door Lock - Voice Controlled Home Automation - Smart Lighting - Smart Mailbox - Electricity Usage Monitor - Proximity Garage Door Opener - Vision Based Authentic Entry System

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of this course, students will be able to

CO1: analyze the 8-bit series microcontroller architecture, features and pin details

CO2: write embedded C programs for embedded system application

CO3: design and develop real time systems using AVR microcontrollers

CO4: design and develop the systems based on vision mechanism

CO5: design and develop a real time home automation system

REFERENCES:

1. Dhananjay V. Gadre, "Programming and Customizing the AVR Microcontroller", McGraw-Hill, 2001.
2. Joe Pardue, "C Programming for Microcontrollers ", Smiley Micros, 2005.
3. Steven F. Barrett, Daniel J. Pack, "ATMEL AVR Microcontroller Primer : Programming and Interfacing", Morgan & Claypool Publishers, 2012
4. Mike Riley, "Programming Your Home - Automate With Arduino, Android and Your Computer", the Pragmatic Programmers, Llc, 2012.
5. Richard Szeliski, "Computer Vision: Algorithms and Applications", Springer, 2011.
6. Kevin P. Murphy, "Machine Learning - a Probabilistic Perspective", the MIT Press Cambridge, Massachusetts, London, 2012.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	<u>1</u>		<u>1</u>	<u>1</u>	<u>1</u>	
2	<u>1</u>	3	<u>1</u>	<u>1</u>	<u>1</u>	3
3	<u>1</u>	3	<u>1</u>	<u>1</u>	<u>1</u>	3
4	<u>1</u>	3	<u>1</u>	<u>1</u>	<u>1</u>	3
5	<u>1</u>	3	<u>1</u>	<u>1</u>	<u>1</u>	3
Avg	<u>(5/5)=1</u>	(12/4)=3	<u>(5/5)=1</u>	<u>(5/5)=1</u>	<u>(5/5)=1</u>	(12/4)=3

CX4016**ENVIRONMENTAL SUSTAINABILITY**

L T P C
3 0 0 3

UNIT I INTRODUCTION**9**

Valuing the Environment: Concepts, Valuing the Environment: Methods, Property Rights, Externalities, and Environmental Problems

UNIT II CONCEPT OF SUSTAINABILITY**9**

Sustainable Development: Defining the Concept, the Population Problem, Natural Resource Economics: An Overview, Energy, Water, Agriculture

UNIT III SIGNIFICANCE OF BIODIVERSITY**9**

Biodiversity, Forest Habitat, Commercially Valuable Species, Stationary - Source Local Air Pollution, Acid Rain and Atmospheric Modification, Transportation

UNIT IV POLLUTION IMPACTS**9**

Water Pollution, Solid Waste and Recycling, Toxic Substances and Hazardous Wastes, Global Warming.

UNIT V ENVIRONMENTAL ECONOMICS**9**

Development, Poverty, and the Environment, Visions of the Future, Environmental economics and policy by Tom Tietenberg, Environmental Economics

TOTAL : 45 PERIODS**REFERENCES**

1. Andrew Hoffman, Competitive Environmental Strategy - A Guide for the Changing Business Landscape, Island Press.
2. Stephen Doven, Environment and Sustainability Policy: Creation, Implementation, Evaluation, the Federation Press, 2005
3. Robert Brinkmann., Introduction to Sustainability, Wiley-Blackwell., 2016
4. Niko Roorda., Fundamentals of Sustainable Development, 3rd Edn, Routledge, 2020
5. Bhavik R Bakshi., Sustainable Engineering: Principles and Practice, Cambridge University Press, 2019

TX4092**TEXTILE REINFORCED COMPOSITES****L T P C****3 0 0 3****UNIT I REINFORCEMENTS****9**

Introduction – composites –classification and application; reinforcements- fibres and its properties; preparation of reinforced materials and quality evaluation; preforms for various composites

UNIT II MATRICES**9**

Preparation, chemistry, properties and applications of thermoplastic and thermoset resins; mechanism of interaction of matrices and reinforcements; optimization of matrices

UNIT III COMPOSITE MANUFACTURING**9**

Classification; methods of composites manufacturing for both thermoplastics and thermosets- Hand layup, Filament Winding, Resin transfer moulding, prepregs and autoclave moulding, pultrusion, vacuum impregnation methods, compression moulding; post processing of composites and composite design requirements

UNIT IV TESTING**9**

Fibre volume and weight fraction, specific gravity of composites, tensile, flexural, impact, compression, inter laminar shear stress and fatigue properties of thermoset and thermoplastic composites.

UNIT V MECHANICS**9**

Micro mechanics, macro mechanics of single layer, macro mechanics of laminate, classical lamination theory, failure theories and prediction of inter laminar stresses using at ware

TOTAL: 45 PERIODS**REFERENCES**

1. BorZ.Jang, "Advanced Polymer composites", ASM International, USA, 1994.
2. Carlsson L.A. and Pipes R.B., "Experimental Characterization of advanced composite Materials", Second Edition, CRC Press, New Jersey, 1996.
3. George Lubin and Stanley T. Peters, "Handbook of Composites", Springer Publications, 1998.
4. Mel. M. Schwartz, "Composite Materials", Vol. 1 & 2, Prentice Hall PTR, New Jersey, 1997.
5. Richard M. Christensen, "Mechanics of composite materials", Dover Publications, 2005.
6. Sanjay K. Mazumdar, "Composites Manufacturing: Materials, Product, and Process

NT4002

NANOCOMPOSITE MATERIALS

L T P C
3 0 0 3

UNIT I BASICS OF NANOCOMPOSITES 9

Nomenclature, Properties, features and processing of nanocomposites. Sample Preparation and Characterization of Structure and Physical properties. Designing, stability and mechanical properties and applications of super hard nanocomposites.

UNIT II METAL BASED NANOCOMPOSITES 9

Metal-metal nanocomposites, some simple preparation techniques and their properties. Metal- Oxide or Metal-Ceramic composites, Different aspects of their preparation techniques and their final properties and functionality. Fractal based glass-metal nanocomposites, its designing and fractal dimension analysis. Core-Shell structured nanocomposites

UNIT III POLYMER BASED NANOCOMPOSITES 9

Preparation and characterization of diblock Copolymer based nanocomposites; Polymer Carbon nanotubes based composites, their mechanical properties, and industrial possibilities.

UNIT IV NANOCOMPOSITE FROM BIOMATERIALS 9

Natural nanocomposite systems - spider silk, bones, shells; organic-inorganic nanocomposite formation through self-assembly. Biomimetic synthesis of nanocomposites material; Use of synthetic nanocomposites for bone, teeth replacement.

UNIT V NANOCOMPOSITE TECHNOLOGY 9

Nanocomposite membrane structures- Preparation and applications. Nanotechnology in Textiles and Cosmetics-Nano-fillers embedded polypropylene fibers – Soil repellence, Lotus effect - Nano finishing in textiles (UV resistant, anti-bacterial, hydrophilic, self-cleaning, flame retardant finishes), Sun-screen dispersions for UV protection using titanium oxide – Colour cosmetics. Nanotechnology in Food Technology - Nanopackaging for enhanced shelf life - Smart/Intelligent packaging.

TOTAL : 45 PERIODS

REFERENCES:

1. Introduction to Nanocomposite Materials. Properties, Processing, Characterization- Thomas E. Twardowski. 2007. DEStech Publications. USA.
2. Nanocomposites Science and Technology - P. M. Ajayan, L.S. Schadler, P. V. Braun 2006.
3. Physical Properties of Carbon Nanotubes- R. Saito 1998.
4. Carbon Nanotubes (Carbon , Vol 33) - M. Endo, S. Iijima, M.S. Dresselhaus 1997.

5. The search for novel, superhard materials- Stan Veprjek (Review Article) JVST A, 1999
6. Nanometer versus micrometer-sized particles-Christian Brosseau, Jamal BeN Youssef, Philippe Talbot, Anne-Marie Konn, (Review Article) J. Appl. Phys, Vol 93, 2003
7. Diblock Copolymer, - Aviram (Review Article), Nature, 2002
8. Bikramjit Basu, Kantesh Balani Advanced Structural Ceramics, A John Wiley & Sons, Inc.,
9. P. Brown and K. Stevens, Nanofibers and Nanotechnology in Textiles, Woodhead publication, London, 2006

BY4016

IPR, BIOSAFETY AND ENTREPRENEURSHIP

LT P C

3 0 0 3

UNIT I IPR

9

Intellectual property rights – Origin of the patent regime – Early patents act & Indian pharmaceutical industry – Types of patents – Patent Requirements – Application preparation filing and prosecution – Patentable subject matter – Industrial design, Protection of GMO's IP as a factor in R&D, IP's of relevance to biotechnology and few case studies.

UNIT II AGREEMENTS, TREATIES AND PATENT FILING PROCEDURES

9

History of GATT Agreement – Madrid Agreement – Hague Agreement – WIPO Treaties – Budapest Treaty – PCT – Ordinary – PCT – Conventional – Divisional and Patent of Addition – Specifications – Provisional and complete – Forms and fees Invention in context of “prior art” – Patent databases – Searching International Databases – Country-wise patent searches (USPTO, espacenet(EPO) – PATENT Scope (WIPO) – IPO, etc National & PCT filing procedure – Time frame and cost – Status of the patent applications filed – Precautions while patenting – disclosure/non-disclosure – Financial assistance for patenting – Introduction to existing schemes Patent licensing and agreement Patent infringement – Meaning, scope, litigation, case studies

UNIT III BIOSAFETY

9

Introduction – Historical Background – Introduction to Biological Safety Cabinets – Primary Containment for Biohazards – Biosafety Levels – Biosafety Levels of Specific Microorganisms – Recommended Biosafety Levels for Infectious Agents and Infected Animals – Biosafety guidelines – Government of India.

UNIT IV GENETICALLY MODIFIED ORGANISMS

9

Definition of GMOs & LMOs – Roles of Institutional Biosafety Committee – RCGM – GEAC etc. for GMO applications in food and agriculture – Environmental release of GMOs – Risk Analysis – Risk Assessment – Risk management and communication – Overview of National Regulations and relevant International Agreements including Cartagena Protocol.

UNIT V ENTREPRENEURSHIP DEVELOPMENT

9

Introduction – Entrepreneurship Concept – Entrepreneurship as a career – Entrepreneurial personality – Characteristics of successful Entrepreneur – Factors affecting entrepreneurial growth – Entrepreneurial Motivation – Competencies – Mobility – Entrepreneurship Development Programmes (EDP) - Launching Of Small Enterprise - Definition, Characteristics – Relationship between small and large units – Opportunities for an Entrepreneurial career – Role of small enterprise in economic development – Problems of small scale industries – Institutional finance to entrepreneurs - Institutional support to entrepreneurs.

TOTAL : 45 PERIODS

REFERENCES

1. Bouchoux, D.E., "Intellectual Property: The Law of Trademarks, Copyrights, Patents, and Trade Secrets for the Paralegal", 3rd Edition, Delmar Cengage Learning, 2008.
2. Fleming, D.O. and Hunt, D.L., "Biological Safety: Principles and Practices", 4th Edition, American Society for Microbiology, 2006.
3. Irish, V., "Intellectual Property Rights for Engineers", 2nd Edition, The Institution of Engineering and Technology, 2005.
4. Mueller, M.J., "Patent Law", 3rd Edition, Wolters Kluwer Law & Business, 2009.
5. Young, T., "Genetically Modified Organisms and Biosafety: A Background Paper for Decision-Makers and Others to Assist in Consideration of GMO Issues" 1st Edition, World Conservation Union, 2004.
6. S.S Khanka, "Entrepreneurial Development", S.Chand & Company LTD, New Delhi, 2007.



ANNA UNIVERSITY, CHENNAI
NON- AUTONOMOUS COLLEGES AFFILIATED ANNA UNIVERSITY
M.E. COMMUNICATION SYSTEMS
REGULATIONS – 2021
CHOICE BASED CREDIT SYSTEM

1. PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

- I. Apply technical knowledge and skills to have successful career in industry, government and academia as communication engineers
- II. Pursue multidisciplinary scientific research in communication and related areas
- III. Make use of various state-of art systems and cutting edge technologies to solve various complex engineering problems
- IV. Inculcate leadership skills, team work, effective communication and lifelong learning to the success of their organization and nation
- V. Practice ethics and exhibit commitment in profession to empower / enable rural communication infrastructure

2. PROGRAM OUTCOMES (POs)

1. An ability to independently carry out research/investigation and development work to solve practical problems
2. An ability to write and present a substantial technical report/document
3. Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program
4. Design and analyze RF, Signal processing, Networking, Adaptive and modern communication systems
5. Develop the knowledge in 5G communication techniques, mm wave communication, smart antennas, Massive MIMO and Wireless sensor networks
6. Apply various software tools and cutting edge engineering hardware to provide solutions for complex communication engineering problems

PROGRESS THROUGH KNOWLEDGE

MAPPING OF COURSE OUTCOMES AND PROGRAMME OUTCOMES

		COURSE NAME	PO1	PO2	PO3	PO4	PO5	PO6
YEAR I	SEMESTER I	Linear Algebra, Probability and Queueing Theory						
		Research Methodology and IPR						
		Statistical Signal Processing	3	1	1	1	3	3
		Modern Digital Communication Systems	2.4	-	3	2.4	2.6	1
		Advanced Wireless Communication	1.8	1	1	1.25	1.5	1.6
		Radiating Systems	2.2	2	1.8	1.8	2	2
		Digital Communication Systems Laboratory	2	3	3	2.1	3	2
		Advanced Digital Signal Processing Laboratory	1.2	1	1	1	-	1
	SEMESTER II	RF System Design	2.2	2	2.2	2.4	2.6	2
		Microwave Integrated Circuits	2.2	2	2.2	3	3	2.8
		Advanced Wireless Networks	3	-	3	3	2	3
		Machine Learning	3	1	2	-	-	3
		Wireless Communication Laboratory	1.8	1.8	1.6	1	1	1.6
		Term Paper Writing and seminar	1.6	1.6	1.8	1.8	1.8	-
YEAR II	SEMESTER III	Optical Communication and Networking	3	3	3	2	2.5	2
		Project Work I						
	SEMESTER IV	Project Work II						

PROGRESS THROUGH KNOWLEDGE

ANNA UNIVERSITY, CHENNAI
NON - AUTONOMOUS COLLEGES AFFILIATED ANNA UNIVERSITY
M.E. COMMUNICATION SYSTEMS
REGULATIONS – 2021
CHOICE BASED CREDIT SYSTEM
I TO IV SEMESTERS CURRICULA AND SYLLABI
SEMESTER I

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	MA4156	Linear Algebra, Probability and Queueing Theory	FC	3	1	0	4	4
2.	RM4151	Research Methodology and IPR	RMC	2	0	0	2	2
3.	DS4152	Statistical Signal Processing	PCC	3	0	0	3	3
4.	EL4151	Modern Digital Communication Systems	PCC	3	0	0	3	3
5.	CU4151	Advanced Wireless Communication	PCC	3	0	0	3	3
6.	CU4152	Radiating Systems	PCC	3	0	0	3	3
7.		Audit Course – I*	AC	2	0	0	2	0
PRACTICALS								
8.	EL4161	Digital Communication Systems Laboratory	PCC	0	0	3	3	1.5
9.	CU4161	Advanced Digital Signal Processing Laboratory	PCC	0	0	3	3	1.5
TOTAL				19	1	6	26	21

*Audit course is optional

SEMESTER II

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	CU4251	RF System Design	PCC	3	0	0	3	3
2.	CU4201	Microwave Integrated Circuits	PCC	3	0	2	5	4
3.	CU4202	Advanced Wireless Networks	PCC	3	0	0	3	3
4.	CP4252	Machine Learning	PCC	3	0	2	5	4
5.		Professional Elective I	PEC	3	0	0	3	3
6.		Professional Elective II	PEC	3	0	0	3	3
7.		Audit Course – II*	AC	2	0	0	2	0
PRACTICALS								
8.	CU4211	Wireless Communication Laboratory	PCC	0	0	4	4	2
9.	CU4212	Term Paper Writing and seminar	EEC	0	0	2	2	1
TOTAL				20	0	10	30	23

*Audit course is optional

SEMESTER III

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	CU4301	Optical Communication and Networking	PCC	3	0	0	3	3
2.		Professional Elective III	PEC	3	0	0	3	3
3.		Professional Elective IV	PEC	3	0	2	5	4
4.		Open Elective	OEC	3	0	0	3	3
PRACTICALS								
5.	CU4311	Project Work I	EEC	0	0	12	12	6
TOTAL				12	0	14	26	19

SEMESTER IV

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
PRACTICALS								
1.	CU4411	Project Work II	EEC	0	0	24	24	12
TOTAL				0	0	24	24	12

TOTAL NO. OF CREDITS: 75

PROFESSIONAL ELECTIVES

SEMESTER II, ELECTIVE I

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	EL4071	Electromagnetic Interference and Compatibility	PEC	3	0	0	3	3
2.	CU4071	Advanced Satellite Communication and Navigation Systems	PEC	3	0	0	3	3
3.	CU4072	High Speed Switching and Networking	PEC	3	0	0	3	3
4.	AP4095	Signal Integrity for High Speed Design	PEC	3	0	0	3	3
5.	CU4001	Wavelets and Subband Coding	PEC	3	0	0	3	3

SEMESTER II, ELECTIVE II

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	MU4091	Multimedia Compression Techniques	PEC	3	0	0	3	3
2.	NC4251	Cognitive Radio Networks	PEC	3	0	0	3	3
3.	CU4074	Speech Processing	PEC	3	0	0	3	3
4.	CU4002	mm Wave Communication	PEC	3	0	0	3	3
5.	CU4003	Analog and Mixed Signal VLSI Design	PEC	3	0	0	3	3

SEMESTER III, ELECTIVE III

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CU4075	Ultra Wide Band Communications	PEC	3	0	0	3	3
2.	CU4076	VLSI for Wireless Communication	PEC	3	0	0	3	3
3.	VL4073	MEMS and NEMS	PEC	3	0	0	3	3
4.	CU4004	Advanced Antenna Design	PEC	3	0	0	3	3
5.	CU4005	Software Defined Radios	PEC	3	0	0	3	3

SEMESTER III, ELECTIVE IV

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CU4073	Image Processing and Video Analytics	PEC	3	0	2	5	4
2.	DS4071	Radar Signal Processing	PEC	3	0	2	5	4
3.	EL4291	Telecommunication System Modeling and Simulation	PEC	3	0	2	5	4
4.	EL4072	Signal Detection and Estimation	PEC	3	0	2	5	4
5.	VE4072	Real Time Embedded Systems	PEC	3	0	2	5	4

AUDIT COURSES (AC)

Registration for any of these courses is optional to students

SL. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS
			L	T	P	
1.	AX4091	English for Research Paper Writing	2	0	0	0
2.	AX4092	Disaster Management	2	0	0	0
3.	AX4093	Constitution of India	2	0	0	0
4.	AX4094	நற்றமிழ் இலக்கியம்	2	0	0	0

LIST OF OPEN ELECTIVES FOR PG PROGRAMMES

SL. NO.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS
			L	T	P	
1.	OCE431	Integrated Water Resources Management	3	0	0	3
2.	OCE432	Water, Sanitation and Health	3	0	0	3
3.	OCE433	Principles of Sustainable Development	3	0	0	3
4.	OCE434	Environmental Impact Assessment	3	0	0	3
5.	OIC431	Blockchain Technologies	3	0	0	3
6.	OIC432	Deep Learning	3	0	0	3
7.	OME431	Vibration and Noise Control Strategies	3	0	0	3
8.	OME432	Energy Conservation and Management in Domestic Sectors	3	0	0	3
9.	OME433	Additive Manufacturing	3	0	0	3
10.	OME434	Electric Vehicle Technology	3	0	0	3
11.	OME435	New Product Development	3	0	0	3
12.	OBA431	Sustainable Management	3	0	0	3
13.	OBA432	Micro and Small Business Management	3	0	0	3
14.	OBA433	Intellectual Property Rights	3	0	0	3
15.	OBA434	Ethical Management	3	0	0	3
16.	ET4251	IoT for Smart Systems	3	0	0	3
17.	ET4072	Machine Learning and Deep Learning	3	0	0	3
18.	PX4012	Renewable Energy Technology	3	0	0	3
19.	PS4093	Smart Grid	3	0	0	3
20.	CP4391	Security Practices	3	0	0	3
21.	MP4251	Cloud Computing Technologies	3	0	0	3
22.	IF4072	Design Thinking	3	0	0	3
23.	MU4153	Principles of Multimedia	3	0	0	3
24.	CX4016	Environmental Sustainability	3	0	0	3

25.	TX4092	Textile Reinforced Composites	3	0	0	3
26.	NT4002	Nanocomposite Materials	3	0	0	3
27.	BY4016	IPR, Biosafety and Entrepreneurship	3	0	0	3

FOUNDATION COURSES (FC)

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	MA4156	Linear Algebra, Probability and Queueing Theory	3	1	0	4	I

PROFESSIONAL CORE COURSES (PCC)

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	DS4152	Statistical Signal Processing	3	0	0	3	I
2.	EL4151	Modern Digital Communication Systems	3	0	0	3	I
3.	CU4151	Advanced Wireless	3	0	0	3	I
4.	CU4152	Radiating Systems	3	0	0	3	I
5.	EL4161	Digital Communication Systems Laboratory	0	0	3	1 . 5	I
6.	CU4161	Advanced Digital Signal Processing Laboratory	0	0	3	1 . 5	I
7.	CU4251	RF System Design	3	0	0	3	II
8.	CU4201	Microwave Integrated Circuits	3	0	2	4	II
9.	CU4202	Advanced Wireless Networks	3	0	0	3	II
10.	CP4252	Machine Learning	3	0	2	4	II
11.	CU4211	Wireless Communication Laboratory	0	0	4	2	II
12.	CU4301	Optical Communication and Networking	3	0	0	3	III

RESEARCH METHODOLOGY AND IPR COURSES (RMC)

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	RM4151	Research Methodology and IPR	2	0	0	2	1

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	CU4212	Term Paper Writing and Seminar	0	0	2	1	II
2.	CU4311	Project Work I	0	0	12	6	III
3.	CU4411	Project Work II	0	0	24	12	IV

SUMMARY

Sl. No.	NAME OF THE PROGRAMME: M.E. COMMUNICATION SYSTEMS					
	SUBJECT AREA	CREDITS PER SEMESTER				CREDITS TOTAL
		I	II	III	IV	
1.	FC	04	00	00	00	04
2.	PCC	15	16	03	00	34
3.	PEC	00	06	07	00	13
4.	RMC	02	00	00	00	02
5.	OEC	00	00	03	00	03
6.	EEC	00	01	06	12	19
7.	Non Credit/Audit Course	✓	✓	00	00	
8.	TOTAL CREDIT	21	23	19	12	75

PROGRESS THROUGH KNOWLEDGE

COURSE OBJECTIVES:

The objective of this course is to enable the student to

- grasp the basic concepts of Probability, Random variables, correlation and regression.
- characterize the phenomena which evolve with respect to time in a probabilistic manner.
- encourage students to develop a working knowledge of the ventral ideas of linear algebra.
- acquire skills in analyzing Queueing Models.
- develop a fundamental understanding of linear programming models and apply the simplex method for solving linear programming problems.

UNIT – I LINEAR ALGEBRA 12

Vector spaces – Norms – Inner products – Eigenvalues using QR transformations – QR factorization – Generalized eigenvectors – Jordan Canonical forms – Singular value decomposition and applications – Pseudo inverse – Least square approximations.

UNIT – II PROBABILITY AND RANDOM VARIABLES 12

Probability Concepts – Axioms of probability – Conditional probability – Bayes theorem – Random variables – Probability functions – Two-dimensional random variables – Joint distributions – Marginal and conditional distributions – Correlation – Linear Regression.

UNIT – III RANDOM PROCESSES 12

Classification – Stationary random process – Markov process – Markov chain – Poisson process – Gaussian process – Auto correlation – Cross correlation.

UNIT – IV QUEUEING THEORY 12

Markovian queues – Single and multi-server models – Little's formula – Steady state analysis – Self-service queue.

UNIT – V LINEAR PROGRAMMING 12

Formulation – Graphical solution – Simplex method – Big M method – Variants of Simplex method – Transportation problems – Assignment models.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

After the completion of the course, the student will be able to

- apply various methods in Linear Algebra to solve the system of linear equations.
- use two-dimensional random variables, correlations and regression in solving application problem.
- apply the ideas of Random Processes.
- understand the basic characteristic features of a queueing system and acquire skills in analyzing queueing models.
- apply the Simplex method for solving linear programming problems.

REFERENCES:

1. Miller, S.L. and Childers D.G., "Probability and Random Processes with Applications to Signal Processing and Communications", Academic Press, 2004.
2. Friedberg A.H, Insel A.J. and Spence L, "Linear Algebra", Prentice Hall of India, New Delhi, 2004.
3. Gross, D., Shortie, J.F., Thompson, J.M and Harris, C.M., "Fundamentals of Queueing Theory", 4th Edition, Wiley, 2014.
4. T. Veerarajan, "Probability, Statistics and Random Process with Queueing Theory and Queueing Network, Tata McGraw Hill, 4th Edition, 2017.
5. Taha H.A., "Operations Research: An Introduction", 9th Edition, Pearson Education Asia, New Delhi, 2016.
6. Richard Bronson, "Matrix Operations" Schaum's outline series, McGraw Hill, 2nd Edition, New York, 2011.
7. Oliver C. Ibe, "Fundamentals of Applied Probability and Random Processes", Academic Press, (An Imprint of Elsevier), Boston, 2014.

RM4151**RESEARCH METHODOLOGY AND IPR****L T P C****2 0 0 2****UNIT I RESEARCH DESIGN****6**

Overview of research process and design, Use of Secondary and exploratory data to answer the research question, Qualitative research, Observation studies, Experiments and Surveys.

UNIT II DATA COLLECTION AND SOURCES**6**

Measurements, Measurement Scales, Questionnaires and Instruments, Sampling and methods. Data - Preparing, Exploring, examining and displaying.

UNIT III DATA ANALYSIS AND REPORTING**6**

Overview of Multivariate analysis, Hypotheses testing and Measures of Association. Presenting Insights and findings using written reports and oral presentation.

UNIT IV INTELLECTUAL PROPERTY RIGHTS**6**

Intellectual Property – The concept of IPR, Evolution and development of concept of IPR, IPR development process, Trade secrets, utility Models, IPR & Bio diversity, Role of WIPO and WTO in IPR establishments, Right of Property, Common rules of IPR practices, Types and Features of IPR Agreement, Trademark, Functions of UNESCO in IPR maintenance.

UNIT V PATENTS**6**

Patents – objectives and benefits of patent, Concept, features of patent, Inventive step, Specification, Types of patent application, process E-filing, Examination of patent, Grant of patent, Revocation, Equitable Assignments, Licences, Licensing of related patents, patent agents, Registration of patent agents.

TOTAL : 30 PERIODS**REFERENCES:**

1. Cooper Donald R, Schindler Pamela S and Sharma JK, "Business Research Methods", Tata McGraw Hill Education, 11e (2012).

2. Catherine J. Holland, "Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets", Entrepreneur Press, 2007.
3. David Hunt, Long Nguyen, Matthew Rodgers, "Patent searching: tools & techniques", Wiley, 2007.
4. The Institute of Company Secretaries of India, Statutory body under an Act of parliament, "Professional Programme Intellectual Property Rights, Law and practice", September 2013.

DS4152

STATISTICAL SIGNAL PROCESSING

L T P C

3 0 0 3

COURSE OBJECTIVES:

- To introduce the basics of random signal processing
- To learn the concept of estimation and signal modeling
- To know about optimum filters and adaptive filtering and its applications

UNIT I DISCRETE RANDOM SIGNAL PROCESSING 9

Discrete random processes – Ensemble averages – Wide sense stationary process – Properties - Ergodic process – Sample mean & variance - Auto-correlation and Auto-correlation matrices- Auto covariance and Cross covariance- Properties – White noise process – Wiener Khintchine relation - Power spectral density – Filtering random process – Spectral Factorization Theorem – Special types of Random Processes – AR,MA, ARMA Processes – Yule-Walker equations.

UNIT II PARAMETER ESTIMATION THEORY 9

Principle of estimation and applications-Properties of estimates-unbiased and consistent estimators, Minimum Variance Unbiased Estimates (MVUE)-Cramer Rao bound- Efficient estimators; Criteria of estimation: Methods of maximum likelihood and its properties ; Bayesian estimation : Mean square error and MMSE, Mean Absolute error, Hit and Miss cost function and MAP estimation

UNIT III SPECTRUM ESTIMATION 9

Estimation of spectra from finite duration signals, Bias and Consistency of estimators - Non-Parametric methods: Periodogram, Modified Periodogram, Bartlett, Welch and Blackman-Tukey methods, Parametric Methods: AR, MA and ARMA spectrum estimation - Detection of Harmonic signals - Performance analysis of estimators. MUSIC and ESPRIT algorithms

UNIT IV SIGNAL MODELING AND OPTIMUM FILTERS 9

Introduction- Least square method – Pade approximation – Prony's method – Levinson Recursion – Lattice filter - FIR Wiener filter – Filtering – Linear Prediction – Non Causal and Causal IIR Wiener Filter – MSE – State-space model and the optimal state estimation problem, discrete Kalman filter, continuous-time Kalman filter, extended Kalman filter.

UNIT V ADAPTIVE FILTERS 9

FIR Adaptive filters - Newton's steepest descent method – Widrow Hoff LMS Adaptive algorithm – Convergence – Normalized LMS – Applications: Noise cancellation, channel equalization, echo canceller, Adaptive Recursive Filters: RLS adaptive algorithm, Exponentially weighted RLS-sliding window RLS. Matrix inversion Lemma, Initialization, tracking of nonstationarity.

COURSE OUTCOMES:**On the successful completion of the course, students will be able to**

CO1: Analyze discrete time random processes

CO2: Apply appropriate model for estimation and signal modeling for the given problem

CO3: Analyze non-parametric and parametric methods for spectral estimation

CO4: Design optimum filter for the given problem

CO5: Design adaptive filters for different applications

TOTAL:45 PERIODS**REFERENCES:**

1. Monson. H. Hayes, Statistical Digital Signal Processing and Modelling, John Willey and Sons, 1996 (Reprint 2008)
2. Simon Haykin, Adaptive Filter Theory, Pearson Prentice Hall, 5th edition, 2014
3. D.G. Manolakis, V.K. Ingle and S.M. Kogon, Statistical and Adaptive Signal Processing, Artech House Publishers, 2005.
4. Steven. M. Kay, Modern Spectral Estimation, Theory and Application, Pearson India, 2009
5. A.Veloni, N I. Miridakis, E Boukouvala, Digital and Statistical Signal Processing, CRC Press, 2019
6. S Nandi, D Kundu, Statistical Signal Processing- Frequency Estimation, Springer Nature Singapore, 2nd edition , 2020
7. M.D. Srinath, P.K. Rajasekaran and R. Viswanathan, Statistical Signal Processing with Applications, PHI, 1996.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	3	1	1	1	3	3
2	3	1	1	1	3	3
3	3	1	1	1	3	3
4	3	1	1	1	3	3
5	3	1	1	1	3	3
Avg	3	1	1	1	3	3

PROGRESS THROUGH KNOWLEDGE

EL4151**MODERN DIGITAL COMMUNICATION SYSTEMS****L T P C****3 0 0 3****COURSE OBJECTIVES:**

- To understand the coherent and non coherent receivers and their performance under AWGN channel conditions
- To understand the effect of signalling through bandlimited channels and Equalization techniques used to overcome ISI
- To understand different channel models, channel capacity and different block coding techniques
- To understand the principle of convolutional coding and different decoding techniques
- To understand the basics of OFDM as a multicarrier communication and CDMA as a multiuser communication technique.

UNIT I COHERENT AND NON-COHERENT COMMUNICATION 9

Coherent receivers – Optimum receivers in WGN – IQ modulation & demodulation – QAM modulation and demodulation Noncoherent receivers in random phase channels; MFSK receivers – Rayleigh and Rician channels – Partially coherent receivers – DPSK; M-PSK; M-DPSK-BER Performance Analysis. Carrier Synchronization Bit synchronization.

UNIT II EQUALIZATION TECHNIQUES 9

Band Limited Channels- ISI – Nyquist Criterion- Controlled ISI-Partial Response signals- Equalization algorithms– Linear equalizer – Decision feedback equalization – Adaptive Equalization algorithms.

UNIT III BLOCK CODED DIGITAL COMMUNICATION 9

Architecture and performance – Binary block codes; – Shannon’s channel coding theorem; Channel capacity; Matched filter; Concepts of Spread spectrum communication – Coded BPSK and DPSK demodulators– Linear block codes; Hamming; Golay; Cyclic; BCH ; Reed – Solomon codes. Space time block codes.

UNIT IV CONVOLUTIONAL CODED DIGITAL COMMUNICATION 9

Representation of codes using Polynomial, State diagram, Tree diagram, and Trellis diagram – Decoding techniques using Maximum likelihood, Viterbi algorithm, Sequential and Threshold methods – Error probability performance for BPSK and Viterbi algorithm, Turbo Coding.

UNIT V MULTICARRIER AND MULTIUSER COMMUNICATIONS 9

Single Vs multicarrier modulation, orthogonal frequency division multiplexing (OFDM), Modulation and demodulation in an OFDM system, An FFT algorithmic implementation of an OFDM system, Bit and power allocation in multicarrier modulation, Peak-to-average ratio in multicarrier modulation. Introduction to CDMA systems, multiuser detection in CDMA systems – optimum multiuser receiver, suboptimum detectors, successive interference cancellation.

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1: Differentiate coherent and non coherent receivers and analyse their performance under AWGN channel conditions

CO2: Illustrate the effect of signalling through bandlimited channels and Equalization techniques used to overcome ISI

CO3: Determine the channel capacity and design various block coding techniques to combat channel errors

CO4: Construct convolutional coders and analyze the performance of different decoding techniques.

CO5: Describe the basics of OFDM as a multicarrier communication and CDMA as a multiuser communication technique.

TOTAL:45 PERIODS

REFERENCES:

1. John G. Proakis and Masoud Salehi “Digital Communication”, Fifth Edition, Mc Graw Hill Publication, 2014.
2. Simon Haykin, “Digital communication Systems”, John Wiley and sons, 2014.
3. Bernard Sklar and Pabitra Kumar Ray, “Digital Communications Fundamentals & Applications ”, second edition, Pearson Education, 2009.
4. Lathi B P and Zhi Ding, “Modern Digital and Analog communication Systems”, Oxford

University Press, 2011.

5. Richard Van Nee & Ramjee Prasad, "OFDM for Multimedia Communications" Artech House Publication, 2001.

6. Theodore S.Rappaport, "Wireless Communications", 2nd edition, Pearson Education, 2002.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	2	-	3	2	2	1
2	2	-	3	2	2	1
3	3	-	3	3	3	1
4	3	-	3	3	3	1
5	2	-	3	2	3	1
Avg	2.4	-	3	2.4	2.6	1

CU4151

ADVANCED WIRELESS COMMUNICATION

L T P C
3 0 0 3

COURSE OBJECTIVES:

- To learn the concepts of wireless communication.
- To know about the various propagation methods, Channel models, capacity calculations
- multiple antennas and multiple user techniques used in the mobile communication.

UNIT I WIRELESS CHANNEL PROPAGATION AND MODEL 9

Propagation of EM signals in wireless channel – Reflection, diffraction and Scattering-free space, two ray. Small scale fading- channel classification- channel models – COST -231 Hata model, NLOS Multipath Fading Models: Rayleigh, Rician, Nakagami, 5G Channel model requirements and Measurements, propagation scenarios, METIS channel models, Map-based model, stochastic model.

UNIT II CAPACITY OF WIRELESS CHANNELS 9

Capacity in AWGN, capacity of flat fading channel, capacity of frequency selective fading channels. Capacity of MISO, SIMO systems.

UNIT III DIVERSITY 9

Realization of independent fading paths, Receiver Diversity: Selection combining, Threshold Combining, Maximum-ratio Combining, Equal gain Combining. Transmitter Diversity: Channel known at transmitter, Channel unknown at the transmitter.

UNIT IV MIMO COMMUNICATIONS 9

Narrowband MIMO model, Parallel decomposition of the MIMO channel, MIMO channel capacity, MIMO Diversity Gain: Beam forming, Diversity-Multiplexing trade-offs, Space time Modulation and coding : STBC, STTC, Spatial Multiplexing and BLAST Architectures.

UNIT V MULTI USER SYSTEMS**9**

Introduction to MUD, Linear decorrelator, MMSE MUD, Adaptive MUD, MIMO-MUD Application of convex optimization to wireless design.

TOTAL: 45 PERIODS**COURSE OUTCOMES:**

At the end of the course, the student will be able to:

CO1: Analyze the wireless channel characteristics and identify appropriate channel models

CO2: Understand the mathematics behind the capacity calculation under different channel conditions

CO3: Understand the implication of diversity combining methods and the knowledge of channel

CO4: Understand the concepts in MIMO Communications

CO5: Understand multiple access techniques and their use in different multi-user scenarios.

REFERENCES :

1. David Tse and Pramod Viswanath, *Fundamentals of wireless communications*, Cambridge University Press, First Edition, 2012
2. Andrea Goldsmith, *Wireless Communications*, Cambridge University Press, 2007.
3. Harry R. Anderson, "Fixed Broadband Wireless System Design", John Wiley, India, 2003.
4. Andreas.F. Molisch, "Wireless Communications", John Wiley, India, 2006.
5. Simon Haykin & Michael Moher, "Modern Wireless Communications", Pearson Education, 2007.
6. Rappaport. T.S., "Wireless communications", Pearson Education, 2003.
7. Gordon L. Stuber, "Principles of Mobile Communication", Springer International Ltd., 2001.
8. Upena Dalal, "Wireless Communication", Oxford Higher Education, 2009.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	2	1	1	-	-	2
2	2	-	1	2	1	-
3	2	1	1	1	-	-
4	2	1	1	1	2	2
5	1	-	1	1	-	1
Avg	1.8	1	1	1.25	1.5	1.6

CU4152**RADIATING SYSTEMS****L T P C****3 0 0 3****COURSE OBJECTIVES:**

- To understand Antenna basics
- To learn about Antenna arrays and their characteristics
- To study about operating Antennas
- To familiarize with modern Antennas and Measurement Techniques

- To learn about recent trends in Antenna Design

UNIT I ANTENNA FUNDAMENTALS & WIRE ANTENNAS 9

Introduction –Types of Antennas – Radiation Mechanism – Current distribution on wire antennas – Maxwell’s equations – Antenna fundamental parameters – Radiation integrals – Radiation from surface and line current distributions – dipole, monopole, loop antenna

UNIT II ANTENNA ARRAYS 9

Linear array –uniform array, end fire and broad side array, gain, beam width, side lobe level; Linear array synthesis techniques – Binomial and Chebyshev distributions; Two dimensional uniform arrays; phased array antennas, smart antennas, switched beam and adaptive arrays, Mutual Coupling in Finite Arrays

UNIT III APERTURE ANTENNAS 9

Field equivalence principle, Radiation from Rectangular and Circular apertures, Babinet’s principle, Slot antenna; Horn antenna; Reflector antenna, aperture blockage, and design consideration. Radiation Mechanism and Excitation techniques, Microstrip dipole; Patch, Rectangular patch, Circular patch – Microstrip array and feed network; Lens Antennas

UNIT IV MODERN ANTENNAS & MEASUREMENT TECHNIQUES 9

Base station antennas, PIFA – Antennas for WBAN – RFID Antennas – Automotive antennas, MIMO Antennas, Diversity techniques – Antenna impedance and radiation pattern measurements

UNIT V RECENT TRENDS IN ANTENNA DESIGN 9

UWB antenna arrays – Vivaldi antenna arrays – Artificial magnetic conductors/High impedance surfaces – Antennas in medicine – Plasma antennas – Antennas for millimeter wave communication - optimization techniques – Numerical methods

SUGGESTED ACTIVITIES:

1. Design and develop an antenna to receive AM and FM radio
2. Design Yagi-Uda Antenna at very high frequency band
3. Design Microstrip patch antenna for mobile applications
4. Design and develop Microstrip dipole antenna
5. Design reflector antenna for satellite - TV reception

TOTAL:45 PERIODS

COURSE OUTCOMES:

At the end of the course, the student will be able to:

CO1: Understand the fundamentals behind the different techniques in antenna technology.

CO2: Understand the challenges associated in designing antennas based on different technologies

CO3: Understand the capability and assess the performance of various antennas.

CO4: Identify the antennas specific to the applications, design and characterize.

CO5: Understand the need for optimizing in antenna design and the methodologies for the same.

REFERENCES:

1. Balanis.A, "Antenna Theory Analysis and Design", John Wiley and Sons, New York, 3rd Edition,1982.
2. Frank B. Gross, "Frontiers in Antennas", Mc Graw Hill, 2011.
3. S. Drabowitch, A. Papiernik, H.D.Griffiths, J.Encinas, B.L.Smith, "Modern Antennas", Springer Publications, 2nd Edition, 2007.
4. Krauss.J.D, "Antennas", John Wiley and sons, New York, 2nd Edition, 1997.
5. I.J. Bahl and P. Bhartia, "Microstrip Antennas", Artech House,Inc.,1980
6. W.L.Stutzman and G.A.Thiele, "Antenna Theory and Design", John Wiley& Sons Inc., 2nd Edition, 1998.
7. Jim R. James,P.S.Hall , "Handbook of Microstrip Antennas" IEE Electromagnetic wave series 28, Volume 2,1989.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	1	-	1	1	1	-
2	3	-	2	1	1	-
3	2	-	2	1	2	-
4	3	-	2	3	3	-
5	2	3	2	3	3	2
Avg	11/5 = 2.2	3/1=3	9/5 = 1.8	9/5 =1.8	10/5 = 2	2/1 =2

EL4161

**DIGITAL COMMUNICATION SYSTEMS
LABORATORY****L T P C
0 0 3 1.5****COURSE OBJECTIVES:**

- To study & measure the performance of digital communication systems.
- To provide a comprehensive knowledge of Wireless Communication.
- To learn about the design of digital filter and its adaptive filtering algorithms.

LIST OF EXPERIMENTS (MATLAB/SCILAB/CABVIEW)**USE APPROPRIATE SIMULATION TOOLS FOR THE FOLLOWING EXPERIMENTS:**

1. Generation & detection of binary digital modulation techniques using SDR
2. Spread Spectrum communication system-Pseudo random binary sequence generation-Baseband DSSS.
3. MIMO system transceiver design using MATLAB/SCILAB/LABVIEW
4. Performance evaluation of simulated CDMA system
5. Channel Coder/decoder design (block codes / convolutional codes/ turbo codes)
6. OFDM transceiver design using MATLAB /SCILAB/LABVIEW
7. Channel equalizer design using MATLAB (LMS, RLS algorithms)
8. Design and Analysis of Spectrum Estimators (Bartlett, Welch) using MATLAB
9. BER performance Analysis of M-ary digital Modulation Techniques (coherent & non

- coherent) in AWGN Environment using MATLAB/SCILAB/LABVIEW
10. Design and performance analysis of Lossless Coding Techniques - Huffman Coding and Lempel Ziv Algorithm using MATLAB/SCILAB/LABVIEW
 11. Noise / Echo cancellation using MATLAB (LMS / RLS algorithms).
 12. Study of synchronization (frame, bit, symbol.)
 13. Wireless channel characterization.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

Upon the completion of course, students are able to

- Implement the adaptive filtering algorithms
- Generate and detect digital communication signals of various modulation techniques using MATLAB.
- Evaluate cellular mobile communication technology and propagation model.
- Apply mathematical formulation to analyze spectrum estimation of a signal and bit rate determination of a transmission link
- Analyze the performance of optimization algorithms for equalizing the channel or noise/echo cancellation
- Able to design synchronization algorithm for Digital Communication systems

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	2	3	3	2	3	2
2	2	3	3	2	3	2
3	2	3	3	2	3	2
4	2	3	3	2	3	2
5	2	3	3	2	3	2
6	2	3	3	3	3	2
Avg	2	3	3	2.1	3	2

PROGRESS THROUGH KNOWLEDGE

CU4161

**ADVANCED DIGITAL SIGNAL PROCESSING
LABORATORY**

**L T P C
0 0 3 1.5**

COURSE OBJECTIVES:

- To enable the student to verify the basic principles of random signal processing, spectral estimation methods and additive white Gaussian noise (AWGN) channel characterization
- To design and conduct experiments, as well as to analyze and interpret data to produce meaningful conclusions and match with theoretical concepts.

LIST OF EXPERIMENTS

USE APPROPRIATE SIMULATION TOOLS FOR THE FOLLOWING EXPERIMENTS:

1. Generation of Standard discrete time sequences (Unit Impulse, Unit Step, Unit Ramp, Sinusoidal and exponential signals) and carrying out of arithmetic operations and plot the results
2. Generation of random sequences satisfying the given probability distributions such as Uniform, Gaussian, Rayleigh and Rician.
3. Design of FIR filters for the given specification and plot the frequency response of the designed filter
4. Design of IIR filters for the given specification and plot the frequency response of the designed filter
5. Analysis of finite word length effects of FIR filter coefficients
6. Estimation of power spectrum of the given random sequence using Nonparametric methods (Bartlett, Welch and Blackman Tukey)
7. Estimation of power spectrum of the given random sequence using parametric methods (AR, MA and ARMA)
8. Upsampling the discrete time sequence by L times and plot the spectrum of both the given sequence and upsampled sequence
9. Downsampling the discrete time sequence by M times and plot the spectrum of both the given sequence and down sampled sequence
10. Design an adaptive filter to extract a desired signal from the given noisy signal by cancelling the noise using LMS Algorithm
11. Design an adaptive filter to extract a desired signal from the given noisy signal by cancelling the noise using RLS Algorithm
12. Implementation of Digital Filter Banks for the given specifications

TOTAL : 45 PERIODS

COURSE OUTCOMES:

Upon the completion of course, students will be able to

- Generate deterministic/Random sequences using simulation tool
- Design and analyze the frequency response of FIR/IIR digital filters for the given specifications
- Estimate power spectrum of the given random sequence using parametric/nonparametric estimation methods
- Implement adaptive filters using LMS/RLS algorithm
- Analyze the discrete time systems at various sampling rates

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	1	1	-	-	-	1
2	1	1	-	-	-	1
3	1	1	-	-	-	1
4	2	1	1	1	-	1
5	1	1	-	-	-	1

Avg	1.2	1	1	1	-	1
------------	-----	---	---	---	---	---

CU4251

RF SYSTEM DESIGN

L T P C

3 0 0 3

COURSE OBJECTIVES:

- Be familiar with RF transceiver system design for wireless communications
- Be exposed to design methods of receivers and transmitters used in communication systems
- Design RF circuits and systems using an advanced design tool.
- Exemplify different synchronization methods circuits and describe their block schematic and design criteria
- Measure RF circuits and systems with a spectrum analyzer.

UNIT I BASICS OF RADIO FREQUENCY SYSTEM DESIGN 9

Definitions and models of Linear systems and Non-linear system. Specification parameters: Gain, noise figure, SNR, Characteristic impedance, S-parameters, Impedance matching and Decibels. Elements of digital base band signalling: complex envelope of band pass signals, Average value, RMS value, Crest factor, Sampling, jitter, modulation techniques, filters, pulse shaping, EVM, BER, sensitivity, selectivity, dynamic range and, adjacent and alternate channel power leakages

UNIT II RADIO ARCHITECTURES AND DESIGN CONSIDERATIONS 9

Superheterodyne architecture, direct conversion architecture, Low IF architecture, band-pass sampling radio architecture, System Design Considerations for an Analog Frontend Receiver in Cognitive Radio Applications, Interference, Near, In-band & wide-band considerations.

UNIT III AMPLIFIER MODELING AND ANALYSIS 9

Noise: Noise equivalent model for Radio frequency device, amplifier noise model, cascade performance, minimum detectable signal, performance of noisy systems in cascade. Non-Linearity: Amplifier power transfer curve, gain compression, AM-AM, AM-PM, polynomial approximations, Saleh model, Wiener model and Hammerstein model, intermodulation, Single and two tone analyses, second and third order distortions and measurements, SOI and TOI points, cascade performance of nonlinear systems.

UNIT IV MIXER AND OSCILLATOR MODELING AND ANALYSIS 9

Mixers: Frequency translation mechanisms, frequency inversion, image frequencies, spurious calculations, principles of mixer realizations. Oscillators: phase noise and its effects, effects of oscillator spurious components, frequency accuracy, oscillator realizations: Frequency synthesizers, NCO.

UNIT V APPLICATIONS OF SYSTEMS DESIGN 9

Multimode and multiband Superheterodyne transceiver: selection of frequency plan, receiver system and transmitter system design – Direct conversion transceiver: receiver system and transmitter system design.

TOTAL:45 PERIODS

COURSE OUTCOMES:**Upon the completion of course, students will be able to****CO1:** understand the specifications of transceiver modules**CO2:** understand pros and cons of transceiver architectures and their associated design considerations**CO3:** understand the impact of noise and amplifier non-linearity of amplification modules and also will learn the resultant effect during cascade connections**CO4:** get exposure about spurs and generation principles during signal generation and frequency translations**CO5:** understand the case study of transceiver systems and aid to select specification parameters**REFERENCES**

1. The Design of CMOS Radio-Frequency Integrated Circuits by Thomas H. Lee. Cambridge University Press, 2004.
2. Qizheng Gu, "RF System Design of Transceivers for Wireless Communications", Springer, 2005.
3. Kevin McClaning, "Wireless Receiver Design for Digital Communications," Yes Dee Publications, 2012.
4. M C Jeruchim, P Balapan and K S Shanmugam, "Simulation of Communication systems: Modeling, Methodology and Techniques", Kluwer Academic/Plenum Publishers, 2 nd Edition, 2000.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	3	2	2	2	2	2
2	3	2	2	3	3	2
3	2	3	3	2	3	1
4	1	2	3	3	3	3
5	2	1	1	2	2	2
Avg	2.2	2	2.2	2.4	2.6	2

PROGRESS THROUGH KNOWLEDGE

CU4201**MICROWAVE INTEGRATED CIRCUITS****L T P C****3 0 2 4****COURSE OBJECTIVES:**

- To familiarize different transmission lines used at Microwave frequencies
- To design impedance matching networks using lumped and distributed elements
- To design and analyze different microwave components
- To use SMITH chart to analyze the region of stability and instability for designing amplifiers and oscillators
- To simulate and to test the microwave components under laboratory conditions

UNIT I**PLANAR TRANSMISSION LINES AND COMPONENTS****9**

Review of Transmission line theory – S parameters-Transmission line equations – reflection

coefficient – VSWR – Microstrip lines: Structure, waves in microstrip, Quasi-TEM approximation, Coupled lines: Even mode and odd mode analysis – Microstrip discontinuities and components – Strip line – Slot line – Coplanar waveguide – Filters – Power dividers and Couplers

UNIT II IMPEDANCE MATCHING NETWORKS 9

Circuit Representation of two port RF/Microwave Networks: Low Frequency Parameters, High Frequency Parameters, Transmission Matrix, ZY Smith Chart, Design of Matching Circuits using Lumped Elements, Matching Network Design using Distributed Elements

UNIT III MICROWAVE AMPLIFIER AND OSCILLATOR DESIGN 9

Characteristics of microwave transistors – Stability considerations in active networks – Gain Consideration in Amplifiers – Noise Consideration in active networks – Broadband Amplifier design – Oscillators: Oscillator versus Amplifier Design – Oscillation conditions – Design and stability considerations of Microwave Transistor Oscillators.

UNIT IV MIXERS AND CONTROL CIRCUITS 9

Mixer Types – Conversion Loss – SSB and DSB Mixers – Design of Mixers: Single Ended Mixers – Single Balanced Mixers – Sub Harmonic Diode Mixers, Microwave Diodes, Phase Shifters – PIN Diode Attenuators

UNIT V MICROWAVE IC DESIGN AND MEASUREMENT TECHNIQUES 9

Microwave Integrated Circuits – MIC Materials- Hybrid versus Monolithic MICs – Multichip Module Technology – Fabrication Techniques, Miniaturization techniques, Introduction to SOC, SOP, Test fixture measurements, probe station measurements, thermal and cryogenic measurements, experimental field probing techniques.

PRACTICAL EXERCISES: 30 PERIODS

1. Study of transmission line parameters – Impedance analysis
2. Design of impedance matching networks
3. Design of low pass and high pass filter
4. Design of band-pass and band-stop filters
5. Design of branch line couplers
6. Design of phase shifters
7. Design of Mixers
8. Design of Power dividers

COURSE OUTCOMES:

Upon the completion of course, students will be able to

CO1 : understand the concepts of planar transmission line

CO2: Design impedance matching circuits using LC components and stubs.

CO3: Design and analyze microwave components.

CO4: Perform stability analysis and be able to design amplifiers and oscillators at microwave frequencies.

CO5: Perform simulations, fabricate and test microwave devices.

TOTAL:45+30=75 PERIODS

REFERENCES

1. Jia Sheng Hong, M. J. Lancaster, “Microstrip Filters for RF/Microwave Applications”, John Wiley & Sons, 2001
2. David M. Pozar, “Microwave Engineering”, John Wiley & Sons, 4th edition 2012
3. Reinhold Ludwig and Powel Bretchko, RF Circuit Design – Theory and Applications”,

Pearson Education Asia, First Edition,2001.

4. Thomas H.Lee, “Planar Microwave Engineering”, Cambridge University Press, 2004

5. Matthew M. Radmanesh, “Radio Frequency and Microwave Electronics”, Pearson Education, 2002

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	2	2	2	3	3	3
2	2	2	2	3	3	3
3	3	2	3	3	3	3
4	2	2	2	3	3	2
5	2	2	2	3	3	3
Avg	2.2	2	2.2	3	3	2.8

CU4202

ADVANCED WIRELESS NETWORKS

L T P C
3 0 0 3

COURSE OBJECTIVES:

The students should be made to:

- study about advanced wireless network, LTE, 4G and Evolutions from LTE to LTE.
- study about wireless IP architecture, Packet Data Protocol and LTE network architecture
- study about adaptive link layer, hybrid ARQ and graphs routing protocol.
- study about mobility management, cellular network, and micro cellular networks

UNIT I INTRODUCTION

9

Introduction to 1G/2G/3G/4G Terminology. Evolution of Public Mobile Services -Motivation for IP Based Wireless Networks -Requirements and Targets for Long Term Evolution (LTE) - Technologies for LTE- 4G Advanced Features and Roadmap Evolutions from LTE to LTE-A - Wireless Standards. Network Model-Network Connectivity-Wireless Network Design with Small World Properties

UNIT II WIRELESS IP NETWORK ARCHITECTURES

9

3GPP Packet Data Networks - Network Architecture - Packet Data Protocol (PDP) Context - Configuring PDP Addresses on Mobile Stations - Accessing IP Networks through PS Domain – LTE network Architecture - Roaming Architecture- Protocol Architecture- Bearer Establishment Procedure -Inter-Working with other RATs.

UNIT III ADAPTIVE LINK AND NETWORK LAYER

9

Link Layer Capacity of Adaptive Air Interfaces-Adaptive Transmission in *Ad Hoc* Networks- Adaptive Hybrid ARQ Schemes for Wireless Links-Stochastic Learning Link Layer Protocol-Infrared Link Access Protocol-Graphs and Routing Protocols-Graph Theory-Routing with Topology Aggregation-Network and Aggregation Models

UNIT IV MOBILITY MANAGEMENT 9
 Cellular Networks-Cellular Systems with Prioritized Handoff-Cell Residing Time Distribution-
 Mobility Prediction in Pico- and Micro-Cellular Networks

UNIT V QUALITY OF SERVICE 9
 QoS Challenges in Wireless IP Networks - QoS in 3GPP - QoS Architecture, Management and
 Classes -QoS Attributes - Management of End-to-End IP QoS - EPS Bearers and QoS in LTE
 networks

COURSE OUTCOMES:

Upon the completion of course, students will be able to

- CO1:** get an exposure to the latest 4G networks and LTE
- CO2:** Understand about the wireless IP architecture and LTE network architecture.
- CO3:** know the adaptive link layer and network layer graphs and protocol.
- CO4:** Understand the mobility management and cellular network.
- CO5:** Understand the wireless sensor network architecture and its concept.

TOTAL:45 PERIODS

REFERENCES

1. Ayman ElNashar, Mohamed El-saidny, Mahmoud Sherif, "Design, Deployment and Performance of 4G-LTE Networks: A Practical Approach", John Wiley & Sons, 2014.
2. Crosspoint Boulevard, "Wireless and Mobile All-IP Networks", Wiley Publication, 2005.
3. Jyh-Cheng Chen and Tao Zhang, "IP-Based Next-Generation Wireless Networks Systems, Architectures, and Protocols", John Wiley & Sons, Inc. Publication,2006.
4. Minoru Etoh, "Next Generation Mobile Systems 3G and Beyond," Wiley Publications,2005.
5. Savo Glisic," Advanced Wireless Networks-Technology and Business Models", Third Edition, John Wiley & Sons, Ltd, 2016
6. Savo Glisic,"Advanced Wireless Networks-4G Technologies", John Wiley & Sons, Ltd,2006.
7. Stefania Sesia, IssamToufik and Matthew Baker, "LTE – The UMTS Long Term Evolution From Theory to Practice", John Wiley & Sons, Inc. Publication, Second Edition, 2011.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	3	-	3	3	2	3
2	3	-	3	3	2	3
3	3	-	3	3	2	3
4	3	-	3	3	2	3
5	3	-	3	3	2	3
Avg	3	-	3	3	2	3

COURSE OBJECTIVES:

- To understand the concepts and mathematical foundations of machine learning and types of problems tackled by machine learning
- To explore the different supervised learning techniques including ensemble methods
- To learn different aspects of unsupervised learning and reinforcement learning
- To learn the role of probabilistic methods for machine learning
- To understand the basic concepts of neural networks and deep learning

UNIT I INTRODUCTION AND MATHEMATICAL FOUNDATIONS 9

What is Machine Learning? Need –History – Definitions – Applications - Advantages, Disadvantages & Challenges -Types of Machine Learning Problems – Mathematical Foundations - Linear Algebra & Analytical Geometry -Probability and Statistics- Bayesian Conditional Probability -Vector Calculus & Optimization - Decision Theory - Information theory

UNIT II SUPERVISED LEARNING 9

Introduction-Discriminative and Generative Models -Linear Regression - Least Squares -Under-fitting / Overfitting -Cross-Validation – Lasso Regression- Classification - Logistic Regression- Gradient Linear Models -Support Vector Machines –Kernel Methods -Instance based Methods - K-Nearest Neighbours - Tree based Methods –Decision Trees –ID3 – CART - Ensemble Methods –Random Forest - Evaluation of Classification Algorithms

UNIT III UNSUPERVISED LEARNING AND REINFORCEMENT LEARNING 9

Introduction - Clustering Algorithms -K – Means – Hierarchical Clustering - Cluster Validity - Dimensionality Reduction –Principal Component Analysis – Recommendation Systems - EM algorithm. Reinforcement Learning – Elements -Model based Learning – Temporal Difference Learning

UNIT IV PROBABILISTIC METHODS FOR LEARNING 9

Introduction -Naïve Bayes Algorithm -Maximum Likelihood -Maximum Apriori -Bayesian Belief Networks -Probabilistic Modelling of Problems -Inference in Bayesian Belief Networks – Probability Density Estimation - Sequence Models – Markov Models – Hidden Markov Models

UNIT V NEURAL NETWORKS AND DEEP LEARNING 9

Neural Networks – Biological Motivation- Perceptron – Multi-layer Perceptron – Feed Forward Network – Back Propagation-Activation and Loss Functions- Limitations of Machine Learning – Deep Learning– Convolution Neural Networks – Recurrent Neural Networks – Use cases

45 PERIODS**SUGGESTED ACTIVITIES:**

1. Give an example from our daily life for each type of machine learning problem
2. Study at least 3 Tools available for Machine Learning and discuss pros & cons of each
3. Take an example of a classification problem. Draw different decision trees for the example and explain the pros and cons of each decision variable at each level of the tree
4. Outline 10 machine learning applications in healthcare
5. Give 5 examples where sequential models are suitable.
6. Give at least 5 recent applications of CNN

PRACTICAL EXERCISES:

30 PERIODS

1. Implement a Linear Regression with a Real Dataset (<https://www.kaggle.com/harrywang/housing>). Experiment with different features in building a model. Tune the model's hyperparameters.
2. Implement a binary classification model. That is, answers a binary question such as "Are houses in this neighborhood above a certain price?" (use data from exercise 1). Modify the classification threshold and determine how that modification influences the model. Experiment with different classification metrics to determine your model's effectiveness.
3. Classification with Nearest Neighbours. In this question, you will use the scikit-learn's KNN classifier to classify real vs. fake news headlines. The aim of this question is for you to read the scikit-learn API and get comfortable with training/validation splits. Use California Housing Dataset
4. In this exercise, you'll experiment with validation sets and test sets using the dataset. Split a training set into a smaller training set and a validation set. Analyze deltas between training set and validation set results. Test the trained model with a test set to determine whether your trained model is overfitting. Detect and fix a common training problem.
5. Implement the k-means algorithm using <https://archive.ics.uci.edu/ml/datasets/Codon+usage> dataset
6. Implement the Naïve Bayes Classifier using <https://archive.ics.uci.edu/ml/datasets/Gait+Classification> dataset
7. Project - (in Pairs) Your project must implement one or more machine learning algorithms and apply them to some data.
 - a. Your project may be a comparison of several existing algorithms, or it may propose a new algorithm in which case you still must compare it to at least one other approach.
 - b. You can either pick a project of your own design, or you can choose from the set of pre-defined projects.
 - c. You are free to use any third-party ideas or code that you wish as long as it is publicly available.
 - d. You must properly provide references to any work that is not your own in the write-up.
 - e. Project proposal You must turn in a brief project proposal. Your project proposal should describe the idea behind your project. You should also briefly describe software you will need to write, and papers (2-3) you plan to read.

List of Projects (datasets available)

1. Sentiment Analysis of Product Reviews
2. Stock Prediction
3. Sales Forecasting
4. Music Recommendation
5. Handwriting Digit Classification
6. Fake News Detection
7. Sports Prediction
8. Object Detection
9. Disease Prediction

COURSE OUTCOMES:

Upon the completion of course, students will be able to

CO1: Understand and outline problems for each type of machine learning

CO2: Design a Decision tree and Random forest for an application

CO3: Implement Probabilistic Discriminative and Generative algorithms for an application and analyze the results.

CO4: Use a tool to implement typical Clustering algorithms for different types of applications.

CO5: Design and implement an HMM for a Sequence Model type of application and identify applications suitable for different types of Machine Learning with suitable justification.

TOTAL:75 PERIODS

REFERENCES

1. Stephen Marsland, "Machine Learning: An Algorithmic Perspective", Chapman & Hall/CRC, 2nd Edition, 2014.
2. Kevin Murphy, "Machine Learning: A Probabilistic Perspective", MIT Press, 2012
3. Ethem Alpaydin, "Introduction to Machine Learning", Third Edition, Adaptive Computation and Machine Learning Series, MIT Press, 2014
4. Tom M Mitchell, "Machine Learning", McGraw Hill Education, 2013.
5. Peter Flach, "Machine Learning: The Art and Science of Algorithms that Make Sense of Data", First Edition, Cambridge University Press, 2012.
6. Shai Shalev-Shwartz and Shai Ben-David, "Understanding Machine Learning: From Theory to Algorithms", Cambridge University Press, 2015
7. Christopher Bishop, "Pattern Recognition and Machine Learning", Springer, 2007.
8. Hal Daumé III, "A Course in Machine Learning", 2017 (freely available online)
9. Trevor Hastie, Robert Tibshirani, Jerome Friedman, "The Elements of Statistical Learning", Springer, 2009 (freely available online)
10. Aurélien Géron , Hands-On Machine Learning with Scikit-Learn and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems 2nd Edition, o'reilly, (2017)

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	3	1	2	-	-	3
2	3	1	2	-	-	3
3	3	1	2	-	-	3
4	3	1	2	-	-	3
5	3	1	2	-	-	3
Avg	3	1	2	-	-	3

CU4211

WIRELESS COMMUNICATION LABORATORY

**L T P C
0 0 4 2**

COURSE OBJECTIVES:

- To enable the student to verify the basic principles of random signal processing, spectral estimation methods, wireless and AWGN channel characterization, application of adaptive filter algorithms for communication system design, coding and modulation design, synchronization aspects and the overall baseband system design.
- To design and conduct experiments, as well as to analyze and interpret data to produce meaningful conclusions and match with theoretical concepts.
- To enable the student to appreciate the practical aspects of baseband system design and understand the associated challenges.

LIST OF EXPERIMENT:

1. Spectral Characterisation of communication signals (using Spectrum Analyzer)
2. Design and Analysis of Spectrum Estimators (Bartlett , Welch)
3. Design and analysis of digital modulation techniques on an SDR platform
4. Carrier and Symbol timing Synchronization using SDR platform
5. CDMA signal generation and RAKE receiver design using DSP/MATLAB/ SIMULINK
6. Design and performance analysis of error control encoder and decoder (Block and Convolutional Codes)
7. Wireless Channel equalizer design using DSP (ZF / LMS / RLS)
8. Wireless Channel Estimation and Diversity Combining
9. Design and simulation of Microstrip patch antenna
10. Analysis of Antenna Radiation Pattern and measurement

TOTAL: 60 PERIODS**COURSE OUTCOMES:**

CO1: The student would be able to design and conduct experiments to demonstrate the trade-offs involved in the design of basic and advanced coding and modulation techniques and the advanced baseband signal conditioning methods.

CO2: The student would be capable of applying communication engineering principles and design tools and will be well practiced in design skills.

CO3: The student would be able to comprehensively record and report the measured data, write reports, communicate research ideas and do oral presentations effectively.

CO4: The student would be capable of analyzing and interpreting the experimental measurement data and produce meaningful conclusions

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	3	1	1	1	1	1
2	3	1	1	1	-	2
3	1	2	2	-	-	-
4	1	3	2	-	-	-
5	1	2	2	-	-	2
Avg	1.8	1.8	1.6	1	1	1.6

CU4212**TERM PAPER WRITING AND SEMINAR****L T P C
0 0 2 1**

In this course, students will develop their scientific and technical reading and writing skills that they need to understand and construct research articles. A term paper requires a student to obtain information from a variety of sources (i.e., Journals, dictionaries, reference books) and then place it in logically developed ideas. The work involves the following steps:

1. Selecting a subject, narrowing the subject into a topic

2. Stating an objective.
3. Collecting the relevant bibliography (atleast 15 journal papers)
4. Preparing a working outline.
5. Studying the papers and understanding the authors contributions and critically analysing each paper.
6. Preparing a working outline
7. Linking the papers and preparing a draft of the paper.
8. Preparing conclusions based on the reading of all the papers.
9. Writing the Final Paper and giving final Presentation

Please keep a file where the work carried out by you is maintained.

Activities to be carried out

Activity	Instructions	Submission week	Evaluation
Selection of area of interest and Topic	You are requested to select an area of interest, topic and state an objective	2 nd week	3 % Based on clarity of thought, current relevance and clarity in writing
Stating an Objective			
Collecting Information about your area & topic	<ol style="list-style-type: none"> 1. List 1 Special Interest Groups or professional society 2. List 2 journals 3. List 2 conferences, symposia or workshops 4. List 1 thesis title 5. List 3 web presences (mailing lists, forums, news sites) 6. List 3 authors who publish regularly in your area 7. Attach a call for papers (CFP) from your area. 	3 rd week	3% (the selected information must be area specific and of international and national standard)
Collection of Journal papers in the topic in the context of the objective – collect 20 & then filter	<ul style="list-style-type: none"> • You have to provide a complete list of references you will be using- Based on your objective -Search various digital libraries and Google Scholar • When picking papers to read - try to: • Pick papers that are related to each other in some ways and/or that are in the same field so that you can write a meaningful survey out of them, • Favour papers from well-known journals and conferences, • Favour “first” or “foundational” papers in the field (as indicated in other people’s survey paper), 	4 th week	6% (the list of standard papers and reason for selection)

	<ul style="list-style-type: none"> • Favour more recent papers, • Pick a recent survey of the field so you can quickly gain an overview, • Find relationships with respect to each other and to your topic area (classification scheme/categorization) • Mark in the hard copy of papers whether complete work or section/sections of the paper are being considered 		
Reading and notes for first 5 papers	<p>Reading Paper Process</p> <ul style="list-style-type: none"> • For each paper form a Table answering the following questions: • What is the main topic of the article? • What was/were the main issue(s) the author said they want to discuss? • Why did the author claim it was important? • How does the work build on other's work, in the author's opinion? • What simplifying assumptions does the author claim to be making? • What did the author do? • How did the author claim they were going to evaluate their work and compare it to others? • What did the author say were the limitations of their research? • What did the author say were the important directions for future research? <p>Conclude with limitations/issues not addressed by the paper (from the perspective of your survey)</p>	5 th week	8% (the table given should indicate your understanding of the paper and the evaluation is based on your conclusions about each paper)
Reading and notes for next 5 papers	Repeat Reading Paper Process	6 th week	8% (the table given should indicate your understanding of the paper and the evaluation is based on your conclusions about each paper)
Reading and notes for final 5 papers	Repeat Reading Paper Process	7 th week	8% (the table given should indicate your understanding of the paper and the evaluation is based on

			your conclusions about each paper)
Draft outline 1 and Linking papers	Prepare a draft Outline, your survey goals, along with a classification / categorization diagram	8 th week	8% (this component will be evaluated based on the linking and classification among the papers)
Abstract	Prepare a draft abstract and give a presentation	9 th week	6% (Clarity, purpose and conclusion) 6% Presentation & Viva Voce
Introduction Background	Write an introduction and background sections	10 th week	5% (clarity)
Sections of the paper	Write the sections of your paper based on the classification / categorization diagram in keeping with the goals of your survey	11 th week	10% (this component will be evaluated based on the linking and classification among the papers)
Your conclusions	Write your conclusions and future work	12 th week	5% (conclusions – clarity and your ideas)
Final Draft	Complete the final draft of your paper	13 th week	10% (formatting, English, Clarity and linking) 4% Plagiarism Check Report
Seminar	A brief 15 slides on your paper	14 th & 15 th week	10% (based on presentation and Viva-voce)

TOTAL: 30 PERIODS

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	1	1	1	1	1	-
2	1	1	1	1	1	-
3	1	1	2	2	2	-
4	2	2	2	2	2	-
5	3	3	3	3	3	-

Avg	8/5=1.6	8/5=1.6	9/5=1.8	9/5=1.8	9/5=1.8	-
------------	---------	---------	---------	---------	---------	---

CU4301

OPTICAL COMMUNICATION AND NETWORKING

L T P C
3 0 0 3

COURSE OBJECTIVES:

- To enable the student to understand the basic principles of operation of optical system components, the different network architectures and issues associated with network design.
- To enable the student to understand the differences in the design of data plane and the control plane and the routing, switching and the resource allocation methods and the network management and protection methods in vogue.

UNIT I OPTICAL SYSTEM COMPONENTS AND NETWORK DESIGN 9

Optical System Components – MZIM, Multiplexers; filters; switches; wavelength converters; optical amplifiers – EDFA, Raman Amplifiers and hybrid; Transmission system Engineering – System Model, Aimer penalty – transmitter, receiver, cross talk, dispersion compensation, wavelength stabilization, FWM.

UNIT II COHERENT SYSTEMS 9

Basic principles of Coherent detections – Practical constraints – Injection laser line width state of polarization, local oscillator power, fiber limitations; Modulation formats – ASK, FSK, PSK, DPSK and polarization shift keying (POL SK); Demodulation schemes – Homodyne, Heterodyne – Synchronous and Non synchronous detection; Comparison; Carrier recovery in Coherent detection.

UNIT III OPTICAL NETWORK ARCHITECTURES 9

Introduction to Optical Networks; First Generation optical networks –SONET / SDH Network, Second Generation (WDM) Optical Networks, Need for Multilayered Architecture-, Layers and Sub-layers, Spectrum partitioning, Optical Network Nodes, Network Access Stations, Overlay Processor, Logical network overlays.

UNIT IV NETWORK CONNECTIONS 9

Connection Management and Control; Static Networks, Wavelength Routed Networks; Linear Light wave networks; Logically Routed Networks; Routing and Wavelength Assignment , Traffic Grooming in Optical Networks

UNIT V OPTICAL NETWORK SURVIVABILITY 9

Protection and Restoration Objectives, Fault Protection and Restoration Techniques in the Logical Layer – Point-to-Point Systems, SONET Self-Healing Rings, Interconnection Techniques, Architectures with Arbitrary Mesh Topologies ,Optical-Layer Protection: Point-to-Point and Ring Architectures, Mesh Architectures

COURSE OUTCOMES:

Upon the completion of course, students will be able to

CO1: demonstrate an understanding of the differences and challenges involved in the design of optical systems and networks.

CO2: apply his knowledge for designing a fiber optic system addressing the channel impairments.

CO3: Familiar with the architectures and the protocol stack in use in optical networks and would be able to identify a suitable backbone infrastructure for our present and future communication needs.

CO4: understand how connections are managed in the network and the pros and cons of the different approaches

CO5: appreciate the need for network survivability and the methodologies used.

TOTAL:45 PERIODS

REFERENCES

1. Max Ming-Kang Liu, "Principles and Applications of Optical Communication", Tata McGraw Hill Education Pvt., Ltd., New Delhi. 2010
2. Thomas E. Stern, Georgios Ellinas, Krishna Bala, "Multiwavelength Optical Networks – Architecture, Design and control ", Cambridge University Press, 2nd Edition, 2009.
3. Rajiv Ramaswami and Kumar N. Sivarajan, "Optical Networks : A Practical Perspective", Harcourt Asia Pte Ltd., Second Edition 2006.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	3	3	3	2	-	1
2	3	3	3	2	3	3
3	3	3	3	2	2	1
4	3	3	3	2	2	2
5	3	3	3	2	3	3
Avg	3	3	3	2	2.5	2

EL4071 ELECTROMAGNETIC INTERFERENCE AND COMPATIBILITY L T P C
3 0 0 3

COURSE OBJECTIVES:

- To gain broad conceptual understanding of the various aspects of electromagnetic (EM) interference and compatibility
- To develop a theoretical understanding of electromagnetic shielding effectiveness
- To understand ways of mitigating EMI by using shielding, grounding and filtering
- To understand the need for standards and to appreciate measurement methods
- To understand how EMI impacts wireless and broadband technologies

UNIT I INTRODUCTION & SOURCES OF EM INTERFERENCE 9

Introduction - Classification of sources - Natural sources - Man-made sources - Survey of the electromagnetic environment.

UNIT II EM SHIELDING 9

Introduction - Shielding effectiveness - Far-field sources - Near-field sources - Low-frequency, magnetic field shielding - Effects of apertures

UNIT III INTERFERENCE CONTROL TECHNIQUES 9
 Equipment screening - Cable screening - grounding - Power-line filters - Isolation - Balancing - Signal-line filters - Nonlinear protective devices.

UNIT IV EMC STANDARDS, MEASUREMENTS AND TESTING 9
 Need for standards - The international framework - Human exposure limits to EM fields -EMC measurement techniques - Measurement tools - Test environments.

UNIT V EMC CONSIDERATIONS IN WIRELESS AND BROADBAND TECHNOLOGIES 9
 Efficient use of frequency spectrum - EMC, interoperability and coexistence - Specifications and alliances - Transmission of high-frequency signals over telephone and power networks – EMC and digital subscriber lines - EMC and power line telecommunications.

SUGGESTED ACTIVITIES:

1. Investigate various case studies related to EMIC. Example: Chernobyl Disaster in 1986.
2. Develop some understanding about the design of EM shields in electronic system design and packaging.

COURSE OUTCOMES:

Upon completion of this course, the student will be able to

- CO1:**Demonstrate knowledge of the various sources of electromagnetic interference
- CO2:**Display an understanding of the effect of how electromagnetic fields couple through apertures, and solve simple problems based on that understanding
- CO3:**Explain the EMI mitigation techniques of shielding and grounding
- CO4:**Explain the need for standards and EMC measurement methods
- CO5:**Discuss the impact of EMC on wireless and broadband technologies

TOTAL:45 PERIODS

REFERENCES

1. Christopoulos C, Principles and Techniques of Electromagnetic Compatibility, CRC Press, Second Edition, Indian Edition, 2013.
2. Paul C R, Introduction to Electromagnetic Compatibility, Wiley India, Second Edition,2008.
3. Kodali V P, Engineering Electromagnetic Compatibility, Wiley India, Second Edition,2010.
4. Henry W Ott, Electromagnetic Compatibility Engineering, John Wiley & Sons Inc, Newyork,2009.
5. Scott Bennett W, Control and Measurement of Unintentional Electromagnetic Radiation, John Wiley& Sons Inc., Wiley Interscience Series, 1997.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	3	2	1	2	3	3
2	2	2	2	3	3	2
3	2	1	2	3	3	3

COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

CO1: Discuss Satellite navigation and global positioning system

CO2: Understand deep space networks and inter planetary missions

CO3: Demonstrate an understanding of the different interferences and attenuation mechanisms affecting the satellite link design.

CO4: Demonstrate an understanding of the different communication, sensing and navigational applications of satellite.

CO5: Familiar with the implementation aspects of existing satellite based systems.

TOTAL:45 PERIODS

REFERENCES

1. Adimurthy.V,"Concept design and planning of India's first interplanetary mission" Current Science, VOL. 109, NO. 6, 1054 25 SEPTEMBER 2015.
2. Anil K. Maini, Varsha Agrawal, 'Satellite Technology: Principles and Applications', Third Edition, Wiley, 2014.
3. Daniel Minoli' "Innovations in Satellite Communication and Satellite Technology" Wiley, 2015
4. Daniel Minoli, "Satellite Systems Engineering in an IPv6 Environment", CRC Press, First Edition, 2009.
5. Hofmann-Wellenhof B., Lichtenegger H., and Elmar Wasle, "Global Navigational Satellite Systems" Springer-Verlag, 2008.
6. Jim Taylor, " Deep Space Communications" John Wiley & Sons, 2016.
7. Louis J. Ippolito, Jr. "Satellite Communications Systems Engineering: Atmospheric Effects, Satellite Link Design and System Performance", Second Edition, 2017
8. <http://www.isro.gov.in/pslv-c25-mars-orbiter-mission>

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	-	-	-	-	1	1
2	-	-	1	-	3	1
3	-	-	1	-	2	1
4	-	-	2	-	2	2
5	3	3	2	3	3	2
Avg	3	3	1.5	3	2.2	1.4

CU4072

HIGH SPEED SWITCHING AND NETWORKING

L T P C

3 0 0 3

COURSE OBJECTIVES:

- To explore the various space division switches
- To enable the various network performance analysis
- To get the clear idea about the various multimedia application

- To get a clear idea about the traffic and Queuing systems.
- Interpret the basics of security management and the various attacks & its countermeasures

UNIT I SWITCHING ARCHITECTURES 9

Shared medium switches – Shared memory switches – Space division switches – Cross bar based switching architecture – Input queued, Output queued and Combined input-output queued switches – Non blocking and blocking cross bar switches – Banyan networks – Batched Banyan networks – Optical switches – Unbuffered and buffered switches – Buffering strategies – Optical packet switches and Optical burst switches – MEMS optical switches

UNIT II NETWORK PERFORMANCE ANALYSIS 9

Objectives and requirements for Quality of Service (QoS) in high performance networks. Architecture of high performance networks (HPN), design issues, protocols for HPN, VHF backbone networks, virtual interface architectures, virtual interface for networking, High-speed switching and routing - internet and PSTN IP switching techniques, SRP protocols, SRP authentication, and key exchange, comparison of TCP/IP, FTP, TELNET, queuing systems, network modeling as a graph

UNIT III MULTIMEDIA NETWORKING APPLICATIONS 9

Streaming stored Audio and Video, Best effort service, protocols for real time interactive applications, Beyond best effort, scheduling and policing mechanism, integrated services, RSVP-differentiated services.

UNIT IV PACKET QUEUES AND DELAY ANALYSIS 9

Little's theorem, Birth and Death process, queueing discipline- Control & stability -, Markovian FIFO queueing system, Non-markovian - Pollaczek-Khinchin formula and M/G/1, M/D/1, self-similar models and Batch-arrival model, Networks of Queues – Burke's theorem and Jackson Theorem.

UNIT V NETWORK SECURITY AND MANAGEMENT 9

Principles of cryptography – Elliptic-AES Authentication – integrity – key distribution and certification– Access control and: fire walls – DoS-attacks and counter measures – security in many layers. Infrastructure for network management – The internet standard management framework – SMI, MIB, SNMP, Security and administration – ASN.1.

COURSE OUTCOMES:

Upon completion the students will be able to

CO1: Understand the fundamental concepts of the switching architecture involved in various switching types

CO2: Interpret the basics of various protocols and QoS in the network performance

CO3: Understand the various types of multimedia networking application

CO4: Recognize the concepts of various analysis method involved in the processing

CO5: Understand fundamental issues involved in providing the security as well as the management.

TOTAL:45 PERIODS

REFERENCES

1. Achille Pattavina, "Switching Theory Architectures and performance in Broadband ATM networks", John Wiley & Sons Ltd. New York, 2007.
2. Elhanany, Itamar, Hamdi and Mounir, "High Performance Packet Switching Architectures", Springer 2007

3. Walrand .J. Varatya, "High Performance Communication Network", Morgan Kaufmann – Harcourt Asia Pvt. Ltd., 2nd Edition, 2000.
4. Fred Halsall and Lingana Gouda Kulkarni, "Computer Networking and the Internet", Fifth Edition, Pearson Education, 2012.
5. Nader F.Mir, "Computer and Communication Networks", Pearson Education, 2009.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	-	-	2	3	-	-
2	2	-	2	3	-	3
3	2	-	2	3	-	3
4	2	-	2	3	-	-
5	2	-	-	-	-	-
Avg	8/4=2	-	8/4=2	12/4=3	-	6/2=3

AP4095

SIGNAL INTEGRITY FOR HIGH SPEED DESIGN

**L T P C
3 0 0 3**

COURSE OBJECTIVES:

- To identify sources affecting the speed of digital circuits.
- To introduce methods to improve the signal transmission characteristics

UNIT I

SIGNAL PROPAGATION ON TRANSMISSION LINES

9

Transmission line equations, wave solution, wave vs. circuits, initial wave, delay time, Characteristic impedance , wave propagation, reflection, and bounce diagrams Reactive terminations – L, C , static field maps of micro strip and strip line cross-sections, per unit length parameters, PCB layer stackups and layer/Cu thicknesses, cross-sectional analysis tools, Zo and Td equations for microstrip and stripline Reflection and terminations for logic gates, fan-out, logic switching , input impedance into a transmission-line section, reflection coefficient, skin-effect, dispersion.

UNIT II

MULTI-CONDUCTOR TRANSMISSION LINES AND CROSS-TALK

9

Multi-conductor transmission-lines, coupling physics, per unit length parameters ,Near and far-end cross-talk, minimizing cross-talk (stripline and microstrip) Differential signalling, termination, balanced circuits ,S-parameters, Lossy and Lossless models.

UNIT III

NON-IDEAL EFFECTS

9

Non-ideal signal return paths – gaps, BGA fields, via transitions , Parasitic inductance and capacitance , Transmission line losses – Rs, tanδ , routing parasitic, Common-mode current, differential-mode current , Connectors.

UNIT IV POWER CONSIDERATIONS AND SYSTEM DESIGN 9

SSN/SSO , DC power bus design , layer stack up, SMT decoupling ,, Logic families, power consumption, and system power delivery , Logic families and speed Package types and parasitic ,SPICE, IBIS models ,Bit streams, PRBS and filtering functions of link-path components , Eye diagrams , jitter , inter-symbol interference Bit-error rate ,Timing analysis.

UNIT V CLOCK DISTRIBUTION AND CLOCK OSCILLATORS 9

Timing margin, Clock slew, low impedance drivers, terminations, Delay Adjustments, canceling parasitic capacitance, Clock jitter.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to

CO1: identify sources affecting the speed of digital circuits.

CO2: identify methods to improve the signal transmission characteristics

CO3: characterise and model multiconductor transmission line

CO4: analyse clock distribution system and understand its design parameters

CO5: analyse nonideal effects of transmission line

REFERENCES

1. H. W. Johnson and M. Graham, High-Speed Digital Design: A Handbook of Black Magic, Prentice Hall, 1993.
2. Douglas Brooks, Signal Integrity Issues and Printed Circuit Board Design, Prentice Hall PTR , 2003.
3. S. Hall, G. Hall, and J. McCall, High-Speed Digital System Design: A Handboo of Interconnect Theory and Design Practices, Wiley-Interscience, 2000.
4. Eric Bogatin , Signal Integrity – Simplified , Prentice Hall PTR, 2003.

TOOLS REQUIRED

1. SPICE, source - <http://www-cad.eecs.berkeley.edu/Software/software.html>
2. HSPICE from synopsis, www.synopsys.com/products/mixedsignal/hspice/hspice.html
3. SPECTRAQUEST from Cadence, <http://www.spectraquest.com> or any equivalent open source tool

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	1	2	2	3	3	2
2	2	2	2	3	3	2
3	1	1	2	3	3	3
4	2	2	1	3	3	2
5	2	2	2	3	3	2
Avg	1.6	1.8	1.8	3	3	2.2

COURSE OBJECTIVES:

- To introduce the fundamentals concepts of wavelet transforms.
- To study system design using Wavelets
- To learn the different wavelet families & their applications.
- To study signal compression and sub-band coding

UNIT I INTRODUCTION TO WAVELETS 9

Introduction to Multirate signal processing- Decimation and Interpolation, Quadrature Mirror Filters, Subband coding, Limitations of Fourier transform, Short time Fourier transform and its drawbacks, Continuous Wavelet transform, Time frequency representation, Wavelet System and its characteristics, Orthogonal and Orthonormal functions and function space

UNIT II MULTIRESOLUTION CONCEPT AND DISCRETE WAVELET TRANSFORM 9

Multiresolution formulation of wavelet systems- signal spaces, scaling function, wavelet function and its properties, Multiresolution analysis, Haar scaling and wavelet function, Filter banks- Analysis and Synthesis, 1D and 2D Discrete wavelet transform, Wavelet Packets, Tree structured filter bank, Multichannel filter bank, Undecimated wavelet transform.

UNIT III WAVELET SYSTEM DESIGN 9

Refinement relation for orthogonal wavelet systems, Restrictions on filter coefficients, Design of Daubechies orthogonal wavelet system coefficients, Design of Coiflet and Symlet wavelets.

UNIT IV WAVELET FAMILIES 9

Continuous Wavelets- Properties of Mexican hat wavelet, Morlet, Gaussian and Meyer wavelets. Orthogonal wavelets- Properties of Haar wavelets, Daubechies wavelets, Symlets, Coiflets and Discrete Meyer wavelets. Properties of Biorthogonal wavelets, Applications of wavelet families.

UNIT V SIGNAL COMPRESSION AND SUBBAND CODING 9

Compression Systems Based on Linear Transforms - Speech and Audio Compression - Image Compression - Video Compression - Joint Source-Channel Coding

COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

CO1: Understand the fundamental concepts of wavelet transforms

CO2: Apprehend detailed knowledge about wavelet transform

CO3: Understand system design using wavelets

CO4: Compare different wavelet families

CO5: Analyze signal compression and sub-band coding

TOTAL:45 PERIODS

REFERENCES

1. C.Sidney Burrus, Ramesh Gopinath & Haito Guo, "Introduction to wavelets and wavelet transform", Prentice Hall, 1998.
2. G.Strang and T.Nguyen, "Wavelet and filter banks", Wesley and Cambridge Press, 1996.
3. Metin Akay, "Time frequency and wavelets in biomedical signal processing", Wiley-IEEE Press, October 1997.
4. M.Vetterli and J. Kovacevic, "Wavelets and sub band coding", Prentice Hall, 1995.

5. .P.Vaidyanathan, "Multi rate systems and filter banks", Prentice Hall 1993
6. Raguveer m Rao & Ajith S. Bopardikar, "Wavelet transforms – Introduction to theory and applications", Addison Wesley, 1998
7. S.Mallet, "A Wavelet tour of Signal Processing", Academic Press 1998

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1				1		
2	1	2	2	2	1	
3	2	3	3	3	1	1
4	1	3	2	2	2	
5	1	2	2	3	2	1
Avg	1.2	2.5	2.2	2.2	1.5	1

MU4091

MULTIMEDIA COMPRESSION TECHNIQUES

**LT PC
3 0 0 3**

COURSE OBJECTIVES:

- To understand the basic ideas of compression algorithms related to multimedia components – Text, speech, audio, image and Video.
- To understand the principles and standards and their applications with an emphasis on underlying technologies, algorithms, and performance.
- To appreciate the use of compression in multimedia processing applications
- To understand and implement compression standards in detail

UNIT I FUNDAMENTALS OF COMPRESSION

9

Introduction To multimedia – Graphics, Image and Video representations – Fundamental concepts of video, digital audio – Storage requirements of multimedia applications – Need for compression – Taxonomy of compression Algorithms - Elements of Information Theory – Error Free Compression – Lossy Compression

UNIT II TEXT COMPRESSION

9

Huffman coding – Adaptive Huffman coding – Arithmetic coding – Shannon-Fano coding – Dictionary techniques – LZW family algorithms.

UNIT III IMAGE COMPRESSION

9

Image Compression: Fundamentals — Compression Standards – JPEG Standard – Sub-band coding – Wavelet Based compression – Implementation using Filters – EZW, SPIHT coders – JPEG 2000 standards – JBIG and JBIG2 standards.

UNIT IV AUDIO COMPRESSION

9

Audio compression Techniques – μ law, A-Law companding – Frequency domain and filtering – Basic sub-band coding – Application to speech coding – G.722 – MPEG audio – progressive encoding – Silence compression, Speech compression – Formant and CELP vocoders.

UNIT V VIDEO COMPRESSION**9**

Video compression techniques and Standards – MPEG video coding: MPEG-1 and MPEG-2 video coding: MPEG-3 and MPEG-4 – Motion estimation and compensation techniques – H.261 Standard – DVI technology – DVI real time compression – Current Trends in Compression standards.

TOTAL :45 PERIODS**COURSE OUTCOMES:**

Upon Completion of the course, the students should be able to

CO1:Implement basic compression algorithms familiar with the use of MATLAB and its equivalent open source environments

CO2:Design and implement some basic compression standards

CO3:Critically analyze different approaches of compression algorithms in multimedia related mini projects.

CO4 : Understand the various audio,speech compression techniques

CO5 :Understand and implement MPEG video coding techniques.

REFERENCES

1. Khalid Sayood: "Introduction to Data Compression", Morgan Kauffman Harcourt India, Third Edition, 2010.
2. David Solomon, "Data Compression – The Complete Reference", Fourth Edition, Springer Verlag, New York, 2006.
3. Yun Q.Shi, Huifang Sun, "Image and Video Compression for Multimedia Engineering, Algorithms and Fundamentals", CRC Press, 2003.
4. Mark S. Drew, Ze-Nian Li, "Fundamentals of Multimedia", PHI, 2009.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	2	-	2	1	1	1
2	3	-	3	2	2	1
3	3	-	3	2	2	1
4	2	-	2	2	2	1
5	2	-	2	2	2	1
Avg	2.4	-	2.4	1.8	1.8	1

NC4251**COGNITIVE RADIO NETWORKS****L T P C****3 0 0 3****COURSE OBJECTIVES:**

- Understand the fundamental concepts of cognitive radio networks.
- Develop the cognitive radio, as well as techniques for spectrum holes detection that cognitive radio takes advantages in order to exploit it.

- Understand the functions of MAC layer and Network layer and its various protocols
- Understand fundamental issues regarding dynamic spectrum access, the radio-resource management and trading
- Interpret the basics of security management and the various attacks & its countermeasures

UNIT I INTRODUCTION TO COGNITIVE RADIO 9

Cognitive Radio : Techniques and signal processing History and background, Communication policy and Spectrum Management, Cognitive radio cycle, Cognitive radio architecture, SDR architecture for cognitive radio, Spectrum sensing Single node sensing: energy detection, cyclo stationary and wavelet based sensing- problem formulation and performance analysis based on probability of detection Vs SNR. Cooperative sensing: different fusion rules, wideband spectrum

UNIT II SPECTRUM SENSING AND TRADING 9

Introduction –Spectrum Sensing – Multiband Spectrum Sensing – Sensing Techniques – Other algorithms – Comparison – Performance Measure & Design Trade-Offs : Receiver operating characteristics – Throughput Performance measure –Fundamental limits and trade-off. Introduction to spectrum trading, classification to spectrum trading, radio resource pricing, brief discussion on economics theories in DSA (utility, auction theory), classification of auctions (single auctions, double auctions, concurrent, sequential)

UNIT III MAC PROTOCOLS AND NETWORK LAYER DESIGN 9

Functionality of MAC protocol in spectrum access –classification –Interframe spacing and MAC challenges – QOS – Spectrum sharing in CRAHN –CRAHN models – CSMA/CA based MAC protocols for CRAHN – Routing in CRN– Centralized and Distributed protocols – Geographical Protocol

UNIT IV DYNAMIC SPECTRUM ACCESS AND MANAGEMENT 9

Spectrum broker, Dynamic spectrum access architecture- centralized dynamic spectrum access, distributed dynamic spectrum access, Inter- and intra-RAN dynamic spectrum allocation, Spectrum management, Spectrum sharing, Spectrum mobility issues

UNIT V TRUSTED COGNITIVE RADIO NETWORKS AND RESEARCH CHALLENGES 9

Trust for CRN :Fundamentals – Models – Effects of Trust Management –Security properties in CRN – Route Disruption attacks –Jamming attacks –PU Emulation attacks. Network layer and transport layer issues, cross layer design for cognitive radio networks.

COURSE OUTCOMES:

Upon the completion of the course, students will be able to

CO1: Understand the fundamental concepts of cognitive radio networks.

CO2: Interpret the basics of various spectrum sensing techniques and algorithms

CO3: Understand the functions of MAC layer and Network layer and its various protocols

CO4: Recognize the concepts of cooperative spectrum sensing and handoff process

CO5: Understand fundamental issues regarding dynamic spectrum access, the radio-resource management and trading, as well as a number of optimization techniques for better spectrum exploitation.

TOTAL:45 PERIODS

REFERENCES

1. Cognitive Radio, Software Defined Radio and Adaptive Wireless Systems”, Hüseyin Arslan, Springer, ISBN 978-1-4020-5541-6 (HB), 2007.
2. Linda Doyle, “Essentials of Cognitive Radio”, Cambridge University Press, 2009.
3. Kwang-Cheng Chen, Ramjee Prasad, “Cognitive radio networks”, John Wiley & Sons Ltd., 2009.
4. Cognitive Radio Technology”, by Bruce A. Fette, Elsevier, ISBN 10: 0-7506-7952-2, 2006.
5. Alexander M. Wyglinski, Maziar Nekovee, and Y. Thomas Hou, “Cognitive Radio Communications and Networks - Principles and Practice”, Elsevier Inc., 2010.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	3	-	3	3	2	3
2	3	-	3	3	2	3
3	3	-	3	3	2	3
4	3	-	3	3	2	3
5	3	-	3	3	2	3
Avg	3	-	3	3	2	3

CU4074

SPEECH PROCESSING

L T P C
3 0 0 3

COURSE OBJECTIVES:

- To introduce speech production and related parameters of speech.
- To illustrate the concepts of speech signal representations and coding.
- To understand different speech modeling procedures such Markov and their implementation issues.
- To gain knowledge about text analysis and speech synthesis.

UNIT I FUNDAMENTALS OF SPEECH PROCESSING 9

Introduction – Spoken Language Structure – Phonetics and Phonology – Syllables and Words – Syntax and Semantics – Probability, Statistics and Information Theory – Probability Theory – Estimation Theory – Significance Testing – Information Theory.

UNIT II SPEECH SIGNAL REPRESENTATIONS AND CODING 9

Overview of Digital Signal Processing – Speech Signal Representations – Short time Fourier Analysis – Acoustic Model of Speech Production – Linear Predictive Coding – Cepstral Processing – Formant Frequencies – The Role of Pitch – Speech Coding – LPC Coder, CELP, Vcoders.

UNIT III SPEECH RECOGNITION 9

Hidden Markov Models – Definition – Continuous and Discontinuous HMMs – Practical Issues – Limitations. Acoustic Modeling – Variability in the Speech Signal – Extracting Features – Phonetic Modeling – Adaptive Techniques – Confidence Measures – Other Techniques.

UNIT IV TEXT ANALYSIS**9**

Lexicon – Document Structure Detection – Text Normalization – Linguistic Analysis – Homograph Disambiguation – Morphological Analysis – Letter-to-sound Conversion – Prosody – Generation schematic – Speaking Style – Symbolic Prosody – Duration Assignment – Pitch Generation

UNIT V SPEECH SYNTHESIS**9**

Attributes – Formant Speech Synthesis – Concatenative Speech Synthesis – Prosodic Modification of Speech – Source-filter Models for Prosody Modification – Evaluation of TTS Systems.

COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

CO1: Model speech production system and describe the fundamentals of speech.

CO2: Extract and compare different speech parameters.

CO3: Choose an appropriate statistical speech model for a given application.

CO4: Design a speech recognition system.

CO5: Use different text analysis and speech synthesis techniques.

TOTAL:45 PERIODS**REFERENCES**

1. Ben Gold and Nelson Morgan, "Speech and Audio Signal Processing, Processing and Perception of Speech and Music", Wiley- India Edition, 2006
2. Claudio Becchetti and Lucio Prina Ricotti, "Speech Recognition", John Wiley and Sons, 1999.
3. Daniel Jurafsky and James H Martin, "Speech and Language Processing – An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition", Pearson Education, 2002.
4. Frederick Jelinek, "Statistical Methods of Speech Recognition", MIT Press, 1997.
5. Lawrence Rabiner and Biing-Hwang Juang, "Fundamentals of Speech Recognition", Pearson Education, 2003.
6. Steven W. Smith, "The Scientist and Engineer's Guide to Digital Signal Processing", California Technical Publishing, 1997.
7. Thomas F Quatieri, "Discrete-Time Speech Signal Processing – Principles and Practice", Pearson Education, 2004.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	3		2	3	1	1
2	3		2	3	1	1
3	3		2	3	1	1
4	3		2	3	1	1
5	3		2	3	1	1
Avg	15/5=3		10/5=2	15/5=3	5/5=1	5/5=1

COURSE OBJECTIVES:

- To understand the fundamentals of Millimeter wave devices and circuits.
- To understand the various components of Millimeter wave Communications system.
- To know the antenna design at Millimeter wave frequencies.
-

UNIT I INTRODUCTION 9

Millimeter wave characteristics- millimeter wave wireless, implementation challenges, Radio wave propagation for mm wave: Large scale propagation channel effects, small scale channel effects, Outdoor and Indoor channel models, Emerging applications of millimeter wave communications.

UNIT II mm WAVE DEVICES AND CIRCUITS 9

Millimeter wave generation and amplification: Peniotrons, Ubitrons, Gyrotrons and Free electron lasers. HEMT, models for mm wave Transistors, transistor configurations, Analog mm wave components: Amplifiers, Mixers, VCO, PLL. Metrics for analog mm wave devices, Consumption factor theory, Trends and architectures for mm wave wireless, ADC's and DAC's.

UNIT III mm WAVE COMMUNICATION SYSTEMS 9

Modulations for millimeter wave communications: OOK, PSK, FSK, QAM, OFDM, Millimeter wave link budget, Transceiver architecture, Transceiver without mixer, Receiver without Oscillator, Millimeter wave calibration, production and manufacture, Millimeter wave design considerations.

UNIT IV mm WAVE MIMO SYSTEMS 9

Massive MIMO Communications, Spatial diversity of Antenna Arrays, Multiple Antennas, Multiple Transceivers, Noise coupling in MIMO system, Potential benefits for mm wave systems, Spatial, Temporal and Frequency diversity, Dynamic spatial, frequency and modulation allocation.

UNIT V ANTENNAS FOR MM WAVE SYSTEMS 9

Antenna beamwidth, polarization, advanced beam steering and beam forming, mm wave design consideration, On-chip and In package mm wave antennas, Techniques to improve gain of on-chip antennas, Implementation for mm wave in adaptive antenna arrays, Device to Device communications over 5G systems, Design techniques of 5G mobile.

COURSE OUTCOMES:

Upon completion of the course the student will be able to

CO1: understand the Millimeter wave characteristics and implementation challenges faced.

CO2: understand Millimeter devices and circuits

CO3: apply his knowledge on the Modulation techniques for millimeter wave communications

CO4: design antenna for Millimeter wave frequencies

CO5: Familiar with Millimeter wave technology

TOTAL:45 PERIODS

REFERENCES

1. K.C. Huang, Z. Wang, "Millimeter Wave Communication Systems", Wiley-IEEE Press, March 2011.
2. Robert W. Heath, Robert C. Daniel, James N. Theodore S. Rappaport, Murdock, "Millimeter Wave Wireless Communication", Prentice Hall, 2014.
3. Xiang, W; Zheng, K; Shen, X.S; "5G Mobile Communications: Springer, 2016.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	1	2	3	3	2	3
2	-	2	3	-	3	3
3	-	2	3	-	3	3
4	2	3	3	3	2	2
5	3	3	3	2	3	3
Avg	2	2.4	3	2.6	2.6	2.8

CU4003

ANALOG AND MIXED SIGNAL VLSI DESIGN

L T P C

3 0 0 3

COURSE OBJECTIVES:

- To study the concepts of MOS large signal model and small signal model
- To understand the concepts of D/A conversion methods and their architectures.
- To learn filters for ADC.
- To study about the switched capacitor circuits.

UNIT I INTRODUCTION AND BASIC MOS DEVICES 9

Challenges in analog design-Mixed signal layout issues- MOSFET structures and characteristics large signal and small signal model of single stage Amplifier-Source follower- Common gate stage – Cascode Stage – large and small signal analysis of differential amplifier with active load, pole-zero estimation, zero value time constant method, frequency response of CS, cascade and Cascode amplifiers

UNIT II SUBMICRON CIRCUIT DESIGN 9

Submicron CMOS process flow, Capacitors and resistors, Current mirrors, Digital Circuit Design, Delay Elements – Adders- OP Amp parameters and Design

UNIT III DATA CONVERTERS 9

Static and dynamic errors in DAC and ADC – Architectures & Characteristics of Sample and Hold Digital to Analog Converters- DAC- R-2R, weighted DAC, multiplying DAC, segmented DAC and sigma delta DAC. ADC – Flash ADC, pipelined ADC, successive approximation ADC, sigma delta ADC.

UNIT IV SNR IN DATA CONVERTERS 9

Overview of SNR of Data Converters- Clock Jitters- Improving Using Averaging – Decimating Filters for ADC- Band pass and High Pass Sinc Filters- Interpolating Filters for DAC

UNIT V SWITCHED CAPACITOR CIRCUITS 9

Resistors, First order low pass Circuit, Switched capacitor Amplifier, Switched Capacitor Integrator – Design of flip around sample and hold circuit – pipelined ADC.

COURSE OUTCOMES:

Upon completion of the course , the student will be able to

CO1: Understand the Basic MOS devices characteristics & Analyze their frequency responses

CO2: Design submicron circuit.

CO3: Apply his knowledge on the DAC & ADC conversions.

CO4: Analyze the SNR in Data converters.

CO5: Design and analyze switched capacitor circuits

TOTAL:45 PERIODS

REFERENCES

1. J. Jacob Wikner, Mikael Gustavsson, Nianxiong Tan "CMOS Data Converters for Communications" Springer, 2000.
2. Van de Plassche, Rudy J., "CMOS Integrated Analog-to-Digital and Digital-to-Analog Converters" Springer, 2003.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	2		2	3	3	1
2	2		2	3	3	1
3	2		2	3	3	1
4	2		2	3	3	1
5	2		2	3	3	1
Avg	10/5=2		10/5=2	15/5=3	15/5=3	5/5=1

CU4075

ULTRA WIDE BAND COMMUNICATIONS

L T P C
3 0 0 3

COURSE OBJECTIVES:

- To give fundamental concepts related to Ultra wide band
- To understand the channel model and signal processing for UWB.
- To acquire knowledge about UWB antennas and regulations.

UNIT I INTRODUCTION TO UWB

9

History, Definition, FCC Mask, UWB features, Benefits and challenges, UWB Interference: IEEE 802.11.a Interference, Signal to Interference ratio calculation, Interference with other wireless services.

UNIT II UWB TECHNOLOGIES AND CHANNEL MODELS

9

Impulse Radio, Pulsed Multiband, Multiband OFDM, features : Complexity, Power Consumption, Security and achievable data rate. MIMO Multiband OFDM, Differential multiband OFDM, Performance characterization, Ultra Wide Band Wireless Channels
Channel model: Impulse Response Modeling of UWB Wireless Channels, IEEE UWB channel model, Path loss, Delay profiles, Time and frequency modeling.

UNIT III UWB SIGNAL PROCESSING**9**

Data Modulation schemes, UWB Multiple Access Modulation, BER, Rake Receiver, Transmit-Reference (T-R) Technique, UWB Range- Data Rate Performance, UWB Channel Capacity, UWB Wireless Locationing: Position Locationing Methods, Time of Arrival Estimation, NLOS Location Error , Locationing with OFDM

UNIT IV UWB ANTENNAS**9**

Antenna Requirements, Radiation Mechanism of the UWB Antennas, Types of Broad band antennas, Parameters, Analysis of UWB Antennas, Link Budget for UWB System. Design examples of broad band UWB antennas.

UNIT V UWB APPLICATIONS AND REGULATIONS**9**

Ultra wideband receiver architecture, Wireless Ad hoc Networking, UWB Wireless Sensor, RFID, Consumer Electronics and Personal, Asset Location, Medical applications, UWB Regulation and standards in various countries , UWB Regulation in ITU, IEEE Standardization

COURSE OUTCOMES:

Upon completion the students will be able to

CO1: Understand the basic concepts of UWB ..

CO2: Understand the basic concepts of UWB technologies.

CO3: Assess the performance of UWB channels.

CO4: Apply the UWB signal processing

CO5: Design UWB antenna for various applications.

TOTAL:45 PERIODS**REFERENCES**

1. Homayoun Nikookar and Ramjee Prasad, "Introduction to Ultra Wideband for Wireless Communications" 1st Edition, Springer Science & Business Media B.V. 2010.
2. Thomas Kaiser, Feng Zheng "Ultra Wideband Systems with MIMO", 1st Edition, John Wiley & Sons Ltd, New York, 2010.
3. W. Pam Siriwongpairat and K. J. Ray Liu, "Ultra-Wideband Communications Systems: Multiband OFDM approach" John Wiley and IEEE press, New York 2008.
4. Huseyin Arslan, Zhi Ning Chen, Maria-Gabriella Di Benedetto "Ultra Wideband Wireless communication" Wiley-Interscience; 1st edition 2006.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	-	-	2	3	2	2
2	2	-	2	3	2	2
3	-	-	-	-	-	2
4	-	-	2	3	2	2
5	2	-	-	3	2	2
Avg	4/2=2	-	6/3=2	12/4=3	8/4=2	10/5=2

COURSE OBJECTIVES:

- To understand the concepts of basic wireless communication concepts.
- To study the parameters in receiver and low noise amplifier design.
- To study the various types of mixers designed for wireless communication.
- To study and design PLL and VCO.
- To understand the concepts of transmitters and power amplifiers in wireless communication.

UNIT I COMMUNICATION CONCEPTS 9

Introduction – Overview of Wireless systems – Standards – Access Methods – Modulation schemes – Classical channel – Wireless channel description – Path loss – Multipath fading – Standard Translation.

UNIT II RECEIVER ARCHITECTURE & LOW NOISE AMPLIFIERS 9

Receiver front end – Filter design – Non-idealities – Design parameters – Noise figure & Input intercept point. LNA Introduction – Wideband LNA design – Narrow band LNA design: Impedance matching & Core amplifier.

UNIT III MIXERS 9

Balancing Mixer - Qualitative Description of the Gilbert Mixer - Conversion Gain – Distortion – Noise - A Complete Active Mixer. Switching Mixer – Distortion, Conversion Gain & Noise in Unbalanced Switching Mixer - A Practical Unbalanced Switching Mixer. Sampling Mixer - Conversion Gain, Distortion, Intrinsic & Extrinsic Noise in Single Ended Sampling Mixer.

UNIT IV FREQUENCY SYNTHESIZERS 9

PLL – Phase detector – Dividers – Voltage Controlled Oscillators – LC oscillators – Ring Oscillators – Phase noise – Loop filters & design approaches – A complete synthesizer design example (DECT) – Frequency synthesizer with fractional divider.

UNIT V TRANSMITTER ARCHITECTURES & POWER AMPLIFIERS 9

Transmitter back end design – Quadrature LO generator – Power amplifier design.

COURSE OUTCOMES:

At the end of this course, the student should be able to

CO1: Able to recollect basic wireless communication concepts.

CO2: To understand the parameters in receiver and design a low noise amplifier

CO3: In a position to apply his knowledge on various types of mixers designed for wireless communication.

CO4: Design PLL and VCO

CO5: Understand the concepts of transmitters and utilize the power amplifiers in wireless communication.

TOTAL:45 PERIODS

REFERENCES

1. Bosco H Leung “VLSI for Wireless Communication”, Pearson Education, 2002.
2. B.Razavi ,”RF Microelectronics” , Prentice-Hall ,1998.
3. Behzad Razavi, “Design of Analog CMOS Integrated Circuits” McGraw-Hill, 1999.

4. Emad N Farag and Mohamed I Elmasry, "Mixed Signal VLSI wireless design – Circuits & Systems", Kluwer Academic Publishers, 2000.
5. J. Crols and M. Steyaert, "CMOS Wireless Transceiver Design," Boston, Kluwer Academic Pub., 1997.
6. Thomas H.Lee, "The Design of CMOS Radio – Frequency Integrated Circuits", Cambridge University Press ,2003.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	2	1	1	-	-	-
2	1	-	2	3	-	-
3	2	-	2	1	1	1
4	1	-	2	2	1	1
5	2	-	2	1	1	1
Avg	1.6	1	1.8	1.7	1	1

VL4073

MEMS AND NEMS

L T P C
3 0 0 3

COURSE OBJECTIVES:

- to introduce the concepts of Micro Electro Mechanical devices.
- to know the fabrication process of microsystems.
- to know the design concepts of micro sensors and micro actuators.
- to familiarize concepts of Quantum Mechanics and Nano systems.

UNIT I OVERVIEW

9

New trends in Engineering and Science: Micro and Nanoscale systems, introduction to design of MEMS and NEMS, MEMS and NEMS – applications, devices and structures. Materials for MEMS: Silicon, Silicon compounds, polymers, metals

UNIT II MEMS FABRICATION TECHNOLOGIES

9

Microsystem Fabrication Processes: Photolithography, Ion Implantation, Diffusion, Oxidation. Thin Film Depositions: LPCVD, Sputtering, Evaporation, Electroplating; Etching Techniques: Dry and Wet Etching, Electrochemical Etching; Micromachining: Bulk Micromachining, Surface Micromachining, High Aspect- Ratio (LIGA and LIGA-Like) Technology; Packaging: Microsystems Packaging, Essential Packaging Technologies, Selection of Packaging Materials

UNIT III MICRO SENSORS

9

MEMS Sensors: Design of Acoustic Wave Sensors, Resonant Sensor, Vibratory Gyroscope, Capacitive and Piezo Resistive Pressure Sensors- Engineering Mechanics Behind These Microsensors. Case Study: Piezo-Resistive Pressure Sensor.

UNIT IV MICRO ACTUATORS**9**

Design of Actuators: Actuation Using Thermal Forces, Actuation Using Shape Memory Alloys, Actuation Using Piezoelectric Crystals, Actuation using Electrostatic Forces (Parallel Plate, Torsion Bar, Comb Drive Actuators), Micromechanical Motors and Pumps. Case Study: Comb Drive Actuators.

UNIT V NANOSYSTEMS AND QUANTUM MECHANICS**9**

Atomic Structures and Quantum Mechanics, Molecular and Nanostructure Dynamics: Schrodinger Equation and Wave Function Theory, Density Functional Theory, Nanostructures and Molecular Dynamics, Electromagnetic Fields and their Quantization, Molecular Wires and Molecular Circuits

TOTAL:45 PERIODS**COURSE OUTCOMES:**

At the end of this course, the student will be able to:

CO1:Discuss micro sensors**CO2:**Explain micro actuators**CO3:**Outline nanosystems and Quantum mechanics**CO4:**Design micro actuators for different applications**CO5:**Analyze atomic structures**REFERENCES**

1. Chang Liu, "Foundations of MEMS", Pearson Education India Limited, 2006.
2. Marc Madou, "Fundamentals of Microfabrication", CRC Press 1997.
3. Stephen D. Senturia, "Micro System Design", Kluwer Academic Publishers, 2001
4. Sergey Edward Lyshevski, "MEMS and NEMS: Systems, Devices, and Structures" CRC Press, 2002.
5. Tai Ran Hsu, "MEMS and Microsystems Design and Manufacture", Tata Mcraw Hill, 2002.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	2	2	1	3	3	2
2	2	2	2	3	3	2
3	2	1	2	3	3	2
4	2	2	2	2	2	2
5	1	2	1	2	2	2
Avg	1.8	1.8	1.6	2.6	2.6	2

CU4004**ADVANCED ANTENNA DESIGN****L T P C****3 0 0 3****COURSE OBJECTIVES:**

- To understand the antenna radiation characteristics and arrays.
- To enhance the student knowledge in the area of various antenna design.
- To enhance the student knowledge in the area of antenna for practical applications.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	2	2	2	3	3	2
2	3	3	3	3	3	2
3	2	2	2	3	3	2
4	2	2	2	3	3	3
5	2	2	2	3	3	3
Avg	2.2	2	2	3	3	2

CU4005

SOFTWARE DEFINED RADIOS

L T P C
3 0 0 3

COURSE OBJECTIVES:

- To learn various design principles of software defined radio.
- To understand challenges of receiver design.
- To design smart antennas for SDR.

UNIT I INTRODUCTION TO SOFTWARE RADIO CONCEPTS 9

SDR concepts & history, Benefits of SDR, SDR Forum, Ideal SDR architecture, SDR Based End-to-End Communication, Worldwide frequency band plans, Aim and requirements of the SCA. Architecture Overview, Functional View, Networking Overview, Core Framework, Real Time Operating Systems.

UNIT II RADIO FREQUENCY IMPLEMENTATION ISSUES 9

Purpose of RF front – end, Dynamic range, RF receiver front – end topologies, Enhanced flexibility of the RF chain with software radios, Importance of the components to overall performance, Transmitter architectures and their issues, Noise and distortion in the RF chain, ADC & DAC distortion, Pre-distortion, Flexible RF systems using micro-electromechanical systems.

UNIT III MULTIRATE SIGNAL PROCESSING IN SDR 9

Sample rate conversion principles, Polyphase filters, Digital filter banks, Timing recovery in digital receivers using multirate digital filters.

UNIT IV SMART ANTENNAS 9

Smart antennas, Adaptive techniques, Phased array antennas, Applying SDR principles to antenna systems, Smart antenna architectures, Low Cost SDR Platform, Requirements and system architecture, Convergence between military and commercial systems, The Future For Software Defined Radio.

UNIT V OBJECT ORIENTED REPRESENTATION OF RADIOS AND NETWORK 9

Networks, Object –oriented programming, Object brokers, Mobile application environments, Joint Tactical radio system. **Case Studies in Software Radio Design:** SPEAKEasy, JTRS, Wireless Information transfer system, SDR-3000 digital transceiver subsystem, Spectrum Ware, Brief

introduction to Cognitive Networking. Processing, Recursive Methods for Adaptive Error Processing.

COURSE OUTCOMES:

At the end of this course, the student will be able to

CO1: Demonstrate advanced knowledge in the evolving paradigm of Software defined radio and technologies for its implementation.

CO2: Analyse complex problems critically in the domains of Radio frequency implementation issues,

CO3: Apply multirate signal processing in SDR

CO4: Implement Smart antenna techniques for better spectrum exploitation for conducting research.

CO5: Apply appropriate techniques for the development of scientific and technological knowledge in designing software defined radios.

TOTAL:45 PERIODS

REFERENCES

1. Jeffrey Hugh Reed, "Software Radio: A Modern Approach to Radio Engineering," Prentice Hall Professional, 2002.
2. Paul Burns, "Software Defined Radio for 3G," Artech House, 2002.
3. Tony J Roupael, "RF and DSP for SDR," Elsevier Newnes Press, 2008
4. P. Kenington, "RF and Baseband Techniques for Software Defined Radio," Artech House, 2005.
5. Dillinger, Madani, Alonistioti (Eds.), Software Defined Radio, Architectures, Systems and Functions, Wiley, 2003
6. Bard, Kovarik, Software Defined Radio, the Software Communications Architecture, Wiley, 2007

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	3	-	3	3	2	3
2	3	-	3	3	2	3
3	3	-	3	3	2	3
4	3	-	3	3	2	3
5	3	-	3	3	2	3
Avg	3	-	3	3	2	3

CU4073

IMAGE PROCESSING AND VIDEO ANALYTICS

L T P C

3 0 2 4

COURSE OBJECTIVES:

- To comprehend the relation between human visual system and machine perception and processing of digital images
- To provide a detailed approach towards image processing applications like enhancement, segmentation, and compression.
- To also explore the integration principles of communication system working with different sampling rates.

- To analysis the fundamentals of digital image processing, image and video analysis
- To present the mathematics and algorithms that underlie image analysis techniques.

UNIT I INTRODUCTION AND DIGITAL IMAGE FUNDAMENTALS 9

Introduction: Introduction & Applications, Elements of visual perception, Image sensing and acquisition, simple image formation, Image sampling and Quantization, Representing digital pixels, Image quality, Introduction to colour image – RGB and HSI Models.

Image enhancement in Spatial domain: Introduction to image enhancement, basic grey level transforms, Histogram, Histogram-processing equalization, Matching & colour histogram, Enhancement using arithmetic/logic operations, spatial filtering, Smoothing spatial filtering, Sharpening spatial filtering.

UNIT II IMAGE PROCESSING TECHNIQUES 9

Image Enhancement: Spatial Domain methods: Histogram Processing, Fundamentals of Spatial Filtering, Smoothing Spatial filters, Sharpening Spatial filters Frequency Domain methods: Basics of filtering in frequency domain, image smoothing, image sharpening, selective filtering Image Segmentation: Segmentation concepts, point, line and Edge detection, Thresholding, region based segmentation

UNIT III VIDEO PROCESSING AND MOTION ESTIMATION 9

Analog video, Digital Video, Time varying Image Formation models : 3D motion models, Geometric Image formation , Photometric Image formation, sampling of video signals, filtering operations 2-D Motion Estimation: Optical flow, general methodologies, pixel based motion estimation, Block matching algorithm, Mesh based motion Estimation, global Motion Estimation, Region based motion estimation, multi resolution motion estimation. Waveform based coding, Block based transform coding, predictive coding, Application of motion estimation in video coding.

UNIT IV INTRODUCTION: VIDEO ANALYTICS 9

Computer Vision: Challenges- Spatial Domain Processing – Frequency Domain Processing-Background Modeling-Shadow Detection-Eigen Faces - Object Detection -Local Features-Mean Shift: Clustering, Tracking - Object Tracking using Active Contours – Tracking & Video Analysis- Kalman filters, condensation, particle, Bayesian filters, hidden Markov models, change detection and model based tracking

UNIT V MOTION UNDERSTANDING 9

Motion estimation and Compensation-Block Matching Method, Motion Segmentation -Thresholding for Change Detection, Estimation of Model parameters - Optical Flow Segmentation-Modified Hough Transform Method- Segmentation for Layered Video Representation-Bayesian Segmentation -Simultaneous Estimation and Segmentation-Motion Field Model - Action Recognition - Low Level Image Processing for Action Recognition

45 PERIODS

PRACTICAL EXERCISES:

30 PERIODS

1. Perform basic operations on images like addition, subtraction etc.
2. Plot the histogram of an image and perform histogram equalization
3. Implement segmentation algorithms
4. Perform video enhancement
5. Perform video segmentation
6. Perform image compression using lossy technique

7. Perform image compression using lossless technique
8. Perform image restoration
9. Convert a colour model into another
10. Calculate boundary features of an image
11. Calculate regional features of an image
12. Detect an object in an image/video using template matching/Bayes classifier

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1: Explore of the limitations of the computational methods on digital images.

CO2: Implement the spatial and frequency domain image transforms on enhancement and restoration of images

CO3: Define the need for compression and evaluate the basic compression algorithms

CO4: Study the techniques to recover the desired signal parameters and information from the signal corrupted by noisy channel

CO5: Understand the algorithms available for performing analysis on video data and address the challenges

CO6: Understand the approaches for identifying and tracking objects and person with motion based algorithms.

TOTAL:45+30=75 PERIODS

REFERENCES

1. Digital Image Processing - Rafael C. Gonzalez, Richard E. Woods, 3rd Edition, Pearson, 2008
2. John J. Proakis, Dimitris G. Manolakis, "Digital Signal Processing", Pearson Education, 2002.
3. Digital Image Processing and Analysis-Human and Computer Vision Application with using CVIP Tools - Scotte Umbaugh, 2nd Ed, CRC Press, 2011
4. John C. Russ, F. Brent Neal-The Image Processing Handbook, Seventh Edition, The Kindle edition (2016), CRC Press,Taylor & Francis Group.
5. John G. Proakis, Masoud Salehi, "Communication Systems Engineering", Prentice Hall, 1994.
6. Richard Szeliski, "Computer Vision: Algorithms and Applications", Springer, 2011.
7. Yao Wang, JornOstermann and Ya-Qin Zhang, "Video Processing and Communications", Prentice Hall, 2001.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	-	-	1	1	-	3
2	-	-	1	1	-	3
3	-	-	1	1	-	3
4	2	2	2	2	1	3
5	3	3	3	3	2	3
Avg	3	3	3	3	2	3
	2.6	2.6	1.8	1.8	1.6	3

COURSE OBJECTIVES:

- To understand the Radar Signal acquisition and sampling in multiple domains
- To provide clear instruction in radar DSP basics
- To equip the skills needed in both design and analysis of common radar algorithms
- To understand the basics of synthetic aperture imaging and adaptive array processing
- To illustrate how theoretical results are derived and applied in practice

UNIT I INTRODUCTION TO RADAR SYSTEMS 9

History and application of radar, basic radar function, elements of pulsed radar, review of signal processing concepts and operations, A preview of basic radar signal processing, radar system components, advanced radar signal processing

UNIT II SIGNAL MODELS 9

Components of a radar signal, amplitude models, types of clutters, noise model and signal-to-noise ratio, jamming, frequency models: the doppler shift, spatial models, spectral model

UNIT III SAMPLING AND QUANTIZATION OF PULSED RADAR SIGNALS 9

Domains and criteria for sampling radar signals, Sampling in the fast time dimension, Sampling in slow time: selecting the pulse repetition interval, sampling the doppler spectrum, Sampling in the spatial and angle dimension, Quantization, I/Q Imbalance and Digital I/Q.

UNIT IV RADAR WAVEFORMS 9

Introduction, The waveform matched filter, Matched filtering of moving targets, The ambiguity function, The pulse burst waveform, frequency-modulated pulse compression waveforms, Range sidelobe control for FM waveforms, the stepped frequency waveform, Phase-modulated pulse compression waveforms, COSTAS Frequency Codes.

UNIT V DOPPLER PROCESSING 9

Alternate forms of the Doppler spectrum, Moving target indication (MTI), Pulse Doppler processing, dwell-to-dwell stagger, Pulse pair processing, additional Doppler processing issues, clutter mapping and the moving target detector, MTI for moving platforms: adaptive displaced phase center antenna processing

PRACTICAL EXERCISES: 30 PERIODS

1. Matched filtering operation
2. Modeling the Propagation of Radar Signals
3. Modeling of radar targets
4. Density-based algorithm for clustering data.
5. MTI radar design, target detection in noise
6. Estimation of bearing angle in noise, clutter modelling
7. Frequency modulated radar signal generation
8. Doppler shift Signal strength
9. SNR loss measurement in pulse compression
10. detection performance of a radar system

TOTAL: 45+30=75 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1: perform radar signal acquisition and sampling

CO2: perform algorithm on radar processing

CO3 :design basic radar algorithm

CO4: design on aperture imaging and array processing

CO5: Illustrate theoretical results are derived and applied in practice

REFERENCES

1. Michael O Kolawole, "Radar systems, Peak Detection and Tracking", Elseveir. 2003
2. Introduction To Radar Systems 3/E, Skolnik, McGraw Hill. 2017
3. Radar Principles, Peyton Z. Peebles, Wiley India 2009
4. And Marvin N. Cohen, Fred E. Nathanson, Radar Design Principles-Signal Processing and the environment PHI, 2nd edition, 2006.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	1	1	1	1	1	1
2	2	2	2	1	2	1
3	3	3	2	3	3	3
4	3	3	2	3	3	3
5	2	2	2	2	2	2
Avg	2.2	2.2	1.8	2	2.2	2

EL4291**TELECOMMUNICATION SYSTEM MODELING AND SIMULATION****L T P C****3 0 2 4****COURSE OBJECTIVES:**

- To enable the student to understand the various aspects of simulation methodology and performance
- To appreciate the significance of selecting sampling frequency and modeling different types of signals and processing them
- To expose the student to the different simulation techniques, their pros and cons and enable him to understand and interpret results using case studies

UNIT I SIMULATION METHODOLOGY**9**

Introduction, Aspects of methodology, Performance Estimation, Simulation sampling frequency, Low pass equivalent simulation models for bandpass signals, Multicarrier signals, Non-linear and time-varying systems, Post processing – Basic graphical techniques and estimations

UNIT II RANDOM SIGNAL GENERATION & PROCESSING**9**

Uniform random number generation, Mapping uniform random variables to an arbitrary pdf, Correlated and Uncorrelated Gaussian random number generation, PN sequence generation, Random signal processing, Testing of random number generators.

UNIT III MONTE CARLO SIMULATION

9

Fundamental concepts, Application to communication systems, Monte Carlo integration, Semi-analytic techniques, Case study: Performance estimation of a wireless system

UNIT IV ADVANCED MODELS & SIMULATION TECHNIQUES

9

Modeling and simulation of non-linearities : Types, Memoryless non-linearities, Non-linearities with memory, Modeling and simulation of Time varying systems : Random process models, Tapped delay line model, Modeling and simulation of waveform channels, Discrete memoryless channel models, Markov model for discrete channels with memory.

UNIT V EFFICIENT SIMULATION TECHNIQUES

9

Tail extrapolation, pdf estimators, Importance Sampling methods, Case study: Simulation of a Cellular Radio System.

PRACTICALS:

1. Study the spectrum of response of linear and non-linear systems for single tone input
2. Generation of OFDM (multicarrier) signal and plot the spectrum (RF and Low pass equivalent)
3. Generation of uniform / Gaussian random numbers and verification of their probability distribution, autocorrelation and spectrum
4. Generation of uncorrelated and correlated random processes and verification of cross-correlations
5. Generation of PN sequence and verification of properties and spectrum.
6. Application of Monte Carlo simulation for estimation of BER of a wireless communication link
7. Study the impact of non-linearity of amplifier on transmitter symbol constellation with the help of Saleh model
8. Studying the effect of time invariant (slow fading) frequency selecting channel with the help of symbol constellation
9. Studying the effect of time variant flat fading (memoryless) channel with the help of symbol constellation

COURSE OUTCOMES:

Upon completion of the course the student will be able to:

CO1: Understand the different signal generation and processing methods

CO2: Mathematically model a physical phenomena.

CO3: Simulate a phenomena so as to depict the characteristics that may be observed in a real experiment.

CO4: Apply knowledge of the different simulation techniques for designing a communication system or channel

CO5: Validate a simulated system performance so as to match a realistic scenario

TOTAL:45+30=75 PERIODS

REFERENCES

1. William.H.Tranter, K. Sam Shanmugam, Theodore. S. Rappaport, Kurt L. Kosbar, Principles of Communication Systems Simulation, Pearson Education (Singapore) Pvt. Ltd, 2004.
2. M.C. Jeruchim, P.Balaban and K. Sam Shanmugam, Simulation of Communication Systems: Modeling, Methodology and Techniques, Plenum Press, New York, 2001.
3. Averill.M.Law and W. David Kelton, Simulation Modeling and Analysis, McGraw Hill Inc., 2000.
4. Geoffrey Gorden, System Simulation, Prentice Hall of India, 2nd Edition, 1992.

5. Jerry Banks and John S. Carson, Discrete Event System Simulation, Prentice Hall of India, 1984.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	-	-	2	3	3	-
2	-	-	2	-	-	-
3	2	-	2	3	-	3
4	-	-	2	3	3	3
5	2	-	-	-	-	3
Avg	4/2=2	-	8/4=2	9/3=3	6/2=3	9/3=3

EL4072

SIGNAL DETECTION AND ESTIMATION

L T P C
3 0 2 4

COURSE OBJECTIVES:

- To understand the concepts of detection and estimation.
- To learn the basics of multi-user detection theory
- To understand the theory behind various estimation techniques.
- To understand Wiener filter and Kalman filter in detail.

UNIT I

REVIEW OF PROBABILITY AND STOCHASTIC PROCESS

9

Conditional Probability, Bayes' Theorem, Random Variables, Conditional Distributions and Densities, moments and distribution of random variables., Stationary Processes Cyclostationary Processes Averages and Ergodicity Autocorrelation Function Power Spectral Density Discrete Time Stochastic Processes, Spatial Stochastic Processes, Random Signals, Relationship of Power Spectral Density and Autocorrelation Function.

UNIT II

SINGLE AND MULTIPLE SAMPLE DETECTION

9

Hypothesis Testing and the MAP Criterion, Bayes Criterion, Minimax Criterion, Neyman-Pearson Criterion, Sequential Detection, The Optimum Digital Detector in Additive Gaussian Noise, Performance of Binary Receivers in AWGN.

UNIT III

FUNDAMENTALS OF ESTIMATION THEORY

9

Formulation of the General Parameter Estimation Problem, Relationship between Detection and Estimation Theory, Types of Estimation Problems, Properties of Estimators, Bayes estimation, Minimax Estimation, Maximum-Likelihood Estimation, Comparison of Estimators of Parameters.

UNIT IV

WIENER AND KALMAN FILTERS

9

Orthogonality Principle, Autoregressive Techniques, Discrete Wiener Filter, Continuous Wiener Filter, Generalization of Discrete and Continuous Filter Representations, Linear Least-Squares Methods, Minimum-Variance Weighted Least-Squares Methods, Minimum-Variance, Least Squares, Kalman Algorithm - Computational Considerations, Signal Estimation, Continuous Kalman Filter, Extended Kalman Filter.

UNIT V APPLICATIONS**9**

Detector Structures in Non-Gaussian Noise , Examples of Noise Models, Receiver Structures, and Error-Rate Performance, Estimation of Non-Gaussian Noise Parameters Fading Multipath Channel Models, Receiver Structures with Known Channel Parameters, Receiver Structures without Knowledge of Phase, Receiver Structures without Knowledge of Amplitude or Phase, Receiver Structures and Performance with No Channel Knowledge.

PRACTICALS:**PERIOD – 30****Suggested List of Experiments**

Software Requirement: Matlab / Python / Equivalent

1. Power Spectrum Estimation of a Random Signal
2. Maximum Likelihood Estimation
3. Design of optimum receiver in AWGN channel
4. Wiener Filter Design
5. Adaptive Filter Design using LMS algorithm
6. Minimum Variance Estimation

COURSE OUTCOMES:**Upon completion of the course the student will be**

CO1: Able to understand the importance of probability and stochastic process concepts in detection and estimation.

CO2: Able to design optimum detector and estimator for AWGN channel

CO3: Able to design and analyze the various estimators.

CO4: Able to design Wiener and Kalman filters to solve linear estimation problems.

CO5: Able to design and develop novel receiver structures suitable for modern technology.

TOTAL:75 PERIODS**REFERENCES**

1. Harry L. Van Trees, "Detection, Estimation and Modulation Theory", Part I John Wiley and Sons, New York, 2004.
2. Ludeman, Lonnie C. Random processes: filtering, estimation, and detection. John Wiley & Sons, Inc., 2003
3. Sergio Verdu " Multi User Detection" Cambridge University Press, 1998
4. Steven M. Kay, "Fundamentals of Statistical Processing, Volume I: Estimation Theory", Prentice Hall Signal Processing Series, Prentice Hall, PTR, New Jersey, 1993.
5. Thomas Schonhoff, "Detection and Estimation Theory", Prentice Hall, New Jersey, 2007.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	3	1	2	2	3	2
2	3	1	2	3	3	2
3	3	2	2	3	3	2
4	3	2	2	3	3	2
5	3	2	2	3	3	2
Avg	3	1.6	2	2.8	3	2

COURSE OBJECTIVES:

- To understand the basics of embedded system and ARM architecture
- To understand the RTOS concepts like scheduling and memory management related to the embedded system
- To learn about the programming aspects of RTOS
- To learn the different protocols of embedded wireless application
- To understand concepts involved in the design of hardware and software components for an embedded system

UNIT I INTRODUCTION 9

Real Time System – Embedded Systems – Architecture of Embedded System – Simple Programming for Embedded System – Process of Embedded System Development – Pervasive Computing – Information Access Devices – Smart Cards – Microcontrollers – ARM Processor -Real Time Microcontrollers.

UNIT II EMBEDDED/REAL TIME OPERATING SYSTEM 9

Operating System Concepts: Processes, Threads, Interrupts, Events - Real Time Scheduling Algorithms - Memory Management – Overview of Operating Systems for Embedded, Real Time Handheld Devices – Target Image Creation – Programming In Linux, Rtlinux, Vxworks, Microcontroller Operating System Overview.

UNIT III CONNECTIVITY 9

Wireless Connectivity - Bluetooth – Other Short Range Protocols – Wireless Application Environment – Service Discovery – Middleware.

UNIT IV REAL TIME UML 9

The Rapid Object-Oriented Process for Embedded Systems (ROPES) Process. MDA and Platform-Independent Models- Scheduling Model-Based Projects- Model Organization Principles- Working with Model-Based Projects - Object Orientation with UML 2.0-Structural Aspects-Object Orientation with UML 2.0-Dynamic Aspects-UML Profile for Schedulability, Performance, and Time. Requirements Analysis – Object Identification Strategies – Object Behaviour – Real Time Design Patterns.

UNIT V SOFTWARE DEVELOPMENT AND APPLICATION 9

Concurrency – Exceptions – Tools – Debugging Techniques – Optimization –Interfacing Digital Camera With USB Port. Interfacing of Sensors and Actuators for a Real Time Industrial Application.

TOTAL: 45 PERIODS**PRACTICAL EXERCISES:****30 PERIODS**

1. Read Input From Switch And Automatic Control/Flash LED for ARM Processor
2. Laboratory Exercises On Task Scheduling
3. Simple Program In Linux, Rtlinux And Vxworks
4. Develop a Real Time Security Monitoring System

COURSE OUTCOMES:

On successful completion of this course, students will be able to

CO1:Make a choice of suitable embedded processor for a given application

CO2:Design the hardware and software for the embedded system

CO3:Design and develop the real time kernel/operating system functions, task control block structure and analyze different task states

CO4:Implement different types of inter task communication and synchronization techniques

CO5:Know about the aspects embedded connectivity in real time systems

REFERENCES:

1. R.J.a.Buhr, D.L.Bailey, "An Introduction To Real-Time Systems", Prentice-Hall International,1999.
2. David E-Simon, "An Embedded Software Primer", Pearson Education, 2007.
3. C.M.Krishna, Kang G.Shin, "Real Time Systems", Mc-Graw Hill, 2010.
4. B.P.Douglass, "Real Time Uml - Advances In the UML for Real-Time Systems, 3rd Edition Addison-Wesley, 2004.
5. K.V.K. Prasad, "Embedded/Real Time Systems: Concepts, Design And Programming", Dream Tech Press, Black Book, 2005.
6. R.Barnett, L.O.Cull, S.Cox, "Embedded C Programming and the Microchip PIC ", Thomason Learning, 2004.
7. Wayne Wolf, "Computers As Components - Principles of Embedded Computer System Design", Mergen Kaufmann Publisher, 2006.
8. Sriram V Iyer, Pankaj Gupta, "Embedded Real Time Systems Programming", Tata Mc-Graw Hill, 2004.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	3	-	3	3	2	2
2	3	1	3	3	2	3
3	2	-	2	2	-	3
4	1	-	2	1	-	2
5	1	-	2	3	3	1
Avg	2	1	2.4	2.4	2.3	2.2

AUDIT COURSES

AX4091

ENGLISH FOR RESEARCH PAPER WRITING

**L T P C
2 0 0 0**

COURSE OBJECTIVES:

- Teach how to improve writing skills and level of readability
- Tell about what to write in each section
- Summarize the skills needed when writing a Title
- Infer the skills needed when writing the Conclusion
- Ensure the quality of paper at very first-time submission

UNIT I INTRODUCTION TO RESEARCH PAPER WRITING 6
Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

UNIT II PRESENTATION SKILLS 6
Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction

UNIT III TITLE WRITING SKILLS 6
Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check

UNIT IV RESULT WRITING SKILLS 6
Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions

UNIT V VERIFICATION SKILLS 6
Useful phrases, checking Plagiarism, how to ensure paper is as good as it could possibly be the first- time submission

TOTAL: 30 PERIODS

COURSE OUTCOMES:

CO1 –Understand that how to improve your writing skills and level of readability

CO2 – Learn about what to write in each section

CO3 – Understand the skills needed when writing a Title

CO4 – Understand the skills needed when writing the Conclusion

CO5 – Ensure the good quality of paper at very first-time submission

REFERENCES:

1. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011
2. Day R How to Write and Publish a Scientific Paper, Cambridge University Press 2006
3. Goldbort R Writing for Science, Yale University Press (available on Google Books) 2006
4. Highman N, Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book 1998.

AX4092

DISASTER MANAGEMENT

L T P C
2 0 0 0

COURSE OBJECTIVES:

- Summarize basics of disaster
- Explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- Illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- Describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
- Develop the strengths and weaknesses of disaster management approaches

UNIT I	INTRODUCTION	6
Disaster: Definition, Factors and Significance; Difference between Hazard And Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.		
UNIT II	REPERCUSSIONS OF DISASTERS AND HAZARDS	6
Economic Damage, Loss of Human and Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.		
UNIT III	DISASTER PRONE AREAS IN INDIA	6
Study of Seismic Zones; Areas Prone To Floods and Droughts, Landslides And Avalanches; Areas Prone To Cyclonic and Coastal Hazards with Special Reference To Tsunami; Post-Disaster Diseases and Epidemics		
UNIT IV	DISASTER PREPAREDNESS AND MANAGEMENT	6
Preparedness: Monitoring Of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological And Other Agencies, Media Reports: Governmental and Community Preparedness.		
UNIT V	RISK ASSESSMENT	6
Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival		

TOTAL : 30 PERIODS

COURSE OUTCOMES:

CO1: Ability to summarize basics of disaster

CO2: Ability to explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.

CO3: Ability to illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.

CO4: Ability to describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.

CO5: Ability to develop the strengths and weaknesses of disaster management approaches

REFERENCES:

1. Goel S. L., Disaster Administration And Management Text And Case Studies”, Deep & Deep Publication Pvt. Ltd., New Delhi, 2009.
2. Nishitha Rai, Singh AK, “Disaster Management in India: Perspectives, issues and strategies “NewRoyal book Company, 2007.
3. Sahni, Pardeep Et. Al. ,” Disaster Mitigation Experiences And Reflections”, Prentice Hall Of India, New Delhi, 2001.

AX4093

CONSTITUTION OF INDIA

L T P C
2 0 0 0

COURSE OBJECTIVES:

Students will be able to:

- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.

- To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional
- Role and entitlement to civil and economic rights as well as the emergence nation hood in the early years of Indian nationalism.
- To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.

UNIT I HISTORY OF MAKING OF THE INDIAN CONSTITUTION

History, Drafting Committee, (Composition & Working)

UNIT II PHILOSOPHY OF THE INDIAN CONSTITUTION

Preamble, Salient Features

UNIT III CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES

Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

UNIT IV ORGANS OF GOVERNANCE

Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.

UNIT V LOCAL ADMINISTRATION

District's Administration head: Role and Importance, □ Municipalities: Introduction, Mayor and role of Elected Representative, CEO, Municipal Corporation. Pachayati raj: Introduction, PRI: Zila Pachayat. Elected officials and their roles, CEO Zila Pachayat: Position and role. Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy.

UNIT VI ELECTION COMMISSION

Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners - Institute and Bodies for the welfare of SC/ST/OBC and women.

TOTAL: 30 PERIODS

COURSE OUTCOMES:

Students will be able to:

- Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
- Discuss the intellectual origins of the framework of argument that informed the conceptualization
- of social reforms leading to revolution in India.
- Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
- Discuss the passage of the Hindu Code Bill of 1956.

SUGGESTED READING

1. The Constitution of India, 1950 (Bare Act), Government Publication.

2. Dr.S.N.Busi, Dr.B. R.Ambedkar framing of Indian Constitution,1st Edition, 2015.
3. M.P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis,2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

AX4094

நற்றமிழ் இலக்கியம்

L T P C
2 0 0 0

UNIT I	சங்க இலக்கியம்	6
	<ol style="list-style-type: none"> 1. தமிழின் துவக்க நூல் தொல்காப்பியம் - எழுத்து, சொல், பொருள் 2. அகநானூறு (82) - இயற்கை இன்னிசை அரங்கம் 3. குறிஞ்சிப் பாட்டின் மலர்க்காட்சி 4. புறநானூறு (95,195) - போரை நிறுத்திய ஔவையார் 	
UNIT II	அறநெறித் தமிழ்	6
	<ol style="list-style-type: none"> 1. அறநெறி வகுத்த திருவள்ளுவர் - அறம் வலியுறுத்தல், அன்புடைமை, ஒப்புறவு அறிதல், ஈகை, புகழ் 2. பிற அறநூல்கள் - இலக்கிய மருந்து - ஏலாதி, சிறுபஞ்சமூலம், திரிகடுகம், ஆசாரக்கோவை (தூய்மையை வலியுறுத்தும் நூல்) 	
UNIT III	இரட்டைக் காப்பியங்கள்	6
	<ol style="list-style-type: none"> 1. கண்ணகியின் புரட்சி - சிலப்பதிகார வழக்குரை காதை 2. சமூகசேவை இலக்கியம் மணிமேகலை - சிறைக்கோட்டம் அறக்கோட்டமாகிய காதை 	
UNIT IV	அருள்நெறித் தமிழ்	6
	<ol style="list-style-type: none"> 1. சிறுபாணாற்றுப்படை - பாரி முல்லைக்குத் தேர் கொடுத்தது, பேகன் மயிலுக்குப் போர்வை கொடுத்தது, அதியமான் ஔவைக்கு நெல்லிக்கனி கொடுத்தது, அரசர் பண்புகள் 2. நற்றிணை - அன்னைக்குரிய புன்னை சிறப்பு 3. திருமந்திரம் (617, 618) - இயமம் நியமம் விதிகள் 4. தர்மச்சாலையை நிறுவிய வள்ளலார் 5. புறநானூறு - சிறுவனே வள்ளலானான் 	

6. அகநானூறு (4) - வண்டு
 நற்றிணை (11) - நண்டு
 கலித்தொகை (11) - யானை, புறா
 ஐந்திணை 50 (27) - மான்
 ஆகியவை பற்றிய செய்திகள்

UNIT V

நவீன தமிழ் இலக்கியம்

6

1. உரைநடைத் தமிழ்,
 - தமிழின் முதல் புதினம்,
 - தமிழின் முதல் சிறுகதை,
 - கட்டுரை இலக்கியம்,
 - பயண இலக்கியம்,
 - நாடகம்,
2. நாட்டு விடுதலை போராட்டமும் தமிழ் இலக்கியமும்,
3. சமுதாய விடுதலையும் தமிழ் இலக்கியமும்,
4. பெண் விடுதலையும் விளிம்பு நிலையினரின் மேம்பாட்டில் தமிழ் இலக்கியமும்,
5. அறிவியல் தமிழ்,
6. இணையத்தில் தமிழ்,
7. சுற்றுச்சூழல் மேம்பாட்டில் தமிழ் இலக்கியம்.

TOTAL : 30 PERIODS

தமிழ் இலக்கிய வெளியீடுகள் / புத்தகங்கள்

1. தமிழ் இணைய கல்விக்கழகம் (Tamil Virtual University)
 - www.tamilvu.org
2. தமிழ் விக்கிப்பீடியா (Tamil Wikipedia)
 - <https://ta.wikipedia.org>
3. தர்மபுர ஆனீன வெளியீடு
4. வாழ்வியல் களஞ்சியம்
 - தமிழ்ப் பல்கலைக்கழகம், தஞ்சாவூர்
5. தமிழ்கலைக் களஞ்சியம்
 - தமிழ் வளர்ச்சித் துறை (thamilvalarchithurai.com)
6. அறிவியல் களஞ்சியம்
 - தமிழ்ப் பல்கலைக்கழகம், தஞ்சாவூர்

REFERENCES:

1. Cech Thomas V., Principles of water resources: history, development, management and policy. John Wiley and Sons Inc., New York. 2003.
2. Mollinga .P. etal “ Integrated Water Resources Management”, Water in South Asia Volume I, Sage Publications, 2006.
3. Technical Advisory Committee, Integrated Water Resources management, Technical Advisory Committee Background Paper No: 4. Global water partnership, Stockholm, Sweden. 2002.
4. Technical Advisory Committee, Dublin principles for water as reflected in comparative assessment of institutional and legal arrangements for Integrated Water Resources Management, Technical Advisory Committee Background paper No: 3. Global water partnership, Stockholm, Sweden. 1999.
5. Technical Advisory Committee, Effective Water Governance”. Technical Advisory Committee Background paper No: 7. Global water partnership, Stockholm, Sweden, 2003.

OCE432

WATER, SANITATION AND HEALTH

L T P C

3 0 0 3

OBJECTIVES:

- Understand the accelerating health impacts due to the present managerial aspects and initiatives in water and sanitation and health sectors in the developing scenario

UNIT I FUNDAMENTALS WASH

9

Meanings and Definition: Safe Water- Health, Nexus: Water- Sanitation - Health and Hygiene – Equity issues-Water security - Food Security. Sanitation And Hygiene (WASH) and Integrated Water Resources Management (IWRM) - Need and Importance of WASH

UNIT II MANAGERIAL IMPLICATIONS AND IMPACT

9

Third World Scenario – Poor and Multidimensional Deprivation--Health Burden in Developing Scenario -Factors contribute to water, sanitation and hygiene related diseases-Social: Social Stratification and Literacy Demography: Population and Migration- Fertility - Mortality- Environment: Water Borne-Water Washed and Water Based Diseases - Economic: Wage - Water and Health Budgeting -Psychological: Non-compliance - Disease Relapse - Political: Political Will.

UNIT III CHALLENGES IN MANAGEMENT AND DEVELOPMENT

9

Common Challenges in WASH - Bureaucracy and Users- Water Utilities -Sectoral Allocation:- Infrastructure- Service Delivery: Health services: Macro and Micro- level: Community and Gender Issues- Equity Issues - Paradigm Shift: Democratization of Reforms and Initiatives.

UNIT IV GOVERNANCE

9

Public health -Community Health Assessment and Improvement Planning (CHA/CHIP)- Infrastructure and Investments on Water, (WASH) - Cost Benefit Analysis – Institutional Intervention-Public Private Partnership - Policy Directives - Social Insurance -Political Will vs Participatory Governance -

UNIT V INITIATIVES

9

Management vs Development -Accelerating Development- Development Indicators -Inclusive Development-Global and Local- Millennium Development Goal (MDG) and Targets - Five Year Plans - Implementation - Capacity Building - Case studies on WASH.

OUTCOMES:

CO1	Capture to fundamental concepts and terms which are to be applied and understood all through the study.
CO2	Comprehend the various factors affecting water sanitation and health through the lens of third world scenario.
CO3	Critically analyse and articulate the underlying common challenges in water, sanitation and health.
CO4	Acquire knowledge on the attributes of governance and its say on water sanitation and health.
CO5	Gain an overarching insight in to the aspects of sustainable resource management in the absence of a clear level playing field in the developmental aspects.

REFERENCES

1. Bonitha R., Beaglehole R., Kjellstorm, 2006, "Basic Epidemiology", 2nd Edition, World Health Organization.
2. Van Note Chism, N. and Bickford, D. J. (2002), Improving the environment for learning: An expanded agenda. *New Directions for Teaching and Learning*, 2002: 91–98. doi: 10.1002/tl.83Improving the Environment for learning: An Expanded Agenda
3. National Research Council. *Global Issues in Water, Sanitation, and Health: Workshop Summary*. Washington, DC: The National Academies Press, 2009.
4. Sen, Amartya 1997. *On Economic Inequality*. Enlarged edition, with annex by James Foster and Amartya Sen, Oxford: Clarendon Press, 1997.
5. *Intersectoral Water Allocation Planning and Management*, 2000, World Bank Publishers www.Amazon.com
6. Third World Network.org (www.twn.org).

OCE433**PRINCIPLES OF SUSTAINABLE DEVELOPMENT****LT PC
3 0 0 3****OBJECTIVES:**

- To impart knowledge on environmental, social and economic dimensions of sustainability and the principles evolved through landmark events so as to develop an action mindset for sustainable development.

UNIT I SUSTAINABILITY AND DEVELOPMENT CHALLENGES**9**

Definition of sustainability – environmental, economical and social dimensions of sustainability - sustainable development models – strong and weak sustainability – defining development-millennium development goals – mindsets for sustainability: earthly, analytical, precautionary, action and collaborative– syndromes of global change: utilisation syndromes, development syndromes, and sink syndromes – core problems and cross cutting Issues of the 21 century - global, regional and local environmental issues – social insecurity - resource degradation –climate change – desertification.

UNIT II PRINCIPLES AND FRAME WORK 9

History and emergence of the concept of sustainable development - our common future - Stockholm to Rio plus 20– Rio Principles of sustainable development – Agenda 21 natural step-peoples earth charter – business charter for sustainable development –UN Global Compact - Role of civil society, business and government – United Nations’ 2030 Agenda for sustainable development – 17 sustainable development goals and targets, indicators and intervention areas

UNIT III SUSTAINABLE DEVELOPMENT AND WELLBEING 9

The Unjust World and inequities - Quality of Life - Poverty, Population and Pollution - Combating Poverty - - Demographic dynamics of sustainability - Strategies to end Rural and Urban Poverty and Hunger – Sustainable Livelihood Framework- Health, Education and Empowerment of Women, Children, Youth, Indigenous People, Non-Governmental Organizations, Local Authorities and Industry for Prevention, Precaution , Preservation and Public participation.

UNIT IV SUSTAINABLE SOCIO-ECONOMIC SYSTEMS 10

Sustainable Development Goals and Linkage to Sustainable Consumption and Production – Investing in Natural Capital- Agriculture, Forests, Fisheries - Food security and nutrition and sustainable agriculture- Water and sanitation - Biodiversity conservation and Ecosystem integrity – Ecotourism - Sustainable Cities – Sustainable Habitats- Green Buildings - Sustainable Transportation — Sustainable Mining - Sustainable Energy– Climate Change –Mitigation and Adaptation - Safeguarding Marine Resources - Financial Resources and Mechanisms

UNIT V ASSESSING PROGRESS AND WAY FORWARD 8

Nature of sustainable development strategies and current practice- Sustainability in global, regional and national context –Approaches to measuring and analysing sustainability– limitations of GDP- Ecological Footprint- Human Development Index- Human Development Report – National initiatives for Sustainable Development - Hurdles to Sustainability - Science and Technology for sustainable development –Performance indicators of sustainability and Assessment mechanism – Inclusive Green Growth and Green Economy – National Sustainable Development Strategy Planning and National Status of Sustainable Development Goals

TOTAL: 45 PERIODS

OUTCOMES:

- On completion of the course, the student is expected to be able to

CO1	Explain and evaluate current challenges to sustainability, including modern world social, environmental, and economic structures and crises.
CO2	Identify and critically analyze the social environmental, and economic dimensions of sustainability in terms of UN Sustainable development goals
CO3	Develop a fair understanding of the social, economic and ecological linkage of Human well being, production and consumption
CO4	Evaluate sustainability issues and solutions using a holistic approach that focuses on connections between complex human and natural systems.
CO5	Integrate knowledge from multiple sources and perspectives to understand environmental limits governing human societies and economies and social justice dimensions of sustainability.

REFERENCES:

1. Tom Theis and Jonathan Tomkin, Sustainability: A Comprehensive Foundation, Rice University, Houston, Texas, 2012

2. A guide to SDG interactions:from science to implementation, International Council for Science, Paris,2017
3. Karel Mulder, Sustainable Development for Engineers - A Handbook and Resource Guide, Roulledge Taylor and Francis, 2017.
4. The New Global Frontier - Urbanization, Poverty and Environmentin the 21st Century - *George Martine,Gordon McGranahan,Mark Montgomery and Rogelio Fernández-Castilla*, IIED and UNFPA, Earthscan, UK, 2008
5. Nolberto Munier, Introduction to Sustainability: Road to a Better Future, Springer, 2006
6. Barry Dalal Clayton and Stephen Bass, Sustainable Development Strategies- a resource book”, Earthscan Publications Ltd, London, 2002.

OCE434

ENVIRONMENTAL IMPACT ASSESSMENT

L T P C
3 0 0 3

OBJECTIVES:

- To make the students to understand environmental clearance, its legal requirements and to provide knowledge on overall methodology of EIA, prediction tools and models, environmental management plan and case studies.

UNIT I INTRODUCTION

9

Historical development of Environmental Impact Assessment (EIA). Environmental Clearance- EIA in project cycle. legal and regulatory aspects in India – types and limitations of EIA –EIA process- screening – scoping - terms of reference in EIA- setting – analysis – mitigation. Cross sectoral issues –public hearing in EIA- EIA consultant accreditation.

UNIT II IMPACT IDENTIFICATION AND PREDICTION

10

Matrices – networks – checklists – cost benefit analysis – analysis of alternatives – expert systems in EIA. prediction tools for EIA – mathematical modeling for impact prediction – assessment of impacts – air – water – soil – noise – biological — cumulative impact assessment

UNIT III SOCIO-ECONOMIC IMPACT ASSESSMENT

8

Socio-economic impact assessment - relationship between social impacts and change in community and institutional arrangements. factors and methodologies- individual and family level impacts. communities in transition-rehabilitation

UNIT IV EIA DOCUMENTATION AND ENVIRONMENTAL MANAGEMENT PLAN

9

Environmental management plan - preparation, implementation and review – mitigation and rehabilitation plans – policy and guidelines for planning and monitoring programmes – post project audit – documentation of EIA findings – ethical and quality aspects of environmental impact assessment

UNIT V CASE STUDIES

9

Mining, power plants, cement plants, highways, petroleum refining industry, storage & handling of hazardous chemicals, common hazardous waste facilities, CETPs, CMSWMF, building and construction projects

TOTAL: 45 PERIODS

OUTCOMES:

- On completion of the course, the student is expected to be able to

CO1	Understand need for environmental clearance, its legal procedure, need of EIA, its types, stakeholders and their roles
CO2	Understand various impact identification methodologies, prediction techniques and model of impacts on various environments
CO3	Understand relationship between social impacts and change in community due to development activities and rehabilitation methods
CO4	Document the EIA findings and prepare environmental management and monitoring plan
CO5	Identify, predict and assess impacts of similar projects based on case studies

REFERENCES:

- EIA Notification 2006 including recent amendments, by Ministry of Environment, Forest and Climate Change, Government of India
- Sectoral Guidelines under EIA Notification by Ministry of Environment, Forest and Climate Change, Government of India
- Canter, L.W., Environmental Impact Assessment, McGraw Hill, New York. 1996
- Lawrence, D.P., Environmental Impact Assessment – Practical solutions to recurrent problems, Wiley-Interscience, New Jersey. 2003
- Lee N. and George C. 2000. Environmental Assessment in Developing and Transitional Countries. Chichester: Willey
- World Bank –Source book on EIA ,1999
- Sam Mannan, Lees' Loss Prevention in the Process Industries, Hazard Identification Assessment and Control, 4th Edition, Butterworth Heineman, 2012.

OIC431**BLOCKCHAIN TECHNOLOGIES****L T P C****3 0 0 3****COURSE OBJECTIVES:**

- This course is intended to study the basics of Blockchain technology.
- During this course the learner will explore various aspects of Blockchain technology like application in various domains.
- By implementing, learners will have idea about private and public Blockchain, and smart contract.

UNIT I INTRODUCTION OF CRYPTOGRAPHY AND BLOCKCHAIN**9**

Introduction to Blockchain, Blockchain Technology Mechanisms & Networks, Blockchain Origins, Objective of Blockchain, Blockchain Challenges, Transactions and Blocks, P2P Systems, Keys as Identity, Digital Signatures, Hashing, and public key cryptosystems, private vs. public Blockchain.

UNIT II BITCOIN AND CRYPTOCURRENCY 9
 Introduction to Bitcoin, The Bitcoin Network, The Bitcoin Mining Process, Mining Developments, Bitcoin Wallets, Decentralization and Hard Forks, Ethereum Virtual Machine (EVM), Merkle Tree, Double-Spend Problem, Blockchain and Digital Currency, Transactional Blocks, Impact of Blockchain Technology on Cryptocurrency.

UNIT III INTRODUCTION TO ETHEREUM 9
 Introduction to Ethereum, Consensus Mechanisms, Metamask Setup, Ethereum Accounts, , Transactions, Receiving Ethers, Smart Contracts.

UNIT-IV INTRODUCTION TO HYPERLEDGER AND SOLIDITY PROGRAMMING 10
 Introduction to Hyperledger, Distributed Ledger Technology & its Challenges, Hyperledger & Distributed Ledger Technology, Hyperledger Fabric, Hyperledger Composer. Solidity - Language of Smart Contracts, Installing Solidity & Ethereum Wallet, Basics of Solidity, Layout of a Solidity Source File & Structure of Smart Contracts, General Value Types.

UNIT V BLOCKCHAIN APPLICATIONS 8
 Internet of Things, Medical Record Management System, Domain Name Service and Future of Blockchain, Alt Coins.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After the completion of this course, student will be able to

- CO1:** Understand and explore the working of Blockchain technology
- CO2:** Analyze the working of Smart Contracts
- CO3:** Understand and analyze the working of Hyperledger
- CO4:** Apply the learning of solidity to build de-centralized apps on Ethereum
- CO5:** Develop applications on Blockchain

REFERENCES:

1. Imran Bashir, "Mastering Blockchain: Distributed Ledger Technology, Decentralization, and Smart Contracts Explained", Second Edition, Packt Publishing, 2018.
2. Narayanan, J. Bonneau, E. Felten, A. Miller, S. Goldfeder, "Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction" Princeton University Press, 2016
3. Antonopoulos, Mastering Bitcoin, O'Reilly Publishing, 2014. .
4. Antonopoulos and G. Wood, "Mastering Ethereum: Building Smart Contracts and Dapps", O'Reilly Publishing, 2018.
5. D. Drescher, Blockchain Basics. Apress, 2017.

OIC432 DEEP LEARNING L T P C
3 0 0 3

COURSE OBJECTIVES:

- Develop and Train Deep Neural Networks.
- Develop a CNN, R-CNN, Fast R-CNN, Faster-R-CNN, Mask-RCNN for detection and recognition
- Build and train RNNs, work with NLP and Word Embeddings
- The internal structure of LSTM and GRU and the differences between them

- The Auto Encoders for Image Processing

UNIT I DEEP LEARNING CONCEPTS

6

Fundamentals about Deep Learning. Perception Learning Algorithms. Probabilistic modelling. Early Neural Networks. How Deep Learning different from Machine Learning. Scalars. Vectors. Matrixes, Higher Dimensional Tensors. Manipulating Tensors. Vector Data. Time Series Data. Image Data. Video Data.

UNIT II NEURAL NETWORKS

9

About Neural Network. Building Blocks of Neural Network. Optimizers. Activation Functions. Loss Functions. Data Pre-processing for neural networks, Feature Engineering. Overfitting and Underfitting. Hyperparameters.

UNIT III CONVOLUTIONAL NEURAL NETWORK

10

About CNN. Linear Time Invariant. Image Processing Filtering. Building a convolutional neural network. Input Layers, Convolution Layers. Pooling Layers. Dense Layers. Backpropagation Through the Convolutional Layer. Filters and Feature Maps. Backpropagation Through the Pooling Layers. Dropout Layers and Regularization. Batch Normalization. Various Activation Functions. Various Optimizers. LeNet, AlexNet, VGG16, ResNet. Transfer Learning with Image Data. Transfer Learning using Inception Oxford VGG Model, Google Inception Model, Microsoft ResNet Model. R-CNN, Fast R-CNN, Faster R-CNN, Mask-RCNN, YOLO

UNIT VI NATURAL LANGUAGE PROCESSING USING RNN

10

About NLP & its Toolkits. Language Modeling . Vector Space Model (VSM). Continuous Bag of Words (CBOW). Skip-Gram Model for Word Embedding. Part of Speech (PoS) Global Co-occurrence Statistics–based Word Vectors. Transfer Learning. Word2Vec. Global Vectors for Word Representation GloVe. Backpropagation Through Time. Bidirectional RNNs (BRNN) . Long Short Term Memory (LSTM). Bi-directional LSTM. Sequence-to-Sequence Models (Seq2Seq). Gated recurrent unit GRU.

UNIT V DEEP REINFORCEMENT & UNSUPERVISED LEARNING

10

About Deep Reinforcement Learning. Q-Learning. Deep Q-Network (DQN). Policy Gradient Methods. Actor-Critic Algorithm. About Autoencoding. Convolutional Auto Encoding. Variational Auto Encoding. Generative Adversarial Networks. Autoencoders for Feature Extraction. Auto Encoders for Classification. Denoising Autoencoders. Sparse Autoencoders

COURSE OUTCOMES:

CO1: Feature Extraction from Image and Video Data

CO2: Implement Image Segmentation and Instance Segmentation in Images

CO3: Implement image recognition and image classification using a pretrained network (Transfer Learning)

CO4: Traffic Information analysis using Twitter Data

CO5: Autoencoder for Classification & Feature Extraction

TOTAL : 45 PERIODS

REFERENCES

1. Deep Learning A Practitioner's Approach Josh Patterson and Adam Gibson O'Reilly Media, Inc.2017

Barriers – Noise control at the receiver -- Sound transmission through barriers – Noise reduction Vs Transmission loss - Enclosures

TOTAL: 45 PERIODS

OUTCOMES:

On Completion of the course the student will be able to

1. apply the basic concepts of vibration in damped and undamped systems
2. apply the basic concepts of noise and to understand its effects on systems
3. select the instruments required for vibration measurement and its analysis
4. select the instruments required for noise measurement and its analysis.
5. recognize the noise sources and to control the vibration levels in a body and to control noise under different strategies.

REFERENCES:

1. Singiresu S. Rao, “Mechanical Vibrations”, Pearson Education Incorporated, 2017.
2. Graham Kelly. Sand Shashidhar K. Kudari, “Mechanical Vibrations”, Tata McGraw –Hill Publishing Com. Ltd., 2007.
3. Ramamurti. V, “Mechanical Vibration Practice with Basic Theory”, Narosa Publishing House, 2000.
4. William T. Thomson, “Theory of Vibration with Applications”, Taylor & Francis, 2003.
5. G.K. Grover, “Mechanical Vibrations”, Nem Chand and Bros.,Roorkee, 2014.
6. A.G. Ambekar, “Mechanical Vibrations and Noise Engineering”, PHI Learning Pvt. Ltd., 2014.
7. David A. Bies and Colin H. Hansen, “Engineering Noise Control – Theory and Practice”, Spon Press, London and New York, 2009.

OME432 ENERGY CONSERVATION AND MANAGEMENT IN DOMESTIC SECTORS

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

1. To learn the present energy scenario and the need for energy conservation.
2. To understand the different measures for energy conservation in utilities.
3. Acquaint students with principle theories, materials, and construction techniques to create energy efficient buildings.
4. To identify the energy demand and bridge the gap with suitable technology for sustainable habitat
5. To get familiar with the energy technology, current status of research and find the ways to optimize a system as per the user requirement

UNIT I ENERGY SCENARIO

9

Primary energy resources - Sectorial energy consumption (domestic, industrial and other sectors), Energy pricing, Energy conservation and its importance, Energy Conservation Act-2001 and its features – Energy star rating.

UNIT II HEATING, VENTILLATION & AIR CONDITIONING

9

Basics of Refrigeration and Air Conditioning – COP / EER / SEC Evaluation – SPV system design & optimization for Solar Refrigeration.

UNIT III LIGHTING, COMPUTER, TV**9**

Specification of Luminaries – Types – Efficacy – Selection & Application – Time Sensors – Occupancy Sensors – Energy conservation measures in computer – Television – Electronic devices.

UNIT IV ENERGY EFFICIENT BUILDINGS**9**

Conventional versus Energy efficient buildings – Landscape design – Envelope heat loss and heat gain – Passive cooling and heating – Renewable sources integration.

UNIT V ENERGY STORAGE TECHNOLOGIES**9**

Necessity & types of energy storage – Thermal energy storage – Battery energy storage, charging and discharging– Hydrogen energy storage & Super capacitors – energy density and safety issues – Applications.

TOTAL: 45 PERIODS**COURSE OUTCOMES:**

Upon completion of this course, the students will be able to:

1. Understand technical aspects of energy conservation scenario.
2. Energy audit in any type for domestic buildings and suggest the conservation measures.
3. Perform building load estimates and design the energy efficient landscape system.
4. Gain knowledge to utilize an appliance/device sustainably.
5. Understand the status and current technological advancement in energy storage field.

REFERENCES:

1. Yogi Goswami, Frank Kreith, Energy Efficiency and Renewable energy Handbook, CRC Press, 2016
2. ASHRAE Handbook 2020 – HVAC Systems & Equipment
3. Paolo Bertoldi, Andrea Ricci, Anibal de Almeida, Energy Efficiency in Household Appliances and Lighting, Conference proceedings, Springer, 2001
4. David A. Bainbridge, Ken Haggard, Kenneth L. Haggard, Passive Solar Architecture: Heating, Cooling, Ventilation, Daylighting, and More Using Natural Flows, Chelsea Green Publishing, 2011.
5. Guide book for National Certification Examination for Energy Managers and Energy Auditors
(Could be downloaded from www.energymanagertraining.com)
6. Ibrahim Dincer and Mark A. Rosen, Thermal Energy Storage Systems and Applications, John Wiley & Sons 2002.
7. Robert Huggins, Energy Storage: Fundamentals, Materials and Applications, 2nd edition, Springer, 2015
8. Ru-shiliu, Leizhang, Xueliang sun, Electrochemical technologies for energy storage and conversion, Wiley publications, 2012.

UNIT I INTRODUCTION**9**

Need - Development - Rapid Prototyping Rapid Tooling – Rapid Manufacturing – Additive Manufacturing. AM Process Chain- Classification – Benefits.

UNIT II DESIGN FOR ADDITIVE MANUFACTURING**9**

CAD Model Preparation - Part Orientation and Support Structure Generation -Model Slicing - Tool Path Generation Customized Design and Fabrication - Case Studies.

UNIT III VAT POLYMERIZATION**9**

Stereolithography Apparatus (SLA)- Materials -Process -Advantages Limitations- Applications. Digital Light Processing (DLP) - Materials – Process - Advantages - Applications. Multi Jet Modelling (MJM) - Principles - Process - Materials - Advantages and Limitations.

UNIT IV MATERIAL EXTRUSION AND SHEET LAMINATION**9**

Fused Deposition Modeling (FDM)- Process-Materials - Applications and Limitations. Sheet Lamination Process: Laminated Object Manufacturing (LOM)- Basic Principle- Mechanism: Gluing or Adhesive Bonding – Thermal Bonding- Materials- Application and Limitation - Bio-Additive Manufacturing Computer Aided Tissue Engineering (CATE) – Case studies

POWDER BASED PROCESS

Selective Laser Sintering (SLS): Process –Mechanism– Typical Materials and Application- Multi Jet Fusion - Basic Principle– Materials- Application and Limitation - Three Dimensional Printing - Materials -Process - Benefits and Limitations. Selective Laser Melting (SLM) and Electron Beam Melting (EBM): Materials – Process - Advantages and Applications. Beam Deposition Process: Laser Engineered Net Shaping (LENS)- Process -Material Delivery - Process Parameters - Materials -Benefits -Applications.

UNIT V CASE STUDIES AND OPPORTUNITIES ADDITIVE MANUFACTURING PROCESSES**9**

Education and training - Automobile- pattern and mould - tooling - Building Printing-Bio Printing - medical implants -development of surgical tools Food Printing -Printing Electronics. Business Opportunities and Future Directions - Intellectual Property.

TOTAL: 45 PERIODS**REFERENCES:**

1. Andreas Gebhardt and Jan-Steffen Hötter “Additive Manufacturing: 3D Printing for Prototyping and Manufacturing”, Hanser publications, United States, 2015, ISBN: 978-1- 56990-582-1.
2. Ian Gibson, David W. Rosen and Brent Stucker “Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing”, 2nd edition, Springer., United States, 2015, ISBN13: 978-1493921126.
3. Amit Bandyopadhyay and Susmita Bose, “Additive Manufacturing”, 1st Edition, CRC Press., United States, 2015, ISBN-13: 978-1482223590
4. Andreas Gebhardt, “Understanding Additive Manufacturing: Rapid Prototyping, Rapid Manufacturing”, Hanser Gardner Publication, Cincinnati., Ohio, 2011, ISBN :9783446425521.
5. Chua C.K., Leong K.F., and Lim C.S., “Rapid prototyping: Principles and applications”, Third edition, World Scientific Publishers, 2010.

UNIT I NEED FOR ELECTRIC VEHICLES 9

History and need for electric and hybrid vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies, comparison of diesel, petrol, electric and hybrid vehicles, limitations, technical challenges

UNIT II ELECTRIC VEHICLE ARCHITECTURE 9

Electric vehicle types, layout and power delivery, performance – traction motor characteristics, tractive effort, transmission requirements, vehicle performance, energy consumption, Concepts of hybrid electric drive train, architecture of series and parallel hybrid electric drive train, merits and demerits, mild and full hybrids, plug-in hybrid electric vehicles and range extended hybrid electric vehicles, Fuel cell vehicles.

UNIT III ENERGY STORAGE 9

Batteries – types – lead acid batteries, nickel based batteries, and lithium based batteries, electrochemical reactions, thermodynamic voltage, specific energy, specific power, energy efficiency, Battery modeling and equivalent circuit, battery charging and types, battery cooling, Ultra-capacitors, Flywheel technology, Hydrogen fuel cell, Thermal Management of the PEM fuel cell

UNIT IV ELECTRIC DRIVES AND CONTROL 9

Types of electric motors – working principle of AC and DC motors, advantages and limitations, DC motor drives and control, Induction motor drives and control, PMSM and brushless DC motor - drives and control , AC and Switch reluctance motor drives and control – Drive system efficiency – Inverters – DC and AC motor speed controllers

UNIT V DESIGN OF ELECTRIC VEHICLES 9

Materials and types of production, Chassis skate board design, motor sizing, power pack sizing, component matching, Ideal gear box – Gear ratio, torque–speed characteristics, Dynamic equation of vehicle motion, Maximum tractive effort – Power train tractive effort Acceleration performance, rated vehicle velocity – maximum gradability, Brake performance, Electronic control system, safety and challenges in electric vehicles. Case study of Nissan leaf, Toyota Prius, tesla model 3, and Renault Zoe cars.

TOTAL: 45 PERIODS**REFERENCES:**

1. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, 2nd edition CRC Press, 2011.
2. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
3. James Larminie, John Lowry, Electric Vehicle Technology Explained - Wiley, 2003.
4. Ehsani, M, "Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design", CRC Press, 2005

COURSE OBJECTIVES:

The main learning objective of this course is to prepare the students for:

1. Applying the principles of generic development process; and understanding the organization structure for new product design and development.
2. Identifying opportunity and planning for new product design and development.
3. Conducting customer need analysis; and setting product specification for new product design and development.
4. Generating, selecting, and testing the concepts for new product design and development.
5. Applying the principles of Industrial design and prototype for new product design and development.

UNIT I INTRODUCTION TO PRODUCT DESIGN & DEVELOPMENT 9

Introduction – Characteristics of Successful Product Development – People involved in Product Design and Development – Duration and Cost of Product Development – The Challenges of Product Development – The Product Development Process – Concept Development: The Front-End Process – Adapting the Generic Product Development Process – Product Development Process Flows – Product Development Organizations.

UNIT II OPPORTUNITY IDENTIFICATION & PRODUCT PLANNING 9

Opportunity Identification: Definition – Types of Opportunities – Tournament Structure of Opportunity Identification – Effective Opportunity Tournaments – Opportunity Identification Process – Product Planning: Four types of Product Development Projects – The Process of Product Planning.

UNIT III IDENTIFYING CUSTOMER NEEDS & PRODUCT SPECIFICATIONS 9

Identifying Customer Needs: The Importance of Latent Needs – The Process of Identifying Customer Needs. Product Specifications: Definition – Time of Specifications Establishment – Establishing Target Specifications – Setting the Final Specifications

UNIT IV CONCEPT GENERATION, SELECTION & TESTING 9

Concept Generation: Activity of Concept Generation – Structured Approach – Five step method of Concept Generation. Concept Selection: Methodology – Concept Screening and Concepts Scoring. Concept testing: Seven Step activities of concept testing.

UNIT V INDUSTRIAL DESIGN & PROTOTYPING 9

Industrial Design: Need and Impact–Industrial Design Process. Prototyping – Principles of Prototyping – Prototyping Technologies – Planning for Prototypes.

TOTAL: 45 PERIODS**COURSE OUTCOMES:**

Upon completion of this course, the students will be able to:

1. Apply the principles of generic development process; and understand the organization structure for new product design and development.
2. Identify opportunity and plan for new product design and development.
3. Conduct customer need analysis; and set product specification for new product design and development.

4. Generate, select, and test the concepts for new product design and development.
5. Apply the principles of Industrial design and prototype for design and develop new products.

TEXT BOOK:

1. Ulrich K.T., Eppinger S. D. and Anita Goyal, "Product Design and Development" McGraw-Hill Education; 7 edition, 2020.

REFERENCES:

1. Belz A., 36-Hour Course: "Product Development" McGraw-Hill, 2010.
2. Rosenthal S., "Effective Product Design and Development", Business One Orwin, Homewood, 1992, ISBN1-55623-603-4.
3. Pugh.S, "Total Design Integrated Methods for Successful Product Engineering", Addison Wesley Publishing, 1991, ISBN0-202-41639-5.
4. Chitale, A. K. and Gupta, R. C., Product Design and Manufacturing, PHI Learning, 2013.
5. Jamnia, A., Introduction to Product Design and Development for Engineers, CRC Press, 2018.

OBA431

SUSTAINABLE MANAGEMENT

**LT P C
3 0 0 3**

COURSE OBJECTIVES:

- To provide students with fundamental knowledge of the notion of corporate sustainability.
- To determine how organizations impacts on the environment and socio-technical systems, the relationship between social and environmental performance and competitiveness, the approaches and methods.

UNIT I MANAGEMENT OF SUSTAINABILITY

9

Management of sustainability -rationale and political trends: An introduction to sustainability management, International and European policies on sustainable development, theoretical pillars in sustainability management studies.

UNIT II CORPORATE SUSTAINABILITY AND RESPONSIBILITY

9

Corporate sustainability parameter, corporate sustainability institutional framework, integration of sustainability into strategic planning and regular business practices, fundamentals of stakeholder engagement.

UNIT III SUSTAINABILITY MANAGEMENT: STRATEGIES AND APPROACHES

9

Corporate sustainability management and competitiveness: Sustainability-oriented corporate strategies, markets and competitiveness, Green Management between theory and practice, Sustainable Consumption and Green Marketing strategies, Environmental regulation and strategic postures; Green Management approaches and tools; Green engineering: clean technologies and innovation processes; Sustainable Supply Chain Management and Procurement.

UNIT IV SUSTAINABILITY AND INNOVATION 9
Socio-technical transitions and sustainability, Sustainable entrepreneurship, Sustainable pioneers in green market niches, Smart communities and smart specializations.

UNIT V SUSTAINABLE MANAGEMENT OF RESOURCES, COMMODITIES AND COMMONS 9
Energy management, Water management, Waste management, Wild Life Conservation, Emerging trends in sustainable management, Case Studies.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- CO1: An understanding of sustainability management as an approach to aid in evaluating and minimizing environmental impacts while achieving the expected social impact.
CO2: An understanding of corporate sustainability and responsible Business Practices
CO3: Knowledge and skills to understand, to measure and interpret sustainability performances.
CO4: Knowledge of innovative practices in sustainable business and community management
CO5: Deep understanding of sustainable management of resources and commodities

REFERENCES:

1. Daddi, T., Iraldo, F., Testa, Environmental Certification for Organizations and Products: Management, 2015
2. Christian N. Madu, Handbook of Sustainability Management 2012
3. Petra Molthan-Hill, The Business Student's Guide to Sustainable Management: Principles and Practice, 2014
4. Margaret Robertson, Sustainability Principles and Practice, 2014
5. Peter Rogers, An Introduction to Sustainable Development, 2006

**OBA432 MICRO AND SMALL BUSINESS MANAGEMENT L T P C
3 0 0 3**

COURSE OBJECTIVES

- To familiarize students with the theory and practice of small business management.
- To learn the legal issues faced by small business and how they impact operations.

UNIT I INTRODUCTION TO SMALL BUSINESS 9
Creation, Innovation, entrepreneurship and small business - Defining Small Business –Role of Owner – Manager – government policy towards small business sector –elements of entrepreneurship –evolution of entrepreneurship –Types of Entrepreneurship – social, civic, corporate - Business life cycle - barriers and triggers to new venture creation – process to assist start ups – small business and family business.

UNIT II SCREENING THE BUSINESS OPPORTUNITY AND FORMULATING THE BUSINESS PLAN 9
Concepts of opportunity recognition; Key factors leading to new venture failure; New venture screening process; Applying new venture screening process to the early stage small firm Role planning in small business – importance of strategy formulation – management skills for small business creation and development.

UNIT III BUILDING THE RIGHT TEAM AND MARKETING STRATEGY 9

Management and Leadership – employee assessments – Tuckman’s stages of group development - The entrepreneurial process model - Delegation and team building - Comparison of HR management in small and large firms - Importance of coaching and how to apply a coaching model.

Marketing within the small business - success strategies for small business marketing - customer delight and business generating systems, - market research, - assessing market performance- sales management and strategy - the marketing mix and marketing strategy.

UNIT IV FINANCING SMALL BUSINESS 9

Main sources of entrepreneurial capital; Nature of ‘bootstrap’ financing - Difference between cash and profit - Nature of bank financing and equity financing - Funding-equity gap for small firms. Importance of working capital cycle - Calculation of break-even point - Power of gross profit margin- Pricing for profit - Credit policy issues and relating these to cash flow management and profitability.

UNIT V VALUING SMALL BUSINESS AND CRISIS MANAGEMENT 9

Causes of small business failure - Danger signals of impending trouble - Characteristics of poorly performing firms - Turnaround strategies - Concept of business valuation - Different valuation measurements - Nature of goodwill and how to measure it - Advantages and disadvantages of buying an established small firm - Process of preparing a business for sale.

TOTAL: 45 PERIODS

COURSE OUTCOMES

- CO1. Familiarise the students with the concept of small business
- CO2. In depth knowledge on small business opportunities and challenges
- CO3. Ability to devise plans for small business by building the right skills and marketing strategies
- CO4. Identify the funding source for small start ups
- CO5. Business evaluation for buying and selling of small firms

REFERENCES

1. Hankinson,A.(2000). “The key factors in the profile of small firm owner-managers that influence business performance. The South Coast Small Firms Survey, 1997-2000.” Industrial and Commercial Training 32(3):94-98.
2. Parker,R.(2000). “Small is not necessarily beautiful: An evaluation of policy support for small and medium-sized enterprise in Australia.” Australian Journal of Political Science 35(2):239-253.
3. Journal articles on SME’s.

**OBA433 INTELLECTUAL PROPERTY RIGHTS L T P C
3 0 0 3**

COURSE OBJECTIVE

- To understand intellectual property rights and its valuation.

UNIT I	INTRODUCTION	9
Intellectual property rights - Introduction, Basic concepts, Patents, Copyrights, Trademarks, Trade Secrets, Geographic Indicators; Nature of Intellectual Property, Technological Research, Inventions and Innovations, History - the way from WTO to WIPO, TRIPS.		
UNIT II	PROCESS	9
New Developments in IPR, Procedure for grant of Patents, TM, GIs, Patenting under Patent Cooperation Treaty, Administration of Patent system in India, Patenting in foreign countries.		
UNIT III	STATUTES	9
International Treaties and conventions on IPRs, The TRIPs Agreement, PCT Agreement, The Patent Act of India, Patent Amendment Act (2005), Design Act, Trademark Act, Geographical Indication Act, Bayh- Dole Act and Issues of Academic Entrepreneurship.		
UNIT IV	STRATEGIES IN INTELLECTUAL PROPERTY	9
Strategies for investing in R&D, Patent Information and databases, IPR strength in India, Traditional Knowledge, Case studies.		
UNIT V	MODELS	9
The technologies Know-how, concept of ownership, Significance of IP in Value Creation, IP Valuation and IP Valuation Models, Application of Real Option Model in Strategic Decision Making, Transfer and Licensing.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES

- CO1: Understanding of intellectual property and appreciation of the need to protect it
- CO2: Awareness about the process of patenting
- CO3: Understanding of the statutes related to IPR
- CO4: Ability to apply strategies to protect intellectual property
- CO5: Ability to apply models for making strategic decisions related to IPR

REFERENCES

1. V. Sople Vinod, Managing Intellectual Property by (Prentice hall of India Pvt.Ltd), 2006.
2. Intellectual Property rights and copyrights, EssEss Publications.
3. Primer, R. Anita Rao and Bhanoji Rao, Intellectual Property Rights, Lastain Book company.
4. Edited by Derek Bosworth and Elizabeth Webster, The Management of Intellectual Property, Edward Elgar Publishing Ltd., 2006.
5. WIPO Intellectual Property Hand book.

OBA434

ETHICAL MANAGEMENT

L T P C
3 0 0 3

COURSE OBJECTIVE

- To help students develop knowledge and competence in ethical management and decision making in organizational contexts.

UNIT I ETHICS AND SOCIETY**9**

Ethical Management- Definition, Motivation, Advantages-Practical implications of ethical management. Managerial ethics, professional ethics, and social Responsibility-Role of culture and society's expectations- Individual and organizational responsibility to society and the community.

UNIT II ETHICAL DECISION MAKING AND MANAGEMENT IN A CRISIS**9**

Managing in an ethical crisis, the nature of a crisis, ethics in crisis management, discuss case studies, analyze real-world scenarios, develop ethical management skills, knowledge, and competencies. Proactive crisis management.

UNIT III STAKEHOLDERS IN ETHICAL MANAGEMENT**9**

Stakeholders in ethical management, identifying internal and external stakeholders, nature of stakeholders, ethical management of various kinds of stakeholders: customers (product and service issues), employees (leadership, fairness, justice, diversity) suppliers, collaborators, business, community, the natural environment (the sustainability imperative, green management, Contemporary issues).

UNIT IV INDIVIDUAL VARIABLES IN ETHICAL MANAGEMENT**9**

Understanding individual variables in ethics, managerial ethics, concepts in ethical psychology-ethical awareness, ethical courage, ethical judgment, ethical foundations, ethical emotions/intuitions/intensity. Utilization of these concepts and competencies for ethical decision-making and management.

UNIT V PRACTICAL FIELD-GUIDE, TECHNIQUES AND SKILLS**9**

Ethical management in practice, development of techniques and skills, navigating challenges and dilemmas, resolving issues and preventing unethical management proactively. Role modelling and creating a culture of ethical management and human flourishing.

TOTAL: 45 PERIODS**COURSE OUTCOMES**

- CO1: Role modelling and influencing the ethical and cultural context.
- CO2: Respond to ethical crises and proactively address potential crises situations.
- CO3: Understand and implement stakeholder management decisions.
- CO4: Develop the ability, knowledge, and skills for ethical management.
- CO5: Develop practical skills to navigate, resolve and thrive in management situations

REFERENCES

1. Brad Agle, Aaron Miller, Bill O' Rourke, The Business Ethics Field Guide: the essential companion to leading your career and your company, 2016.
2. Steiner & Steiner, Business, Government & Society: A managerial Perspective, 2011.
3. Lawrence & Weber, Business and Society: Stakeholders, Ethics, Public Policy, 2020.

COURSE OBJECTIVES:

1. To study about **Internet of Things** technologies and its role in real time applications.
2. To introduce the infrastructure required for IoT
3. To familiarize the accessories and communication techniques for IoT.
4. To provide insight about the embedded processor and sensors required for IoT
5. To familiarize the different platforms and Attributes for IoT

UNIT I INTRODUCTION TO INTERNET OF THINGS 9

Overview, Hardware and software requirements for IOT, Sensor and actuators, Technology drivers, Business drivers, Typical IoT applications, Trends and implications.

UNIT II IOT ARCHITECTURE 9

IoT reference model and architecture -Node Structure - Sensing, Processing, Communication, Powering, Networking - Topologies, Layer/Stack architecture, IoT standards, Cloud computing for IoT, Bluetooth, Bluetooth Low Energy beacons.

UNIT III PROTOCOLS AND WIRELESS TECHNOLOGIES FOR IOT 9**PROTOCOLS:**

NFC, SCADA and RFID, Zigbee MIPI, M-PHY, UniPro, SPMI, SPI, M-PCIe GSM, CDMA, LTE, GPRS, small cell.

Wireless technologies for IoT: WiFi (IEEE 802.11), Bluetooth/Bluetooth Smart, ZigBee/ZigBee Smart, UWB (IEEE 802.15.4), 6LoWPAN, Proprietary systems-Recent trends.

UNIT IV IOT PROCESSORS 9

Services/Attributes: Big-Data Analytics for IOT, Dependability, Interoperability, Security, Maintainability.

Embedded processors for IOT :Introduction to Python programming -Building IOT with RASPERRY PI and Arduino.

UNIT V CASE STUDIES 9

Industrial IoT, Home Automation, smart cities, Smart Grid, connected vehicles, electric vehicle charging, Environment, Agriculture, Productivity Applications, IOT Defense

TOTAL: 45 PERIODS**COURSE OUTCOMES:**

At the end of this course, the students will have the ability to

CO1: Analyze the concepts of IoT and its present developments.

CO2: Compare and contrast different platforms and infrastructures available for IoT

CO3: Explain different protocols and communication technologies used in IoT

CO4: Analyze the big data analytic and programming of IoT

CO5: Implement IoT solutions for smart applications

REFERENCES:

1. ArshdeepBahga and VijaiMadiseti : A Hands-on Approach "Internet of Things", Universities Press 2015.
2. Oliver Hersent , David Boswarthick and Omar Elloumi " The Internet of Things", Wiley,2016.
3. Samuel Greengard, " The Internet of Things", The MIT press, 2015.
4. Adrian McEwen and Hakim Cassimally"Designing the Internet of Things "Wiley,2014.
5. Jean- Philippe Vasseur, Adam Dunkels, "Interconnecting Smart Objects with IP: The Next Internet" Morgan Kuffmann Publishers, 2010.
6. Adrian McEwen and Hakim Cassimally, "Designing the Internet of Things", John Wiley and sons, 2014.
7. Lingyang Song/DusitNiyato/ Zhu Han/ Ekram Hossain," Wireless Device-to-Device Communications and Networks, CAMBRIDGE UNIVERSITY PRESS,2015.
8. OvidiuVermesan and Peter Friess (Editors), "Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems", River Publishers Series in Communication, 2013.
9. Vijay Madiseti , ArshdeepBahga, "Internet of Things (A Hands on-Approach)", 2014.
10. Zach Shelby, Carsten Bormann, "6LoWPAN: The Wireless Embedded Internet", John Wiley and sons, 2009.
11. Lars T.Berger and Krzysztof Iniewski, "Smart Grid applications, communications and security", Wiley, 2015.
12. JanakaEkanayake, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama and Nick Jenkins, " Smart Grid Technology and Applications", Wiley, 2015.
13. UpenaDalal,"Wireless Communications & Networks,Oxford,2015.

ET4072

MACHINE LEARNING AND DEEP LEARNING

**L T P C
3 0 0 3**

COURSE OBJECTIVES:

The course is aimed at

1. Understanding about the learning problem and algorithms
2. Providing insight about neural networks
3. Introducing the machine learning fundamentals and significance
4. Enabling the students to acquire knowledge about pattern recognition.
5. Motivating the students to apply deep learning algorithms for solving real life problems.

UNIT I LEARNING PROBLEMS AND ALGORITHMS

9

Various paradigms of learning problems, Supervised, Semi-supervised and Unsupervised algorithms

UNIT II NEURAL NETWORKS

9

Differences between Biological and Artificial Neural Networks - Typical Architecture, Common Activation Functions, Multi-layer neural network, Linear Separability, Hebb Net, Perceptron, Adaline, Standard Back propagation Training Algorithms for Pattern Association - Hebb rule and Delta rule, Hetero associative, Auto associative, Kohonen Self Organising Maps, Examples of Feature Maps, Learning Vector Quantization, Gradient descent, Boltzmann Machine Learning.

UNIT III MACHINE LEARNING – FUNDAMENTALS & FEATURE SELECTIONS & CLASSIFICATIONS

9

Classifying Samples: The confusion matrix, Accuracy, Precision, Recall, F1- Score, the curse of dimensionality, training, testing, validation, cross validation, overfitting, under-fitting the data, early stopping, regularization, bias and variance. Feature Selection, normalization, dimensionality reduction, Classifiers: KNN, SVM, Decision trees, Naïve Bayes, Binary classification, multi class classification, clustering.

UNIT IV DEEP LEARNING: CONVOLUTIONAL NEURAL NETWORKS

9

Feed forward networks, Activation functions, back propagation in CNN, optimizers, batch normalization, convolution layers, pooling layers, fully connected layers, dropout, Examples of CNNs.

UNIT V DEEP LEARNING: RNNs, AUTOENCODERS AND GANS

9

State, Structure of RNN Cell, LSTM and GRU, Time distributed layers, Generating Text, Autoencoders: Convolutional Autoencoders, Denoising autoencoders, Variational autoencoders, GANs: The discriminator, generator, DCGANs

TOTAL : 45 PERIODS

COURSE OUTCOMES (CO):

At the end of the course the student will be able to

CO1 : Illustrate the categorization of machine learning algorithms.

CO2: Compare and contrast the types of neural network architectures, activation functions

CO3: Acquaint with the pattern association using neural networks

CO4: Elaborate various terminologies related with pattern recognition and architectures of convolutional neural networks

CO5: Construct different feature selection and classification techniques and advanced neural network architectures such as RNN, Autoencoders, and GANs.

REFERENCES:

1. J. S. R. Jang, C. T. Sun, E. Mizutani, Neuro Fuzzy and Soft Computing - A Computational Approach to Learning and Machine Intelligence, 2012, PHI learning
2. Deep Learning, Ian Good fellow, YoshuaBengio and Aaron Courville, MIT Press, ISBN: 9780262035613, 2016.
3. The Elements of Statistical Learning. Trevor Hastie, Robert Tibshirani and Jerome Friedman. Second Edition. 2009.
4. Pattern Recognition and Machine Learning. Christopher Bishop. Springer. 2006.
5. Understanding Machine Learning. Shai Shalev-Shwartz and Shai Ben-David. Cambridge University Press. 2017.

OBJECTIVES:

To impart knowledge on

- Different types of renewable energy technologies
- Standalone operation, grid connected operation of renewable energy systems

UNIT I INTRODUCTION**9**

Classification of energy sources – Co₂ Emission - Features of Renewable energy - Renewable energy scenario in India -Environmental aspects of electric energy conversion: impacts of renewable energy generation on environment Per Capital Consumption - CO₂ Emission - importance of renewable energy sources, Potentials – Achievements– Applications.

UNIT II SOLAR PHOTOVOLTAICS**9**

Solar Energy: Sun and Earth-Basic Characteristics of solar radiation- angle of sunrays on solar collector-Estimating Solar Radiation Empirically - Equivalent circuit of PV Cell- Photovoltaic cell-characteristics: P-V and I-V curve of cell-Impact of Temperature and Insolation on I-V characteristics-Shading Impacts on I-V characteristics-Bypass diode -Blocking diode.

UNIT III PHOTOVOLTAIC SYSTEM DESIGN**9**

Block diagram of solar photo voltaic system : Line commutated converters (inversion mode) - Boost and buck-boost converters - selection of inverter, battery sizing, array sizing - PV systems classification- standalone PV systems - Grid tied and grid interactive inverters- grid connection issues.

UNIT IV WIND ENERGY CONVERSION SYSTEMS**9**

Origin of Winds: Global and Local Winds- Aerodynamics of Wind turbine-Derivation of Betz's limit-Power available in wind-Classification of wind turbine: Horizontal Axis wind turbine and Vertical axis wind turbine- Aerodynamic Efficiency-Tip Speed-Tip Speed Ratio-Solidity-Blade Count-Power curve of wind turbine - Configurations of wind energy conversion systems: Type A, Type B, Type C and Type D Configurations- Grid connection Issues - Grid integrated SCIG and PMSG based WECS.

UNIT V OTHER RENEWABLE ENERGY SOURCES**9**

Qualitative study of different renewable energy resources: ocean, Biomass, Hydrogen energy systems, Fuel cells, Ocean Thermal Energy Conversion (OTEC), Tidal and wave energy, Geothermal Energy Resources.

TOTAL : 45 PERIODS**OUTCOMES:**

After completion of this course, the student will be able to:

- CO1: Demonstrate the need for renewable energy sources.
- CO2: Develop a stand-alone photo voltaic system and implement a maximum power point tracking in the PV system.
- CO3: Design a stand-alone and Grid connected PV system.
- CO4: Analyze the different configurations of the wind energy conversion systems.
- CO5: Realize the basic of various available renewable energy sources

REFERENCES:

1. S.N.Bhadra, D. Kastha, & S. Banerjee "Wind Electrical Systems", Oxford University Press, 2009.
2. Rai. G.D, "Non conventional energy sources", Khanna publishes, 1993.
3. Rai. G.D," Solar energy utilization", Khanna publishes, 1993.
4. Chetan Singh Solanki, "Solar Photovoltaics: Fundamentals, Technologies and Applications", PHI Learning Private Limited, 2012.
5. John Twideu and Tony Weir, "Renewal Energy Resources" BSP Publications, 2006
6. Gray, L. Johnson, "Wind energy system", prentice hall of India, 1995.
7. B.H.Khan, " Non-conventional Energy sources", , McGraw-hill, 2nd Edition, 2009.
8. Fang Lin Luo Hong Ye, " Renewable Energy systems", Taylor & Francis Group,2013.

PS4093

SMART GRID

L T P C
3 0 0 3

COURSE OBJECTIVES

- To Study about Smart Grid technologies, different smart meters and advanced metering infrastructure.
- To know about the function of smart grid.
- To familiarize the power quality management issues in Smart Grid.
- To familiarize the high performance computing for Smart Grid applications
- To get familiarized with the communication networks for Smart Grid applications

UNIT I INTRODUCTION TO SMART GRID

9

Evolution of Electric Grid, Concept, Definitions and Need for Smart Grid, Smart grid drivers, functions, opportunities, challenges and benefits, Difference between conventional & Smart Grid, Comparison of Micro grid and Smart grid, Present development & International policies in Smart Grid, Smart Grid Initiative for Power Distribution Utility in India – Case Study.

UNIT II SMART GRID TECHNOLOGIES

9

Technology Drivers, Smart Integration of energy resources, Smart substations, Substation Automation, Feeder Automation ,Transmission systems: EMS, FACTS and HVDC, Wide area monitoring, Protection and control, Distribution systems: DMS, Volt/Var control, Fault Detection, Isolation and service restoration, Outage management, High-Efficiency Distribution Transformers, Phase Shifting Transformers, Plug in Hybrid Electric Vehicles (PHEV) – Grid to Vehicle and Vehicle to Grid charging concepts.

UNIT III SMART METERS AND ADVANCED METERING INFRASTRUCTURE

9

Introduction to Smart Meters, Advanced Metering infrastructure (AMI) drivers and benefits, AMI protocols, standards and initiatives, AMI needs in the smart grid, Phasor Measurement Unit(PMU) & their application for monitoring & protection. Demand side management and demand response programs, Demand pricing and Time of Use, Real Time Pricing, Peak Time Pricing.

UNIT IV POWER QUALITY MANAGEMENT IN SMART GRID**9**

Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring, Power Quality Audit.

Unit V HIGH PERFORMANCE COMPUTING FOR SMART GRID APPLICATIONS 9

Architecture and Standards -Local Area Network (LAN), House Area Network (HAN), Wide Area Network (WAN), Broadband over Power line (BPL), PLC, Zigbee, GSM, IP based Protocols, Basics of Web Service and CLOUD Computing, Cyber Security for Smart Grid.

TOTAL : 45 PERIODS**COURSE OUTCOME:**

Students able to

CO1: Relate with the smart resources, smart meters and other smart devices.

CO2: Explain the function of Smart Grid.

CO3: Experiment the issues of Power Quality in Smart Grid.

CO4: Analyze the performance of Smart Grid.

CO5: Recommend suitable communication networks for smart grid applications

REFERENCES

1. Stuart Borlase 'Smart Grid: Infrastructure, Technology and Solutions', CRC Press 2012.
2. JanakaEkanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama, 'Smart Grid: Technology and Applications', Wiley, 2012.
3. Mini S. Thomas, John D McDonald, 'Power System SCADA and Smart Grids', CRC Press, 2015
4. Kenneth C.Budka, Jayant G. Deshpande, Marina Thottan, 'Communication Networks for Smart Grids', Springer, 2014
5. SMART GRID Fundamentals of Design and Analysis, James Momoh, IEEE press, A John Wiley & Sons, Inc., Publication.

CP4391**SECURITY PRACTICES****L T P C****3 0 0 3****COURSE OBJECTIVES:**

- To learn the core fundamentals of system and web security concepts
- To have through understanding in the security concepts related to networks
- To deploy the security essentials in IT Sector
- To be exposed to the concepts of Cyber Security and cloud security
- To perform a detailed study of Privacy and Storage security and related Issues

UNIT I SYSTEM SECURITY**9**

Model of network security – Security attacks, services and mechanisms – OSI security architecture -A Cryptography primer- Intrusion detection system- Intrusion Prevention system - Security web applications- Case study: OWASP - Top 10 Web Application Security Risks.

UNIT II NETWORK SECURITY 9
Internet Security - Intranet security- Local Area Network Security - Wireless Network Security - Wireless Sensor Network Security- Cellular Network Security - Mobile security - IOT security - Case Study - Kali Linux.

UNIT III SECURITY MANAGEMENT 9
Information security essentials for IT Managers- Security Management System - Policy Driven System Management- IT Security - Online Identity and User Management System. Case study: Metasploit

UNIT IV CYBER SECURITY AND CLOUD SECURITY 9
Cyber Forensics- Disk Forensics – Network Forensics – Wireless Forensics – Database Forensics – Malware Forensics – Mobile Forensics – Email Forensics- Best security practices for automate Cloud infrastructure management – Establishing trust in IaaS, PaaS, and SaaS Cloud types. Case study: DVWA

UNIT V PRIVACY AND STORAGE SECURITY 9
Privacy on the Internet - Privacy Enhancing Technologies - Personal privacy Policies - Detection of Conflicts in security policies- privacy and security in environment monitoring systems. Storage Area Network Security - Storage Area Network Security Devices - Risk management - Physical Security Essentials.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- CO1:** Understand the core fundamentals of system security
- CO2:** Apply the security concepts to wired and wireless networks
- CO3:** Implement and Manage the security essentials in IT Sector
- CO4:** Explain the concepts of Cyber Security and Cyber forensics
- CO5:** Be aware of Privacy and Storage security Issues.

REFERENCES

1. John R. Vacca, Computer and Information Security Handbook, Third Edition, Elsevier 2017
2. Michael E. Whitman, Herbert J. Mattord, Principles of Information Security, Seventh Edition, Cengage Learning, 2022
3. Richard E. Smith, Elementary Information Security, Third Edition, Jones and Bartlett Learning, 2019
4. Mayor, K.K.Mookhey, Jacopo Cervini, Fairuzan Roslan, Kevin Beaver, Metasploit Toolkit for Penetration Testing, Exploit Development and Vulnerability Research, Syngress publications, Elsevier, 2007. ISBN : 978-1-59749-074-0
5. John Sammons, "The Basics of Digital Forensics- The Primer for Getting Started in Digital Forensics", Syngress, 2012
6. Cory Altheide and Harlan Carvey, "Digital Forensics with Open Source Tools", 2011 Syngress, ISBN: 9781597495875.
7. Siani Pearson, George Yee "Privacy and Security for Cloud Computing" Computer Communications and Networks, Springer, 2013.

COURSE OBJECTIVES:

- To gain expertise in Virtualization, Virtual Machines and deploy practical virtualization solution
- To understand the architecture, infrastructure and delivery models of cloud computing.
- To explore the roster of AWS services and illustrate the way to make applications in AWS
- To gain knowledge in the working of Windows Azure and Storage services offered by Windows Azure
- To develop the cloud application using various programming model of Hadoop and Aneka

UNIT I VIRTUALIZATION AND VIRTUALIZATION INFRASTRUCTURE 6

Basics of Virtual Machines - Process Virtual Machines – System Virtual Machines –Emulation – Interpretation – Binary Translation - Taxonomy of Virtual Machines. Virtualization –Management Virtualization — Hardware Maximization – Architectures – Virtualization Management – Storage Virtualization – Network Virtualization- Implementation levels of virtualization – virtualization structure – virtualization of CPU, Memory and I/O devices – virtual clusters and Resource Management – Virtualization for data center automation

UNIT II CLOUD PLATFORM ARCHITECTURE 12

Cloud Computing: Definition, Characteristics - Cloud deployment models: public, private, hybrid, community – Categories of cloud computing: Everything as a service: Infrastructure, platform, software- A Generic Cloud Architecture Design – Layered cloud Architectural Development – Architectural Design Challenges

UNIT III AWS CLOUD PLATFORM - IAAS 9

Amazon Web Services: AWS Infrastructure- AWS API- AWS Management Console - Setting up AWS Storage - Stretching out with Elastic Compute Cloud - Elastic Container Service for Kubernetes- AWS Developer Tools: AWS Code Commit, AWS Code Build, AWS Code Deploy, AWS Code Pipeline, AWS code Star - AWS Management Tools: Cloud Watch, AWS Auto Scaling, AWS control Tower, Cloud Formation, Cloud Trail, AWS License Manager

UNIT IV PAAS CLOUD PLATFORM 9

Windows Azure: Origin of Windows Azure, Features, The Fabric Controller – First Cloud APP in Windows Azure- Service Model and Managing Services: Definition and Configuration, Service runtime API- Windows Azure Developer Portal- Service Management API- Windows Azure Storage Characteristics-Storage Services- REST API- Blops

UNIT V PROGRAMMING MODEL 9

Introduction to Hadoop Framework - Mapreduce, Input splitting, map and reduce functions, specifying input and output parameters, configuring and running a job –Developing Map Reduce Applications - Design of Hadoop file system –Setting up Hadoop Cluster- Aneka: Cloud Application Platform, Thread Programming, Task Programming and Map-Reduce Programming in Aneka

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: Employ the concepts of virtualization in the cloud computing

CO2: Identify the architecture, infrastructure and delivery models of cloud computing

CO3: Develop the Cloud Application in AWS platform

CO4: Apply the concepts of Windows Azure to design Cloud Application

CO5: Develop services using various Cloud computing programming models.

REFERENCES

1. Bernard Golden, Amazon Web Service for Dummies, John Wiley & Sons, 2013.
2. Raoul Alongi, AWS: The Most Complete Guide to Amazon Web Service from Beginner to Advanced Level, Amazon Asia- Pacific Holdings Private Limited, 2019.
3. Sriram Krishnan, Programming: Windows Azure, O'Reilly, 2010.
4. Rajkumar Buyya, Christian Vacchiola, S.Thamarai Selvi, Mastering Cloud Computing , MCGraw Hill Education (India) Pvt. Ltd., 2013.
5. Danielle Ruest, Nelson Ruest, —Virtualization: A Beginner"s Guidell, McGraw-Hill Osborne Media, 2009.
6. Jim Smith, Ravi Nair , "Virtual Machines: Versatile Platforms for Systems and Processes", Elsevier/Morgan Kaufmann, 2005.
7. John W.Rittinghouse and James F.Ransome, "Cloud Computing: Implementation, Management, and Security", CRC Press, 2010.
8. Toby Velte, Anthony Velte, Robert Elsenpeter, "Cloud Computing, A Practical Approach", McGraw-Hill Osborne Media, 2009.
9. Tom White, "Hadoop: The Definitive Guide", Yahoo Press, 2012.

IF4072

DESIGN THINKING

L T P C
3 0 0 3

COURSE OBJECTIVES:

- To provide a sound knowledge in UI & UX
- To understand the need for UI and UX
- Research Methods used in Design
- Tools used in UI & UX
- Creating a wireframe and prototype

UNIT I

UX LIFECYCLE TEMPLATE

8

Introduction. A UX process lifecycle template. Choosing a process instance for your project. The system complexity space. Meet the user interface team. Scope of UX presence within the team. More about UX lifecycles. Business Strategy. Value Innovation. Validated User Research. Killer UX Design. The Blockbuster Value Proposition. What Is a Value Proposition?.

UNIT II

CONTEXTUAL INQUIRY

10

The system concept statement. User work activity data gathering. Look for emotional aspects of work practice. Abridged contextual inquiry process. Data-driven vs. model-driven inquiry.

Organizing concepts: work roles and flow model. Creating and managing work activity notes. Constructing your work activity affinity diagram (WAAD). Abridged contextual analysis process. History of affinity diagrams.

UNIT III DESIGN THINKING, IDEATION, AND SKETCHING 9

Design-informing models: second span of the bridge . Some general “how to” suggestions. A New example domain: slideshow presentations. User models. Usage models. Work environment models. Barrier summaries. Model consolidation. Protecting your sources. Abridged methods for design-informing models extraction. Design paradigms. Design thinking. Design perspectives. User personas. Ideation. Sketching

UNIT IV UX GOALS, METRICS, AND TARGETS 8

Introduction. UX goals. UX target tables. Work roles, user classes, and UX goals. UX measures. Measuring instruments. UX metrics. Baseline level. Target level. Setting levels. Observed results. Practical tips and cautions for creating UX targets. How UX targets help manage the user experience engineering process.

UNIT V ANALYSING USER EXPERIENCE 10

Sharpening Your Thinking Tools. UX Research and Strength of Evidence. Agile Personas. How to Prioritize Usability Problems. Creating Insights, Hypotheses and Testable Design Ideas. How to Manage Design Projects with User Experience Metrics. Two Measures that Will Justify Any Design Change. Evangelizing UX Research. How to Create a User Journey Map. Generating Solutions to Usability Problems. Building UX Research Into the Design Studio Methodology. Dealing with Common objections to UX Research. The User Experience Debrief Meeting. Creating a User Experience Dashboard.

SUGGESTED ACTIVITIES:

- 1: Hands on Design Thinking process for a product
- 2: Defining the Look and Feel of any new Project
- 3: Create a Sample Pattern Library for that product (Mood board, Fonts, Colors based on UI principles)
- 4: Identify a customer problem to solve.
- 5: Conduct end-to-end user research - User research, creating personas, Ideation process (User stories, Scenarios), Flow diagrams, Flow Mapping

TOTAL : 45 PERIODS

COURSE OUTCOMES:

- CO1:** Build UI for user Applications
- CO2:** Use the UI Interaction behaviors and principles
- CO3:** Evaluate UX design of any product or application
- CO4:** Demonstrate UX Skills in product development
- CO5:** Implement Sketching principles

REFERENCES

1. UX for Developers: How to Integrate User-Centered Design Principles Into Your Day-to-Day Development Work, Westley Knight. Apress, 2018
2. The UX Book: Process and Guidelines for Ensuring a Quality User Experience, Rex Hartson, Pardha Pyla. Morgan Kaufmann, 2012

3. UX Fundamentals for Non-UX Professionals: User Experience Principles for Managers, Writers, Designers, and Developers, Edward Stull. Apress, 2018
4. Lean UX: Designing Great Products with Agile Teams, Gothelf, Jeff, Seiden, and Josh. O'Reilly Media, 2016
5. Designing UX: Prototyping: Because Modern Design is Never Static, Ben Coleman, and Dan Goodwin. SitePoint, 2017

MU4153

PRINCIPLES OF MULTIMEDIA

L T P C
3 0 0 3

COURSE OBJECTIVES:

- To get familiarity with gamut of multimedia and its significance
- To acquire knowledge in multimedia components.
- To acquire knowledge about multimedia tools and authoring.
- To acquire knowledge in the development of multimedia applications.
- To explore the latest trends and technologies in multimedia

UNIT I INTRODUCTION

9

Introduction to Multimedia – Characteristics of Multimedia Presentation – Multimedia Components – Promotion of Multimedia Based Components – Digital Representation – Media and Data Streams – Multimedia Architecture – Multimedia Documents, Multimedia Tasks and Concerns, Production, sharing and distribution, Hypermedia, WWW and Internet, Authoring, Multimedia over wireless and mobile networks.

Suggested Activities:

1. Flipped classroom on media Components.
2. External learning – Interactive presentation.

Suggested Evaluation Methods:

1. Tutorial – Handling media components
2. Quizzes on different types of data presentation.

UNIT II ELEMENTS OF MULTIMEDIA

9

Text-Types, Font, Unicode Standard, File Formats, Graphics and Image data representations – data types, file formats, color models; video – color models in video, analog video, digital video, file formats, video display interfaces, 3D video and TV: Audio – Digitization, SNR, SQNR, quantization, audio quality, file formats, MIDI; Animation- Key Frames and Tweening, other Techniques, 2D and 3D Animation.

Suggested Activities:

1. Flipped classroom on different file formats of various media elements.
2. External learning – Adobe after effects, Adobe Media Encoder, Adobe Audition.

Suggested Evaluation Methods:

1. Demonstration on after effects animations.
2. Quizzes on file formats and color models.

UNIT III MULTIMEDIA TOOLS

9

Authoring Tools – Features and Types – Card and Page Based Tools – Icon and Object Based Tools – Time Based Tools – Cross Platform Authoring Tools – Editing Tools – Painting and Drawing Tools – 3D Modeling and Animation Tools – Image Editing Tools – Sound Editing Tools – Digital Movie Tools.

Suggested Activities:

1. Flipped classroom on multimedia tools.
2. External learning – Comparison of various authoring tools.

Suggested Evaluation Methods:

1. Tutorial – Audio editing tool.
2. Quizzes on animation tools.

UNIT IV MULTIMEDIA SYSTEMS

9

Compression Types and Techniques: CODEC, Text Compression: GIF Coding Standards, JPEG standard – JPEG 2000, basic audio compression – ADPCM, MPEG Psychoacoustics, basic Video compression techniques – MPEG, H.26X – Multimedia Database System – User Interfaces – OS Multimedia Support – Hardware Support – Real Time Protocols – Play Back Architectures – Synchronization – Document Architecture – Hypermedia Concepts: Hypermedia Design – Digital Copyrights, Content analysis.

Suggested Activities:

1. Flipped classroom on concepts of multimedia hardware architectures.
2. External learning – Digital repositories and hypermedia design.

Suggested Evaluation Methods:

1. Quizzes on multimedia hardware and compression techniques.
2. Tutorial – Hypermedia design.

UNIT V MULTIMEDIA APPLICATIONS FOR THE WEB AND MOBILE PLATFORMS

9

ADDIE Model – Conceptualization – Content Collection – Storyboard–Script Authoring Metaphors – Testing – Report Writing – Documentation. Multimedia for the web and mobile platforms. Virtual Reality, Internet multimedia content distribution, Multimedia Information sharing – social media sharing, cloud computing for multimedia services, interactive cloud gaming. Multimedia information retrieval.

Suggested Activities:

1. External learning – Game consoles.
2. External learning – VRML scripting languages.

Suggested Evaluation Methods:

1. Demonstration of simple interactive games.
2. Tutorial – Simple VRML program.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

CO1:Handle the multimedia elements effectively.

CO2:Articulate the concepts and techniques used in multimedia applications.

CO3:Develop effective strategies to deliver Quality of Experience in multimedia applications.

CO4:Design and implement algorithms and techniques applied to multimedia objects.

CO5:Design and develop multimedia applications following software engineering models.

REFERENCES:

1. Li, Ze-Nian, Drew, Mark, Liu, Jiangchuan, "Fundamentals of Multimedia", Springer, Third Edition, 2021.
2. Prabhat K. Andleigh, Kiran Thakrar, "MULTIMEDIA SYSTEMS DESIGN", Pearson Education, 2015.
3. Gerald Friedland, Ramesh Jain, "Multimedia Computing", Cambridge University Press, 2018. (digital book)
4. Ranjan Parekh, "Principles of Multimedia", Second Edition, McGraw-Hill Education, 2017

CX4016	ENVIRONMENTAL SUSTAINABILITY	L	T	P	C
		3	0	0	3
UNIT I	INTRODUCTION				9
	Valuing the Environment: Concepts, Valuing the Environment: Methods, Property Rights, Externalities, and Environmental Problems				
UNIT II	CONCEPT OF SUSTAINABILITY				9
	Sustainable Development: Defining the Concept, the Population Problem, Natural Resource Economics: An Overview, Energy, Water, Agriculture				
UNIT III	SIGNIFICANCE OF BIODIVERSITY				9
	Biodiversity, Forest Habitat, Commercially Valuable Species, Stationary - Source Local Air Pollution, Acid Rain and Atmospheric Modification, Transportation				
UNIT IV	POLLUTION IMPACTS				9
	Water Pollution, Solid Waste and Recycling, Toxic Substances and Hazardous Wastes, Global Warming.				
UNIT V	ENVIRONMENTAL ECONOMICS				9
	Development, Poverty, and the Environment, Visions of the Future, Environmental economics and policy by Tom Tietenberg, Environmental Economics				
					TOTAL : 45 PERIODS

REFERENCES

1. Andrew Hoffman, Competitive Environmental Strategy - A Guide for the Changing Business Landscape, Island Press.
2. Stephen Doven, Environment and Sustainability Policy: Creation, Implementation, Evaluation, the Federation Press, 2005
3. Robert Brinkmann., Introduction to Sustainability, Wiley-Blackwell., 2016
4. Niko Roorda., Fundamentals of Sustainable Development, 3rd Edn, Routledge, 2020
5. Bhavik R Bakshi., Sustainable Engineering: Principles and Practice, Cambridge University Press, 2019

UNIT I REINFORCEMENTS**9**

Introduction – composites –classification and application; reinforcements- fibres and its properties; preparation of reinforced materials and quality evaluation; preforms for various composites

UNIT II MATRICES**9**

Preparation, chemistry, properties and applications of thermoplastic and thermoset resins; mechanism of interaction of matrices and reinforcements; optimization of matrices

UNIT III COMPOSITE MANUFACTURING**9**

Classification; methods of composites manufacturing for both thermoplastics and thermosets- Hand layup, Filament Winding, Resin transfer moulding, prepregs and autoclave moulding, pultrusion, vacuum impregnation methods, compression moulding; post processing of composites and composite design requirements

UNIT IV TESTING**9**

Fibre volume and weight fraction, specific gravity of composites, tensile, flexural, impact, compression, inter laminar shear stress and fatigue properties of thermoset and thermoplastic composites.

UNIT V MECHANICS**9**

Micro mechanics, macro mechanics of single layer, macro mechanics of laminate, classical lamination theory, failure theories and prediction of inter laminar stresses using at ware

TOTAL: 45 PERIODS**REFERENCES**

1. BorZ.Jang, "Advanced Polymer composites", ASM International, USA, 1994.
2. Carlsson L.A. and Pipes R.B., "Experimental Characterization of advanced composite Materials", Second Edition, CRC Press, New Jersey, 1996.
3. George Lubin and Stanley T. Peters, "Handbook of Composites", Springer Publications, 1998.
4. Mel. M. Schwartz, "Composite Materials", Vol. 1 & 2, Prentice Hall PTR, New Jersey, 1997.
5. Richard M. Christensen, "Mechanics of composite materials", Dover Publications, 2005.
6. Sanjay K. Mazumdar, "Composites Manufacturing: Materials, Product, and Process Engineering", CRC Press, 2001

UNIT I BASICS OF NANOCOMPOSITES**9**

Nomenclature, Properties, features and processing of nanocomposites. Sample Preparation and Characterization of Structure and Physical properties. Designing, stability and mechanical properties and applications of super hard nanocomposites.

UNIT II	METAL BASED NANOCOMPOSITES	9
Metal-metal nanocomposites, some simple preparation techniques and their properties. Metal-Oxide or Metal-Ceramic composites, Different aspects of their preparation techniques and their final properties and functionality. Fractal based glass-metal nanocomposites, its designing and fractal dimension analysis. Core-Shell structured nanocomposites		
UNIT III	POLYMER BASED NANOCOMPOSITES	9
Preparation and characterization of diblock Copolymer based nanocomposites; Polymer Carbon nanotubes based composites, their mechanical properties, and industrial possibilities.		
UNIT IV	NANOCOMPOSITE FROM BIOMATERIALS	9
Natural nanocomposite systems - spider silk, bones, shells; organic-inorganic nanocomposite formation through self-assembly. Biomimetic synthesis of nanocomposites material; Use of synthetic nanocomposites for bone, teeth replacement.		
UNIT V	NANOCOMPOSITE TECHNOLOGY	9
Nanocomposite membrane structures- Preparation and applications. Nanotechnology in Textiles and Cosmetics-Nano-fillers embedded polypropylene fibers – Soil repellence, Lotus effect - Nano finishing in textiles (UV resistant, anti-bacterial, hydrophilic, self-cleaning, flame retardant finishes), Sun-screen dispersions for UV protection using titanium oxide – Colour cosmetics. Nanotechnology in Food Technology - Nanopackaging for enhanced shelf life - Smart/Intelligent packaging.		

TOTAL : 45 PERIODS

REFERENCES:

1. Introduction to Nanocomposite Materials. Properties, Processing, Characterization-Thomas E. Twardowski. 2007. DEStech Publications. USA.
2. Nanocomposites Science and Technology - P. M. Ajayan, L.S. Schadler, P. V.Braun 2006.
3. Physical Properties of Carbon Nanotubes- R. Saito 1998.
4. Carbon Nanotubes (Carbon , Vol 33) - M. Endo, S. Iijima, M.S. Dresselhaus 1997.
5. The search for novel, superhard materials- Stan Veprjek (Review Article) JVST A, 1999
6. Nanometer versus micrometer-sized particles-Christian Brosseau, Jamal BeN Youssef, Philippe Talbot, Anne-Marie Konn, (Review Article) J. Appl. Phys, Vol 93, 2003
7. Diblock Copolymer, - Aviram (Review Article), Nature, 2002
8. Bikramjit Basu, Kantesh Balani Advanced Structural Ceramics, A John Wiley & Sons, Inc.,
9. P. Brown and K. Stevens, Nanofibers and Nanotechnology in Textiles, Woodhead publication, London, 2006

BY4016

IPR, BIOSAFETY AND ENTREPRENEURSHIP

L T P C

3 0 0 3

UNIT I IPR

9

Intellectual property rights – Origin of the patent regime – Early patents act & Indian pharmaceutical industry – Types of patents – Patent Requirements – Application preparation filing and prosecution – Patentable subject matter – Industrial design, Protection of GMO's IP as a factor in R&D,IP's of relevance to biotechnology and few case studies.

UNIT II AGREEMENTS, TREATIES AND PATENT FILING PROCEDURES 9

History of GATT Agreement – Madrid Agreement – Hague Agreement – WIPO Treaties – Budapest Treaty – PCT – Ordinary – PCT – Conventional – Divisional and Patent of Addition – Specifications – Provisional and complete – Forms and fees Invention in context of “prior art” – Patent databases – Searching International Databases – Country-wise patent searches (USPTO, Espacenet(EPO) – PATENT Scope (WIPO) – IPO, etc National & PCT filing procedure – Time frame and cost – Status of the patent applications filed – Precautions while patenting – disclosure/non-disclosure – Financial assistance for patenting – Introduction to existing schemes Patent licensing and agreement Patent infringement – Meaning, scope, litigation, case studies

UNIT III BIOSAFETY 9

Introduction – Historical Background – Introduction to Biological Safety Cabinets – Primary Containment for Biohazards – Biosafety Levels – Biosafety Levels of Specific Microorganisms – Recommended Biosafety Levels for Infectious Agents and Infected Animals – Biosafety guidelines – Government of India.

UNIT IV GENETICALLY MODIFIED ORGANISMS 9

Definition of GMOs & LMOs – Roles of Institutional Biosafety Committee – RCGM – GEAC etc. for GMO applications in food and agriculture – Environmental release of GMOs – Risk Analysis – Risk Assessment – Risk management and communication – Overview of National Regulations and relevant International Agreements including Cartagena Protocol.

UNIT V ENTREPRENEURSHIP DEVELOPMENT 9

Introduction – Entrepreneurship Concept – Entrepreneurship as a career – Entrepreneurial personality – Characteristics of successful Entrepreneur – Factors affecting entrepreneurial growth – Entrepreneurial Motivation – Competencies – Mobility – Entrepreneurship Development Programmes (EDP) - Launching Of Small Enterprise - Definition, Characteristics – Relationship between small and large units – Opportunities for an Entrepreneurial career – Role of small enterprise in economic development – Problems of small scale industries – Institutional finance to entrepreneurs - Institutional support to entrepreneurs.

TOTAL : 45 PERIODS

REFERENCES

1. Bouchoux, D.E., “Intellectual Property: The Law of Trademarks, Copyrights, Patents, and Trade Secrets for the Paralegal”, 3rd Edition, Delmar Cengage Learning, 2008.
2. Fleming, D.O. and Hunt, D.L., “Biological Safety: Principles and Practices”, 4th Edition, American Society for Microbiology, 2006.
3. Irish, V., “Intellectual Property Rights for Engineers”, 2nd Edition, The Institution of Engineering and Technology, 2005.
4. Mueller, M.J., “Patent Law”, 3rd Edition, Wolters Kluwer Law & Business, 2009.
5. Young, T., “Genetically Modified Organisms and Biosafety: A Background Paper for Decision-Makers and Others to Assist in Consideration of GMO Issues” 1st Edition, World Conservation Union, 2004.
6. S.S Khanka, “Entrepreneurial Development”, S.Chand & Company LTD, New Delhi, 2007.

