KCG
COLLEGE OF TECHNOLOGY
Affiliated to Anna University
AUTONOMOUS

CURRICULUM AND SYLLABUS

PG

(REGULATIONS 2023)

ACADEMIC YEAR 2023-2024

INDEX

M.E. AERONAUTICAL ENGINEERING

SEMESTER – I

SL. NO	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	23MAP101	Advanced Mathematical Methods	FC	4	0	0	4	4
2	23AEP102	Aerospace Propulsion	PCC	3	0	0	3	3
3	23AEP103	Aircraft Structural Mechanics	PCC	3	1	0	4	4
4	23AEP104	Flight Vehicle Aerodynamics	PCC	4	0	0	4	4
5	23RMP101	Advanced Research Methodology and IPR	RMC	2	0	0	2	2
6	23AN0XX	Professional Elective - I	PEC	3	0	0	3	3
7		Audit Course – I*	AC	2	0	0	2	0
PRACTICALS								
8	23AEP121	Low Speed and High Speed Aerodynamics Laboratory	PCC	0	0	4	4	2
9	23AEP122	Jet Propulsion Laboratory	PCC	0	0	4	4	2
TOTAL				**21**	**1**	**8**	**30**	**24**

SEMESTER – II

SL. NO	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	23AEP201	Advanced Flight Dynamics & Simulation	PCC	3	0	2	5	4
2	23AEP202	CFD for Aerospace Applications	PCC	3	0	0	3	3
3	23AEP203	Analysis of Composite Structures	PCC	3	0	0	3	3
4	23AEP204	Advanced 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
PRACTICALS								
8	23AEP221	Structures Laboratory	PCC	0	0	4	4	2
9	23AEP222	Mini Project with Seminar	EEC	0	0	4	4	2
10	23AEP223	Computational Laboratory	PCC	0	0	4	4	2
TOTAL				**20**	**0**	**14**	**34**	**25**

M.E. MANUFACTURING ENGINEERING

SEMESTER – I

SL. NO	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	23MAP105	Applied Probability and Statistics for Manufacturing Engineering	FC	3	1	0	4	4
2	23MFP101	Advances in Manufacturing Processes	PCC	3	0	0	3	3
3	23MFP102	Advances in Casting and Welding	PCC	3	0	0	3	3
4	23MFP103	Theory of Metal Cutting	PCC	3	0	0	3	3
5	23MFP104	Computer Aided Design and Manufacturing	PCC	3	0	0	3	3
6	23RMP101	Advanced Research Methodology and IPR	RMC	2	0	0	2	2
7		Audit Course – I*	AC	2	0	0	2	0
PRACTICALS								
8	23MFP121	CAD/CAM Laboratory	PCC	0	0	4	4	2
9	23MFP122	Technical Seminar	EEC	0	0	2	2	1
TOTAL				19	1	6	26	21

SEMESTER – II

SL. NO	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	23MFP201	Optimization Techniques in Manufacturing	PCC	3	0	0	3	3
2	23MFP202	Advances in Metrology and Inspection	PCC	3	0	0	3	3
3	23MFP203	Theory of Metal Forming	PCC	3	0	0	3	3
4	23MFP204	Additive Manufacturing	PCC	3	0	0	3	3
5	23MFP205	Fluid Power Automation	PCC	3	0	0	3	3
6		Professional Elective – I	DEC	3	0	0	3	3
7		Professional Elective – II	DEC	3	0	0	3	3
8		Audit Course – II*	AC	2	0	0	2	0
PRACTICALS								
9	23MFP221	Automation and Metal Forming Laboratory	PCC	0	0	4	4	2
10	23MFP222	Advanced Manufacturing Processes Laboratory	PCC	0	0	4	4	2
TOTAL				23	0	8	31	25

M.E. COMMUNICATION SYSTEMS

SEMESTER – I

SL. NO	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	23MAP103	Linear Algebra, Probability and Queueing Theory	FC	3	1	0	4	4
2	23RMP101	Advanced Research Methodology and IPR	RMC	2	0	0	2	2
3	23ECP101	Statistical Signal Processing	PCC	3	0	0	3	3
4	23ECP102	Modern Digital Communication Systems	PCC	3	0	0	3	3
5	23ECP103	Advanced Wireless Communication	PCC	3	0	0	3	3
6	23ECP104	Radiating Systems	PCC	3	0	0	3	3
7		Audit Course – I*	AC	2	0	0	2	0
PRACTICALS								
8.	23ECP121	Digital Communication Systems Laboratory	PCC	0	0	3	3	1.5
9.	23ECP122	Advanced Digital Signal Processing Laboratory	PCC	0	0	3	3	1.5
TOTAL				19	1	6	26	21

SEMESTER – II

SL. NO	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	23ECP201	RF System Design	PCC	3	0	0	3	3
2	23ECP202	Advanced Wireless Networks	PCC	3	0	0	3	3
3	23ECP0xx	Professional Elective I	PEC	3	0	0	3	3
4	23ECP0xx	Professional Elective II	PEC	3	0	0	3	3
THEORY AND PRACTICALS								
5	23ECP211	Microwave Integrated Circuits	PCC	3	0	2	5	4
6	23ECP212	Machine Learning	PCC	3	0	2	5	4
7		Audit Course – II*	AC	2	0	0	2	0
PRACTICALS								
8	23ECP221	Wireless Communication Laboratory	PCC	0	0	4	4	2
9	23ECP222	Term Paper Writing and seminar	EEC	0	0	2	2	1
TOTAL				20	0	10	30	23

M.E. POWER ELECTRONICS AND DRIVES

SEMESTER – I

SL. NO	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	23MAP104	Applied Mathematics for Power Electronics Engineers	FC	3	1	0	4	4
2	23EEP101	Analysis of Electrical Machines	PCC	3	1	0	4	4
3	23EEP102	Analysis of Power Converters	PCC	3	1	0	4	4
4	23EEP103	Modeling and Design of SMPS	PCC	3	0	0	3	3
5	23RMP101	Advanced Research Methodology and IPR	RMC	2	0	0	2	2
6		Professional Elective I	PEC	3	0	0	3	3
7		Audit Course – I*		2	0	0	2	0
PRACTICALS								
8	23EEP121	Power Converters Laboratory	PCC	0	0	4	4	2
9	23EEP122	Analog and Digital Controllers for PE Converters Laboratory	PCC	0	0	4	4	2
TOTAL				**19**	**3**	**8**	**30**	**26**

SEMESTER – II

SL. NO	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	23EEP201	Analysis of Electrical Drives	PCC	3	1	0	4	4
2	23EEP202	Special Electrical Machines	PCC	3	0	0	3	3
3	23EEP203	ElectricVehicles and Power Management	PCC	3	0	0	3	3
4		Professional Elective II	PEC	3	0	0	3	3
5		Professional Elective III	PEC	3	0	0	3	3
6		Audit Course – II*		2	0	0	2	0
PRACTICALS								
7	23EEP221	Power Electronics and Drives Laboratory	PCC	0	0	4	4	2
8	23EEP222	Design Laboratory for Power Electronics Systems	PCC	0	0	4	4	2
TOTAL				**15**	**1**	**8**	**24**	**20**

M.E. COMPUTER SCIENCE AND ENGINEERING

SEMESTER – I

SL. NO	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	23MAP102	Applied Probability and Statistics	FC	3	1	0	4	4
2	23CSP101	Advanced Data Structures and Algorithms	PCC	3	0	0	3	3
3	23CSP102	Advanced Network Technologies	PCC	3	0	0	3	3
4	23CSP103	Computational Intelligence and Data Visualization Techniques	PCC	3	0	0	3	3
5	23RMP101	Advanced Research Methodology and IPR	RMC	2	0	0	2	2
6		Audit Course-I*	AC	2	0	0	2	0
THEORY AND PRACTICALS								
7	23CSP111	Advanced Database Management Systems	PCC	3	0	2	5	4
PRACTICALS								
8	23CSP121	Advanced Data Structures and Algorithms Laboratory	PCC	0	0	4	4	2
TOTAL				**19**	**1**	**6**	**26**	**21**

SEMESTER – II

SL. NO	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	23CSP201	Advanced Software Engineering	PCC	3	0	0	3	3
2		Professional Elective I	PEC	3	0	0	3	3
3		Professional Elective II	PEC	3	0	0	3	3
4		Audit Course – II*	AC	2	0	0	2	0
THEORY AND PRACTICALS								
5	23CSP211	Multicore Architecture and GPU Programming	PCC	3	0	2	5	4
6	23CSP212	Internet of Things and its Applications	PCC	3	0	2	5	4
7	23CSP213	Advanced Operating Systems	PCC	3	0	2	5	4
PRACTICALS								
8	23CSP221	Research Paper Writing and Seminar	EEC	0	0	2	2	1
9	23CSP222	Advanced Software Engineering Laboratory	PCC	0	0	4	4	2
TOTAL				**20**	**0**	**12**	**32**	**24**

SEMESTER I

23MAP101 ADVANCED MATHEMATICAL METHODS L T P C
4 0 0 4

COURSE OBJECTIVES:

- To attain the knowledge of solving Partial Differential Equations using Laplace transform.
- To apply FourierTransform to solve boundary value problems.
- To achieve maxima and minima of a functional.
- To acquire knowledge on using conformal mapping to fluid flowand 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 EQUATION 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 ANDAPPLICATIONS 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:

- **CO1:** Application of Laplace and Fourier transforms to initial value, initial–boundary value and boundary value problems in Partial Differential Equations.
- **CO2:** Maximizing and minimizing the functional that occur in various branches of Engineering Disciplines.
- **CO3:** 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.
- **CO4:** Understand tensor algebra and its applications in applied sciences and engineering and develops ability to solve mathematical problems involving tensors.
- **CO5:** 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. Ramaniah. G. "Tensor Analysis", S. Viswanathan Pvt. Ltd., 1990.

23AEP101 AEROSPACE PROPULSION L T P C
3 0 0 3

COURSE OBJECTIVES:

This course will enable the students

- To gain knowledge on fundamental principles of aircraft and rocket propulsion.
- To describe various types of propulsion system with their merits and challenges.
- To gain adequate knowledge on propellers and its characteristics.
- To be familiar with the working concept of inlets, nozzles and combustion chamber with their applications in a propulsion system.
- 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 ROCKETAND 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 , "GasTurbineTheory",PearsonEducationCanada;7th edition,2017.
2. Gill,WP, Smith,HJ & Ziurys,JE, "Fundamentals of Internal Combustion Engines as applied toReciprocating, 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 &ELGoldsmith. "Intake Aerodynamics", AIAA educationseries.1999.

23AEP102 AIRCRAFT STRUCTURAL MECHANICS L T P C
3 1 0 4

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

COURSEOUTCOMES:

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.

23AEP103 FLIGHT VEHICLE AERODYNAMICS L T P C
4 0 0 4

COURSE OBJECTIVES:

This course will enable the students

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

UNIT-I INTRODUCTION TO AERODYNAMICS 12

Aerodynamic forceand moments, lift and Drag coefficients, Centre of pressure and aerodynamiccentre, Coefficient of pressure, moment coefficient, Continuity and Momentum equations, Pointsource and sink, doublet, Free and Forced Vortex, Uniform parallel flow, combination of basicflows, Pressure and Velocity distributions on bodies with and without circulation in ideal and realfluid flows,Magnus effect

UNIT-II INCOMPRESSIBLE FLOW THEORY 12

Conformal Transformation, Karman ,Trefftz profiles, Kutta condition, Kelvin's Circulation Theoremand the Starting Vortex, Thin aerofoil Theory and its applications. Vortex line, Horse shoe vortex,Biot–Savartlaw,liftinglinetheory,effectofaspectratio.

UNIT-III COMPRESSIBLEFLOW 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, transonicarea rule, Swept wings (ASW and FSW), Supersonic airfoils, Shock-Expansion Theory, Wavedrag,Deltawings.

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:

J.D. Anderson, Fundamentals of Aerodynamics, McGraw-Hill Education, 6th edition, 2017.

Rathakrishnan.E., Gas Dynamics, Prentice Hall of India, 7th edition, 2020.

Shapiro, AH, "Dynamics & Thermodynamics of Compressible Fluid Flow", Ronald Press, 1982.

Houghton, EL and Caruthers, NB,"Aerodynamics for Engineering Students", Butterworth- Heinemann series, 7th edition 2017.

Zucrow, M.J, and Anderson, J.D, "Elements of gas dynamics" McGraw-Hill Book Co., New York, 1989.

Rae, WH and Pope, A, "Low speed Wind Tunnel Testing", John Wiley Publications, 3rd edition, 1999

23AEP121 LOW SPEED AND HIGHSPEED 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

23AEP122 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

23MAP105 APPLIED PROBABILITY AND STATISTICS FOR MANUFACTURING ENGINEERING

L	T	P	C
3	1	0	4

COURSE OBJECTIVES:

- To understand the basics of random variables with emphasison the standard discrete and continuous distributions.
- To understand the basic probability concepts with respect to two dimensional random variab les along with the relationship between the random variables.
- To apply the small and large sample tests through test of hypothesis.
- To understand the basic concepts of sampling distributions and statistical properties of point estimators.
- 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'stheorem 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 – 2^2 Factorial design

TOTAL: 60 PERIODS

COURSE OUTCOMES:

At the end of the course, students will be ableto

- **CO1:** Generalize the performance in terms of probabilities and distributions achieved by determined solutions.
- **CO2:** Make use of some of the commonly encountered two dimensional random variables and equipped for a possible extension to multivariate analysis.
- **CO3:** Describe the basic principles underlying statistical inference (hypothesis testing).
- **CO4:** Acquire the knowledge of applicable large sample theory of estimators and tests.
- **CO5:** Explore the different methods for conducting design of experiments.

REFERENCES:

1. Devore, J. L., "Probability and Statistics for Engineering
   a. and Sciences", 8th Edition, Cengage Learning, 2014.
2. Gupta S.C. and Kapoor V.K.," Fundamentals of Mathematical Statistics",12th Edition, Sultanand Sons,New Delhi,2020.
3. Johnson, R.A., Miller, Iand FreundJ., "MillerandFreund's Probability and Statistics for Engineers", 9th Edition, Pearson Education, Asia, 2016.
4. Rice, J.A., "Mathematical Statistics and Data Analysis", 3rdEdition, CengageLearning, 2015.
5. Ross, S.M.,"Introduction to Probability and Statistics for Engineers and Scientists", 5thEdition, Elsevier,2014.

23MFP101 ADVANCES IN MANUFACTURING PROCESSES **L T P C**
3 0 0 3

COURSE 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 BeamMachining.

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-microbblanking–Powder rolling–Tooling and process parameters.

UNIT-IV MICRO MACHININING AND NANO FABRICATION 9

Theory of micro machining – Micro machining Processes – Micro-milling – Micro-drilling – Micro-turning – Micro-grinding – Micro-polishing – Principle of Micro EDM – Micro wire EDM – PlanetaryMicro EDM – Reverse Micro EDM– Advantages, Challenges. Nano fabrication process- Nano machining techniques – Top / Bottom up Nano fabrication techniques - Sub micron litho graphic technique, conventional film growth technique, Chemicaletching, 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

COURSE OUTCOMES:

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

- **CO1:** Classify the processes and to study the mechanism of material removal and operating parameters of various energy assisted manufacturing processes.
- **CO2:** Describe the different precision machining techniques and its requirements to achieve the best quality of machined surfaces.
- **CO3:** Explain the various advancements in metal forming operations and its process parameters.
- **CO4:** Elaborate on various micromachining and nano fabrication techniques.
- **CO5:** Summarize the different rapid prototyping and surface modification techniques.

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",TataMcGrawHill,2017.
6. Serope Kalpakjian.,"Manufacturing Engineering and Technology" Pearson Education, 2018

23MFP102 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 inCAD 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, Alalloys, Babbitt alloy and Cu alloy.

UNIT-III RECENT TRENDS IN CASTING AND FOUNDRY LAYOUT **9**

Shell moulding, precision investment casting, CO_2 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 alloysteels 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 thermalcycle.

UNIT- V RECENT TRENDS IN WELDING 9

Friction welding, Friction stir welding – Explosive welding– Diffusion bonding– High frequencyinduction welding – Ultrasonic welding – Electron beam welding – Laser beam welding –Plasmawelding – Electroslag welding- Narrow gap, Hybrid twin wire active TIG – Tandem MIG-Modernbrazing and soldering techniques – Induction, Dip resistance, Diffusion processes–Hotgas,Wave and vapour phase soldering. Overview of automation of welding in aerospace, Nuclear, surface transport vehicles and under water welding.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- **CO1:** Design the gating, risers for the casting by applying the basicconcepts.
- **CO2:** Describe the casting metallurgy and to explain the castability of different materials.
- **CO3:** Summarize the recent trends in casting and the layout for foundry operations.
- **CO4:** Elaborate on weld design, defects, testing of weldments and weldability of various materials.
- **CO5:** Explain the recent advancements in various welding techniques in emerging fields.

REFERENCES:

1. ASM Hand book vol.6,welding Brazing & Soldering, 2010
2. ASM Hand book,Vol15, Casting, 2008
3. CarrryB., Modern Welding Technology, Prentice Hall Pvt Ltd.,2005
4. Cornu.J. Advanced welding systems–Volumes I, II and III, JAICO Publishers, 1994.
5. Heineloper & Rosenthal, Principles of Metal Casting, Tata McGrawHill, 2017.
6. Iotrowski–Robotic welding–A guide to selection and application–Society of mechanical Engineers, 1987.
7. JainP.L., Principles of Foundry Technology, Tata McGraw Hill Publishers,

2003
8. Lancaster.J.F.–Metallurgy of welding–George Alien& UnwinPublishers, 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, KhannaTech Publishers,2002
12. P NRao Manufacturing Technology ,Vol 1, 3rd edition,2011

23MFP103 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 familiarize the students various cutting tool materials and its wear mechanisms during the machining operation.
3. Differentiate between single point and multipoint 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, TOOLLIFE AND TOOLWEAR 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 able to

- **CO1:** Explain the basics of orthogonal cutting, oblique cutting and chip formation.
- **CO2:** Discuss the nomenclature of single point and multipoint cutting tools.
- **CO3:** Describe the heat distribution during machining and select the cutting fluids.
- **CO4:** Elaborate on different toolmaterials, toollife and toolwear.
- **CO5:** Detail the wear mechanisms and the effect of chatter in machining.

TOTAL: 45 PERIODS

REFERENCES:

1. Bhattacharya. A., Metal Cutting Theory and practice, Central Book Publishers, India, 2012.
2. Boothroid D.G. & KnightW.A., Fundamentals of machining and machine tools, Marcel Dekker, Newyork, 2005.
3. Shaw.M.C.Metal cutting principles, Oxford Claredon press, 2012.
4. B L Juneja and GSSekhon., Fundamentals of Metal Cutting and MachineTools, 2017.

23MFP104 COMPUTER AIDED DESIGN AND MANUFACTURING L T P C
2 0 0 2

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 CAD AND CAM 9

Introduction to 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 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-IV PROGRAMMING OF CNC MACHINES 9

Structure of CNC program, Coordinate system, G & M codes, cutter radius compensation, tool nose radiuscompensation, 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 sheetmetal forming, generation of CNC programusing CAM softwares.

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 productions cheduling system.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students shall be able to:

- **CO1:** Generalize the importance of CAD, CAM, CIM, Engineering product specification and interpreting geometric specifications.
- **CO2:** Elaborate on the integration of CAD and CAM.
- **CO3:** Describe the implementation of CAD and CAM in manufacturing processes.
- **CO4:** Exhibit competency in manual part program and generation of CNC
- part program using CAM packages.
- **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, NewDelhi,2017.
3. Rao P.N., "CAD/CAM", 3rdEdition, TataMcGraw-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. NeeY.C., Soh K. Ong, YunG.Wang., "Computer Applications in Near Net-Shape Operations", Springer, United Kingdom,2012.
6. Yingfeng Zhang and FeiTao, "Optimization of Manufacturing Systems Using the Internet of things.

23RMP101 ADVANCED 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., Ethics in Research, Dimensions of Research-Purpose, exploration, description, use of research in basic and applied types of research, time dimension in research.

UNIT-II DATA COLLECTION AND SOURCES 6

Measurements, Measurement Scales, Questionnaires and Instruments, Sampling and methods.Data - Preparing, Exploring, examining and displaying, Methods and tools of Research(Quantitative and Qualitative); Sampling techniques: Probability and Non-probability Reliability and Validity, Descriptive Studies, Assessment, Evaluation, Ex-post facto studies.

UNIT-III DATA ANALYSISANDREPORTING 6

Overview of Multivariate analysis, Hypotheses testing and Measures of Association. Presenting Insights and findings using written reports and oral presentation. Content Analysis, case study, ethnographic studies, Analytical and Correlational analysis: Analysis of variance and Covariance, Partial and Multiple Correlation, Regression Analysis, Factor Analysis and Discriminant Analysis, Replication and secondary analysis and Meta Analysis, Experimental Studies: Quasi-experimental and factional designs; single subject experimental research,. Qualitative Research:

UNIT- IV INTELLECTUAL PROPERTY RIGHTS 6

IntellectualProperty— The concept of IPR, Evolution and development of concept of IPR, IPR development process, Trade secrets, utility Models, IPR & Bio diversity, Role ofWIPO and WTO in IPR establishments, Right of Property, Commonrules 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-filling, Examination of patent, Grant of patent, Revocation, Equitable Assignments, Licenses, Licensing of relatedpatents, patentagents, Registration of patent agents.

TOTAL: 30 PERIODS

REFERENCES:

1. Cooper DonaldR, Schindler Pamela Sand Sharma JK, "Business ResearchMethods", Tata McGraw Hill Education,11e(2012).
2. Catherine J. Holland, "Intellectual property: Patents, Trademarks, Copyrights, TradeSecrets", Entrepreneur Press,2007.
3. David Hunt,LongNguyen,MatthewRodgers,"Patentsearching: tools&techniques", Wiley, 2007.
4. The Institute of Company Secretaries of India, Statutory body under an Act of parliament, "Professional ProgrammeIntellectualProperty Rights, Law and practice", September2013.

23MFP121 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 cannedcycle
2. Exercise on CNC Milling Machine: Profile Milling, Mirroring, Scaling&cannedcycle. Study of Sensors, Transducers & PLC: Hall-effect sensor, Pressure sensors, Strain gauge, PLC, LVDT, Loadcell, 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 jointsand 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 additionandremoval 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 view setc.

7. Productivity Enhancement Tools in CAD Software: Feature patterns, duplication, grouping, suppression. Top-downvs.bottom-updesign

CAD LABORATORY

2D modeling and 3D modeling of components such as

1. Bearing
2. Couplings
3. Gears
4. Sheet metal components
5. Jigs, Fixtures and Dieassemblies.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

At the end of this course the students are expected to;

- **CO1:** Interpret mechanical drawings for components, assemblies and use parametric 3D CAD softwaretools in the correct manner for creating their geometric part models, assemblies and automateddrawings.
- **CO2:** 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 quipment.
- **CO3:** 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 orturningapplications.
- **CO4:** Interpreting 3D part model/ part drawings using Computer AidedManufacturing technology through programming, setup, and ensuring safe operation of Computer Numerical Control (CNC) machine tools.
- **CO5:** 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.

23MFP122 TECHNICAL SEMINAR **L T P C**
0 0 2 1

COURSE OBJECTIVES:

- To enrich the communication skills of the student through presentation of topics in recent advances in engineering /technology
- To ensure that students possess a comprehensive understanding of the latest development in his chosen area
- 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.

COURSE OUTCOMES:

At the end of this course the students are expected

- To develop skills to search, read, write, comprehend and present research papers in the areas of manufacturing engineering.
- Updated with the latest technology in the field of Manufacturing Engineering.
- Able to plot graph, sketch, bring out the visual about his understanding on various topics.

TOTAL: 30 PERIODS

23MAP103 LINEAR ALGEBRA, PROBABILITY AND QUEUEING THEORY

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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.

23ECP101 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 SignalProcessing, 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 SignalProcessing, 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.

23ECP102 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 SynchronizationBit 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.

23ECP103 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 mulitiple 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.

23ECP104 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, Babinets 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.

23ECP121 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

23ECC122 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

23MAP104 APPLIED MATHEMATICS FOR POWER ELECTRONICS ENGINEERS

L	T	P	C
3	1	0	4

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 TECNIQUES 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:

After completion of this course, student will be able to

- 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.

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.

23EEP101 ANALYSIS OF ELECTRICAL MACHINES L T P C
3 1 0 4

OBJECTIVES:

- To understand the principles of electro mechanical 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 hormones 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 ELECTRO MECHANICAL 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 ofsteady 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

- Understand the principles of electromechanical energy conversion and study voltage and torque equations of DC motors
- Know the concepts related with AC machines and modeling of 'n' phasemachines
- Interpret the concepts of reference frame theory.
- Apply procedures to develop induction machine model in both machine variable form and reference variable forms
- Follow the procedures to develop synchronous machine model in machine variables form and reference variable form.

REFERENCES:

1 Stephen D. Umans, "Fitzgerald&Kingsley'sElectricMachinery", Tata Mc Graw Hill, 7thEdition, 2020.

2 Bogdan M. Wilamowski, J. DavidIrwin, The Industrial Electronics Handbook, Second Edition, Power Electronics and MotorDrives, 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 HousePvt.Ltd,2018

23EEP102 ANALYSIS OF POWER CONVERTERS L T P C
3 1 0 4

OBJECTIVES:

- To provide them a thematical 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 free wheeling 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 free wheeling 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 completion of this course, student will be able to

- Acquire and apply knowledge of mathematics in power converter analysis
- Model, analyze and understand power electronic system sand equipments.
- Formulate, design and simulatephase controlled rectifiers for generic load and for machine loads
- Design and simulate switched mode inverters for generic load and for machine loads
- Select device and calculate performance parameters of power converters under various operating modes

REFERENCES:

1. Rashid M.H., "PowerElectronics Circuits, Devices and Applications", Pearson, fourth Edition, 10th Impression2021.
2. JaiP.Agrawal, "Power Electronics System Theory and Design", Pearson Education, First Edition, 2015
3. Bimal.K. Bose "Modern Power Electronics and ACDrives", 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. PhilipT.Krein,"Elements of Power Electronics"Indianedition Oxford University Press- 2017
6. P.C. Sen, "Modern Power Electronics", S. Chand Publishing2005.
7. P.S.Bimbra,"Power Electronics",Khanna Publishers, Eleventh Edition,2003
8. Bin Wu, Mehdi Narimani,"High-Power Converters and AC Drives", Wiley, 2nd Edition, 2017

23EEP103 MODELING AND DESIGN OF SMPS L T P C
3 0 0 3

OBJECTIVES:

- To inculcate knowledge on steady state analysis of Non-Isolated DC-DC converter
- To perform steady state analysis of Isolated DC-DC converter
- To educate on different converter dynamics
- To impart knowledge on the design of controllers for DC-DC converters
- 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 completion of this course, student will be able to

- Analyse and design Non-Isolated DC-DC converter
- Analyse and design Isolated DC-DC converter
- Derive transfer function of different converters
- Design controllers for DC-DC converters
- 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, NewDelhi,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: Afirstcourse", Wiley,2011,1stedition.
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 Vanden Bossche and Vencislav Cekov Valchev, "Inductors and Transformers for Power Electronics", CRC Press,1st edition,2005.
8. W.G. Hurley and W.H. Wolfle, "Transformers and Inductors for Power Electronics Theory, Design and Applications", 2013 Wiley, 1st Edition.

23EEP121 POWER CONVERTERS LABORATORY L T P C

0 0 4 2

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&RLEload.
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 a three-phase AC voltage Controller with R load.
10. Simulation of a five-level cascaded multi level inverter with R load.
11. Simulation of a Flyback DC-DC converter

TOTAL: 60 PERIODS

OUTCOMES:

After completion of this course, student will be able to

- Comprehensive understanding on the switching behaviour of Power Electronic switches
- Comprehensive understanding on mathematical modeling of power

electronic system and ability to implement the same using simulation tools

- Ability of the student to use Arduino /microcontroller for power electronic applications
- Ability of the student to design and simulate various topologies of inverters and analyze their harmonic spectrum.
- 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

23EEP122 ANALOG AND DIGITAL CONTROLLERS FOR PE CONVERTERS LABORATORY

L T P C
0 0 4 2

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/OFFcontroller design and verification by using analog circuits
4. Design of Driver Circuit using IR2110
5. Wave form generation by using lookup table
6. Generation of PWM gate pulses with duty cycle control using PWM peripheral of microcontroller r (TI-C2000 family/PIC18)
7. Duty cycle control from IDE
8. Duty Cycle control using a POTconnected to ADC peripheral in a stand alone 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 C2000family/PIC18)
10. Design and testing of signal conditioning circuit to interface voltage/current sensor with micro controller (TI- C2000 family/PIC18)
11. Interface Hall effect voltage and current sensor with micro controller and display the current wave for min the IDE and validate with actual wave for min 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-C2000family/PIC18

TOTAL : 60 PERIODS

OUTCOMES:

After completion of this course, student will be able to

- Identification of suitable analog and digital controller for the converter design.
- Know the advantages of gate driver, sensing and protection circuits in power converters.
- Hands on with different controller with strategies for design.
- Design and testing the proper driving circuits & protection circuits
- Fabrication of Analog & digital controllers for various real time applications

23MAP102 APPLIED PROBABILITY AND STATISTICS L T P C
3 1 0 4

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 and Normal distributions.

UNIT-III TWO DIMENSIONAL RANDOM VARIABLES 12

Joint distributions – Marginal and conditional distributions – Functions of two-dimensional random variables – Regression curve – Correlation- Central Limit Theorem (Without Proof)

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.

REFERENCE BOOKS:

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.

23CSP101 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 ofproblems.

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 maximumdegree.

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

COURSE OUTCOMES:

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

- **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.

23CSP102 ADVANCED NETWORK TECHNOLOGIES L T P C
3 0 0 3

COURSE OBJECTIVES:

- To understand the basic concepts ofnetworks
- To explore various technologies in the wirelessdomain
- To study about 4G and 5G cellularnetworks
- To learn about Network FunctionVirtualization
- To understand the paradigm of Software definednetworks

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. Open Daylight. 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:

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

- **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

REFERENCE BOOKS:

1.James Bernstein, "Networking made Easy", 2018. (UNIT I)

2.HoudaLabiod, Costantino de Santis, HossamAfifi "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

23CSP103 COMPUTATIONAL INTELLIGENCE AND DATA VISUALIZATION TECHNIQUES

L T P C
3 0 0 3

COURSE OBJECTIVES:

- To understand the concept of computational intelligence paradigms and practice assignments
- To understand and apply optimization based on swarm intelligence on various applications
- To develop skills to both design and critique visualizations.
- To understand technological advancements of data visualization and various data visualization techniques
- To understand the methodologies used to visualize large data sets

UNIT-I COMPUTATIONAL INTELLIGENCE PARADIGMS 9

Artificial Neural Networks – Artificial Neuron- Supervised Learning Neural Networks – Unsupervised Learning Neural Networks – Reinforcement Learning - Evolutionary Computation Introduction – Genetic Algorithms - Genetic Programming - Swarm Intelligence - Artificial Immune Systems - Fuzzy Systems - Assignments

UNIT-II COMPUTATIONAL SWARM INTELLIGENCE 9

Particle Swarm Optimization- Basic Particle Swarm Optimization-Social Network Structures - Basic Variations - Basic PSO Parameters - Single-Solution Particle Swarm Optimization-Advanced Topics - Applications - Ant Algorithms - Ant Colony Optimization- Meta-Heuristic- Cemetery Organization and Brood Care-Division of Labor - Advanced Topics – Applications- Traveling Salesman Problem

UNIT-III INTRODUCTION AND FOUNDATION OF DATA VISUALIZATION 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 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- IV 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-V 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.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

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

- **CO1:** Understand the concept of computational intelligence paradigms through practicing assignments
- **CO2:** Apply optimization based on swarm intelligence on various applications
- **CO3:** Visualize the objects in different dimensions and design and process the data for Visualization.
- **CO4:** Apply the visualization techniques in physical sciences, computer science, applied mathematics and medical sciences.
- **CO5:** Apply the virtualization techniques for research projects.

REFERENCE BOOKS:

1. Computational Intelligence An Introduction Andries P. Engelbrecht University of Pretoria South Africa
2. Matthew Ward, Georges Grinstein and Daniel Keim, "Interactive Data Visualization Foundations, Techniques, Applications", 2010.
3. Colin Ware, "Information Visualization Perception for Design", 4th edition, Morgan Kaufmann Publishers, 2021.
4. Robert Spence "Information visualization – Design for interaction", Pearson Education, 2nd Edition, 2007.
5. Alexandru C. Telea, "Data Visualization: Principles and Practice," A. K. Peters Ltd, 2008.

23CSP111 ADVANCED DATABASE MANAGEMENT SYSTEMS **L T P C**
3 0 2 4

COURSE OBJECTIVES:

- Describe the fundamental elements of relational database managementsystems
- 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 XMLdocuments.
- Distinguish the different types of No SQLdatabases
- 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 andDrop
- Enforce Primary Key, Foreign Key, Check, Unique and Not NullConstraints
- CreatingViews

Data Manipulation Language

- Insert, Delete,Update
- Cartesian Product, Equi Join, Left Outer Join, Right Outer Join and Full OuterJoin
- Aggregate Functions
- Set Operations
- Nested Queries Transaction Control
- Language commit, Roll back 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 – Mongo DB Data Model – Mongo DB 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, 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

REFERENCE BOOKS:

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

23CSP121 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 : 30 PERIODS

COURSE OUTCOMES:

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

- **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.

REFERENCE BOOKS:

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/

PG SEMESTER II

23MFP201 OPTIMIZATION TECHNIQUES IN MANUFACTURING

L	T	P	C
3	0	0	3

COURSE 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–Statementof 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–Lagrangian 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 implicite numeration–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

COURSE OUTCOMES:

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

- **CO1:** Classify the various optimization techniques and their approaches.
- **CO2:** Apply classical optimization techniques in problems of Engineering and Technology.
- C**O3:** Use non-linear programming methods of optimization.
- **CO4:** Describe the integer programming, dynamic programming and network programming methods used for optimization.
- **CO5:** Explain the advanced techniques in simulation of optimization to concrete Engineering problems by using computer software.

REFERENCES:

1. HamdyA.Taha, Operations Research–An Introduction, Prentice Hall of India,1997
2. J.K.Sharma, Operations Research – Theory and Applications – Macmillan IndiaLtd., 1997
3. P.K.Gupthaand Man-Mohan, Problems in Operations Research–Sultanchand & 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.

23MFP202 ADVANCES IN METROLOGY AND INSPECTION L T P C
3 0 0 3

COURSE OBJECTIVES:

1. To teach the students basic concepts in various methods of engineering measurement
2. Techniques and applications
3. To make the munderst and the importance o f measurement and inspection in manufacturing industries.
4. To understand the use of Light rays and Laser beams for measurement and their merits
5. To make the students capable of learning to operate and use advanced metrological
   devices with easeinind us trial environments.
6. To teach the use of computer for measuring and processing of measured quantity

UNIT-I CONCEPTS OF METROLOGY 9

Terminologies– Standards of measurement – Errorsin measurement – Interchange ability 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 Rough ness 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 — LaserMicrometer, 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, Imagemodel, Image enhancement, grey scale models, histogram models, Image Transforms-Examples.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

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

- **CO1:** Explain the concepts of metrology.
- **CO2:** Elaborate on surface roughness measurement devices and techniques.
- **CO3:** Describe the process of calibration and measurements using laser interferometry.
- **CO4:** Generalize the advances in measuring machines using laser metrology, machine vision and other computer aided inspection techniques.
- **CO5:** Use computers for image processing and analysis for measurements.

REFERENCES:

1. "ASTEHandbookofIndustriesMetrology",PrenticeHallofIndiaLtd., 1992.
2. Bewoor,A.K.andKulkarni,V.A.,"MetrologyandMeasurement",TataMcGraw-Hill, 2009.
3. Galyer, F.W.andShotbolt, C.R.,"Metrologyforengineers",ELBS,1990.
4. Gupta,I.C.,"AText Bookof engineering metrology",DhanpatRaiandSons, 1996.
5. Jain,R.K.,"EngineeringMetrology",KhqannaPublishers,2008.
6. Rajput,R.K.,"EngineeringMetrologyandInstrumentations",Kataria&SonsPublishers,2001.
7. Smith,G.T.,"IndustrialMetrology",Springer,2002
8. Sonka,M.,Hlavac,V.andBoyle.R.,"ImageProcessing,Analysis,andMachineVision",Cengage-Engineering,2007.
9. Whitehouse,D.J.,"Surface andtheir measurement", HermesPentonLtd, 2004.

23MFP203 THEORY OF METAL FORMING L T P C
3 0 0 3

COURSE 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 inMetal forming
5. To study thevarioussurfacetreatmentprocesses

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 THEORYAND PRACTICE OF BULK FORMING PROCESSES 9

Analysis of plastic deformation in Forging, Rolling, Extrusion, rod/wiredrawing and tubedrawing–Effect of friction–calculation of forces, workdone–Process parameters, equipment used–Defects–applications–Recent advances in Forging, Rolling, Extrusion and Drawing processes–Design consideration in forming–Equal Chanel Angular Pressing-High Pressure Torsion-Repetitive Corrugation and Straightening-Accumulative Roll bonding.

UNIT-III SHEET METAL FORMING 9

Formability studies – Conventional processes – HERF techniques – Superplastic forming techniques – Hydro forming – Stretch forming – Water hammer forming – Principles and processparameters–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 coldisostatic pressing – High speed extrusion – Rubber pad forming – Fine blanking – LASER beamforming

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 metalliclayers–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 – Thermomechanical regimes of Ti and Al alloys during deformation – Formability of welded blank sheet –Laser structured steel sheet-Formability of laminated sheet.

COURSE OUTCOMES:

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

- **CO1:** Apply the theory of plasticity for metal forming processes.
- **CO2:** Elaborate on the analysis of plastic deformation in various bulk forming processes.
- **CO3:** Apply the concept ofpowder metallurgy to make prismatic components
- **CO4:** Explain the powder metallurgy techniques and special forming processes, its process parameters and applications.
- **CO5:** Describe the purpose of surface treatment in metal forming applications.

TOTAL:45 PERIODS

REFERENCES:

1. AltanT.,Metalforming–Fundamentalsandapplications–American Society of Metals, Metalspark, 2003
2. ALTAN.T,SOO-IK-oh,GEGEL,HL–Metal forming, fundamentals and Applications, American Society of Metals, MetalsPark, Ohio,1995.
3. ASM Handbook, Forming and Forging,Ninthedition,Vol–14,2003
4. Dieter G.E.,Mechanical Metallurgy (Revised Edition II) McGrawHillCo.,1988
5. HelmiAYoussef, HassanA.El-Hofy, Manufacturing Technology: Materials, Processes and Equipment,CRC publication press,2012.
6. Marciniak,Z.,DuncanJ.L.,HuS.J.,'Mechanics of Sheet Metal Forming', Butterworth-Heinemann An Imprintof Elsevier,2006
7. Nagpal G.R., Metal FormingProcesses-Khannapublishers, 2005.
8. SAETransactions, Journal of Materials and Manufacturing Section5, 1993-2007
9. SHIROKOBAYASHI, SOO-IK-oh-ALTAN,T, Metalforming and Finite Element Method, Oxford University Press, 2001.
10. Surender Kumar,Technology of Metal Forming Processes, Prentice Hall India Publishers, 2010.

23MFP204 ADDITIVE MANUFACTURING L T P C
3 0 0 3

COURSE 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: Wireframe, surface and solid modelling – data formats - Data interfacing, Part orientation and supportgeneration, Support structure design, Model Slicing, Tool path generation-Software for AM-Casestudies.

UNIT-III LIQUID BASED AND SOLID BASED ADDITIVE MANUFACTURING SYSTEMS 9

Stereo lithography Apparatus (SLA): Principle, pre-buildprocess, 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 ofprocesses, products, materials,

advantages, limitations and applications-Casestudies.

UNIT-IV POWDER BASED ADDITIVE MANUFACTURING SYSTEMS 9

Selective Laser Sintering (SLS): Principle, process, Indirect and direct SLS-powder structures, materials, postprocessing, 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, processcapabilities, material system. Solidbased, Liquidbased and powder based 3DP systems, strength and weakness, Applications and case studies. Shape Deposition Manufacturing (SDM), Ballastic Particle Manufacturing (BPM), Selective Laser Melting, Electron Beam Melting.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- **CO1:** Classify the Additive Manufacturing (AM) processes and its applications.
- **CO2:** Describe the geometric modeling techniques and their application in rapid prototyping.
- **CO3:** Explain the various liquid based and solid based additive manufacturing systems.
- **CO4:** Discuss on the powder based additive manufacturing systems, their advantages and limitations.
- **CO5:** Summarize the other additive manufacturing systems and 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., LeongK.F.andLimC.S.,"Rapid proto typing:Principles and applications", second edition,World Scientific Publishers, 2010.
2. Gebhardt,A.,"Rapid proto typing",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.

23MFP205 FLUID POWER AUTOMATION LT P C
3 0 0 3

COURSE OBJECTIVES:

1. To make the students to learn the basic concepts of hydraulics and pneumatics and their controlling elements in the area ofmanufacturing 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. Abilityto 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-Drivecharacteristics–Linearactuator–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- electrohydraulic servo valves, Digital valves-Different types-characteristics and performance.

UNIT-IV CIRCUIT DESIGN 9

Typical industrial hydraulic circuits-Design methodology – Ladder diagram-cascade, method-truthtable-Karnaughmap method- sequencing circuits-combinational and logic circuit.

UNIT-V ELECTRO PNEUMATICS & ELECTRONIC CONTROL OF HYDRAULIC AND PNEUMATIC CIRCUITS 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

COURSE OUTCOMES:

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

- **CO1:** Interpret in the area of hydraulics, pneumatics and fluid power components and its functions.
- **CO2:** Summarize the standard symbols used in fluid power circuits and assess the suitable component for a particular application.
- **CO3:** Elaborate on control and regulating elements used in the hydrauliccircuits, its characteristics and performance.
- **CO4:** Design hydraulic circuits for various industrial applications by different methods.
- **CO5:** Design and develop a PLC controlled pneumatic circuit for industrial applications.

REFERENCES:

1. Antony Esposito, Fluid Power Systemsandcontrol Prentice-Hall,1988
2. Dudbey.A.Peace, Basic Fluid Power,Prentice Hall Inc, 1967.
3. E.C.FitchandJ.B.Suryaatmadyn.Introduction to fluid logic, McGrawHill,1978
4. Herbert R. Merritt,Hydraulic control systems,JohnWiley& Sons,Newyork,1967
5. PeterRohner, Fluid Power Logic Circuit Design, Mcmelan Prem,1994.
6. PeterRohner, 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.

23MFP221 AUTOMATION AND METAL FORMING LABORATORY

L	T	P	C
0	0	4	2

COURSE OBJECTIVES

1. To train the students on thebasic concepts of metalforming 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 extrusionload
7. Study on two highrolling process

AUTOMATIONLAB

1. Simulation of single and double acting cylinder circuits
2. Simulation of Hydraulic circuits
3. Simulation of electropneumatic circuits
4. Simulation of electrohydraulic circuits
5. Simulation of PLC circuits
6. Software simulation of fluid power circuits using Automation studio.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

- **CO1:** Acquire practical knowledge on bulk metal forming processes.
- **CO2:** Demonstrate on various symbols used inHydraulic and Pneumatic circuits.
- **CO3:** Conduct few sheet metals forming processes and analyse the parameters.
- **CO4:** Design hydraulic circuits for the given applications.
- **CO5:** Use the automation studio software for simulation of circuits.

23MFP222 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	4	2

COURSE OBJECTIVES

1. To analyse the force sinmachining
2. To perform modeling 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

I Analysis of cutting forces during turning/drilling process.

II Analysis of temperature during turning/drilling process.

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 processusing a FEApackage.

III RAPID PROTOTYPING

1. Selection of Rapid PrototypingTechnology.
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 (Positionandorientation) 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

TOTAL: 60 PERIODS

COURSEOUTCOMES:

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

- **CO1:** Perform modelling and simulation of manufacturing processes
- **CO2:** Analyze the process using an FEA package.
- **CO3:** Acquire Competence to execute product development phases.
- **CO4:** Perform robotprogramming for simple applications.

23AEP201 ADVANCED FLIGHT DYNAMICS L T P C
3 0 2 4

COURSEOBJECTIVES:

This course will enable students

- To gainin depth knowledge on aircraft performance in level, climbing, gliding flight modes.
- To get familiarize the equations of motion in accelerated flight modes.
- To impart knowledge on the basic aspects of stability and control of an airplane about three axis.
- To provide adequate knowledge on various parameters that decide the stability level of an airplane.
- 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 STABILITYAND 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.

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.

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

23AEP202 CFD FOR AEROSPACE APPLICATIONS L T P C
3 0 0 3

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 commerciall 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 is entropic 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–Over lapping grids–Grids around multibodies.

UNIT-III TIME DEPENDENT METHODS 9

Stability of solution, Explicit methods, Time split methods, Approximate factorization scheme, Unsteady transonic flow around air foils. Sometime dependent solutions of gas dynamic problems. Numerical solution of unsteady 2-Dheat conduction problems using SLOR methods.

UNIT-IV FINITE VOLUMEMETHOD 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 aero elasticity–Coupling of CFD with structural model–Aero elasticity 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 them aping 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.

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. JohnD.Anderson, "Computational Fluid Dynamics", McGraw Hill

Education,2017.
5. SedatBiringen & Chuen-Yen Chow, "Introduction to Computational Fluid Dynamics
6. by Example", Wiley publishers,2nd edition,2011.
7. Wirz,HJ & Smeldern,JJ,"Numerical Methods in Fluid Dynamics", McGraw-Hill&Co., 1978.

23AEP203 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 incomposites 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 off ibreand matrix materials used incommercial composites as well as some common manufacturing techniques.
5. To gain knowledge on the basic concept sofacoustic emission technique.

UNIT-I FIBERS, MATRICES, AND FABRICATION METHODS 9

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

UNIT-II MICRO MECHANICS 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 MACRO MECHANICS APPROACH 9

Stress Analysis of an Orthotropic Lamina-Hooke's Law-Stiffness and Compliance Matrices-Specially Orthotropic Material-Transversely Isotropic Material & Specially Orthotropic Materialunder 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-PlyLaminates - 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 Platesrepair-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 micro mechanics theory.
- **CO2:** To analyze acomposite 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 incomposites.
- **CO5:** To gain knowledge on non-destructive inspection(NDI) and structural health monitoring of composites.

REFERENCES:

1. Agarwal, BD and Broutman, LJ, "Analysis and Performance of Fibre Composites",John Wiley&Sons, 3rdedition ,2006.
2. Allen Baker, "Composite Materials for Aircraft Structures",AIAA Series, 2ndEdition, 2004.
3. AutarKKaw, "Mechanics of Composite Materials",CRC Press, 2ndedition, 2005.
4. Calcote,LR,"The Analysis of laminated Composite Structures",Von–Nostrand Reinhold Company,NewYork,1998.
5. Isaac M.Daniel&OriIshai, "Mechanics of Composite Materials",OUPUSA publishers, 2ndedition, 2005.

6. Lubing, “Handbook on Advanced Plastics and Fibre Glass”, Von Nostran Reinhold Co., NewYork,1989.

23AEP204 ADVANCED 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 FESolution.

UNIT-IV VIBRATION & BUCKLING 9

Formulation of the Mass and Stiffness Element Matrices for Vibration Problems– Barand 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 andModes.

UNIT-V HEAT TRANSFER & FLUIDMECHANICS 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 simple1-D and 2-D problems using the finite element method.
- **CO4:** Knowledge on how to apply numerical integration techniques effectively infinite 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, Butter worth, Heinemann Publishing, 3rdEdition, 1998.
5. RobertD.Cook, David S.Malkus, MichaelE.PleshaandRobertJ.Witt, Concepts and Applications of Finite Element Analysis, John Wiley&Sons, 4thEdition, 2002.

6. Segerlind, LJ, Applied Finite Element Analysis, John Wiley and Sons Inc., NewYork, 2nd Edition, 1984.
7. TirupathiR. Chandrupatla & Ashok D.Belegundu, Introduction to Finite Elements in Engineering, Prentice Hall, 2002.

23AEP221 **STRUCTURES LABORATORY** **L T P C**
0 0 4 2

COURSE OBJECTIVES:

This laboratory course enables the students

- To get practical knowledge on calibration of photo elastic materials.
- To gain practical exposures on calculating shear centre locations for closed and open sections.
- To provide with the basic knowledge of fabricating a composite laminate.
- To have basic knowledge on unsymmetrical bending of beams.
- 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 incomposite laminates using a coustice mission
6. Non-destructive evaluation of defectsin composite laminates using ultrasonics.
7. Whirling of composites hafts
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 10 experiments will be conducted out of15.

COURSE OUTCOMES:

At the end of the course, students will be able

- **CO1:** To conduct tests and interpret data involving straingauges.
- **CO2:** To get exposureon experimental methods in photo elasticity.
- **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.

LABORATORYE QUIPMENTS REQUIRED

1. Electrical resistance straingauges installation kit.

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

23AEP222 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 acombination of these tasks.

23ANP223 COMPUTATIONAL LABORATORY L T P C
(Consists of FEM & CFD experiments) 0 0 4 2

COURSE OBJECTIVES:

1. This course is intended to make students familiar with differenttypes 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 acommercial software package

EXPERIMENTS IN FEM

LISTOF EXPERIMENTS:

1. Grid generation methods and geometry clean up techniques.
2. Static analysis of a uniform bar subject to different loads-1-Delement
3. Thermal stresses in a uniform and tapered member–1-Delement
4. Static analysis of trusses/frames under different loads
5. Stress analysis & deformation of a beam using 1-Delement & 2-D–in corporation of 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. Stabilityanalysis of a plate underin-plane loads
10. Buckling of solid and thin-walled columns under different end conditions
11. Free vibrationan alysis of a bar /beam
12. Force dresponse of a bar /beam under harmonic excitation
13. Heat transfer analysis using 1-D & 2-Delements–conduction and convection
14. Modelling and analysis of a laminated plate
15. Impact analysis of al aminated plate.
16. Minimum of 6 Experiments to be performed by using FEM Software tools

EXPERIMENTS IN CFD

LISTO FEXPERIMENTS:

a. Numerical simulation of 1-D diffusion and conduction in fluid flows
b. Numerical simulation of 1-D convection-diffusion problems
c. Numerical simulation of 2-D unsteady state heat conduction problem
d. Numerical simulation of 2-D diffusion and 1-D convection combined problems
e. Structured grid generation over air foil section 3-D numerical simulation of flow through CD nozzles
f. 3-D numerical simulation of flow development of a subsonic and supersonic jets
g. Numerical simulation of boundary layer development
h. Numerical simulation of subsonic combustion in a ram jet combustor
i. Numerical simulation of transonic flow over air foils

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 stabilityanalysis of structural components.
- **CO3:** To defineand 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.

LABORATORY EQUIPMENTS REQUIREMENTS

1. Desk top computers
2. MS visual C++
3. CFD software

23ECP201 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.

23ECP202 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.

23ECP211 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 Education, 2002 Frequency and Microwave Electronics", Pearson Education, 2002

23ECP212 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 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 classifer 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)

23ECP221 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

23EEP201 ANALYSIS OF ELECTRICAL DRIVES L T P C
3 1 0 4

OBJECTIVES:

- To understand steady state operation and transient dynamics of a motor load system
- To study and analyse the operation of the converter/chopperfed 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 fedinduction 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, component soft or que, 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 feedsback elements — Closed loop speed control — current and speed loops, P, PI and PID controllers —response comparison. Simulation of converter and chopper fed DCdrive

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–in jection of voltage in the rotor circuit–static scherbius drives – static and modified Kramer drives – sub-synchronous and super-synchronous speedoperation 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 HallInc., New Yersy, 1989
2. R.Krishnan,"Electric Motor Drives–Modeling, Analysis and Control", Prentice-Hall of India Pvt. Ltd.,New Delhi, 2010
3. BimalKBose, "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.,NewDelhi,2002.
3. P.C Sen"Thyristor DC Drives",John wiely and sons,NewYork,1981.

4. W.Leonhard,“Control of Electrical Drives”,Narosa Publishing House,1992.
5. MurphyJ.M.DandTurnbull,“Thyristor Control of AC Motors”,Pergamon Press.

23EEP202 SPECIAL ELECTRICAL MACHINES L T P C
3 0 0 3

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 DCmotors.
- To underst and 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-Sensorlessoperation 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 SYNCHROUNOUS 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 incomparison with radial flux machines and to know the principles of axial flux machines.

REFERENCES:

- Jacek F.Gieras, Dr.Rong-JieWang, Professor Maarten J.Kamper-Axial Flux Permanent Magnet Brushless Machines-Springer Netherlands(2008)
- Bilgin, Berker_Emadi, Ali_Jiang, James Weisheng-Switched reluctance motor drives: fundamentals to applications-CRC(2019)
- Ramu Krishnan-Permanent Magnet Synchronous and Brushless DC Motor Drives-CRC Press, Marcel Applications-CRC Press(2001)
- 6.T.Kenjo, 'Stepping motors and their micro processor controls', Oxford University press, NewDelhi, 2000 Dekker(2009)
- 4.T.J.E.Miller,'Brush less 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)

23EEP203 ELECTRIC VEHICLES AND POWER MANAGEMENT

L T P C
3 0 0 3

OBJECTIVES:

- To understand the concept of electric vehicles and its operations
- To present an over view 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 9

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 9

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 9

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-EVmotor sizing.

UNIT-IV BATTERY ENERGY STORAGE SYSTEM 9

Battery Basics - Different types - Battery Parameters – Battery life & safety impacts –Battery modeling – Design of battery for large vehicles.

UNIT-V ALTERNATIVE ENERGY STORAGE SYSTEMS 9

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 : 45 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. AliEmadi, MehrdadEhsani, JohnM.Miller, "Vehicular Electric Power Systems", Special Indian Edition, Marceldekker, Inc2010.
3. Mehrdad Ehsani, Yimin Gao, Sebastian E.Gay, AliEmadi, 'Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design',CRC Press, 2004.
4. C.C.Chanand K.T.Chau, 'Modern Electric Vehicle Technology', OXFORD University Press, 2001.
5. WieLiu, "Hybrid Electric Vehicle System Modeling and Control", Second Edition, John Wiley & Sons, 2017.

23EEP221 POWER ELECTRONICS AND DRIVES LABORATORY

L T P C
0 0 4 2

OBJECTIVES:

- To control the speed of DC motor-baseddrive 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 motordrive.
5. V/fcontrol of Three-Phase Induction motor.
6. Microcontroller 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 : 60 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 Micro controller and Digital signal processor.

REFERENCES:

- NedMohan, T.M.Undeland and W.PRobbin, “Power Electronics: converters, Application and design” JohnWiley and sons. Wiley India edition,2006
- RashidM.H., “Power Electronics Circuits, Devices and Applications",

Prentice Hal India, NewDelhi, 1995.
- BimalK Bose “Modern Power Electronics and AC Drives” Pearson Education, Second Edition, 2003.
- BinWu, Mehdi Narimani, “High Power Converters and AC Drives, Wiley Publishers, Second Edition, 2017.

23EEP222 DESIGN LABORATORY FOR POWERE LECTRONICS SYSTEMS

L T P C
0 0 4 2

OBJECTIVES:

- To design power converter after selecting the suitable component for typical applications
- To design non-isolated and isolated switching moderegulators
- To simulate analyse and test different switching moderegulators

LISTOFEXPERIMENTS:

1. Selection and Design of components (Inductor, Capacitor, transformers and devices) for power converters
2. Design and testing of Isolated converter design and verification (100W)
3. Design and testing of non-isolated converter design and verification (100W)
4. Mini Project Demonstration with applications

TOTAL : 60 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 conceptual basis required for design and testing of various
- **CO4:** Ability to interact with industry to take up problem of societal importance as mini project designed.
- **CO5:** Ability to compare different possible solution to the same practical problem.

23CSP201 ADVANCED SOFTWARE ENGINEERING L T P C
3 0 0 3

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 AND 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

REFERENCE BOOKS:

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

23CSP211 MULTICORE ARCHITECTURE AND GPU PROGRAMMING

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3	0	2	4

COURSE OBJECTIVES:

- To learn about the various parallel programming paradigms,
- To develop multicore programs and design parallel solutions.
- To understand the basics of GPU architectures
- To understand CPU GPU Program Partitioning
- To write programs for massively parallel processors

UNIT-I 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-II 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-III PARALLEL PROGRAM DEVELOPMENT 9

Case studies – n-Body solvers – Tree Search – OpenMP and MPI implementations and comparison.

UNIT-IV 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-V CUDA PROGRAMMING 9

Using CUDA - Multi GPU - Multi GPU Solutions - Optimizing CUDA Applications: Problem Decomposition, Memory Considerations, Transfers, Thread Usage, Resource Contentions.

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, students will be able to

- **CO1:** Write programs using OpenMP and MPI.
- **CO2:** Design parallel programming solutions to common problems.
- **CO3:** Compare and contrast programming for serial processors and programming for parallel processors.
- **CO4:** Describe GPU Architecture
- **CO5:** Write programs using CUDA, identify issues and debug them

REFERENCE BOOKS:

1. Michael J Quinn, "Parallel programming in C with MPI and OpenMP, Tata McGraw Hill,2003.
2. Victor Alessandrini, Shared Memory Application Programming, 1st Edition, Concepts and Strategies in Multicore Application Programming, Morgan Kaufmann, 2015.
3. Yan Solihin, Fundamentals of Parallel Multicore Architecture, CRC Press, 2015.
4. Shane Cook, CUDA Programming: "A Developer's Guide to Parallel Computing with GPUs (Applications of GPU Computing), First Edition, Morgan Kaufmann, 2012.
5. David R. Kaeli, Perhaad Mistry, Dana Schaa, Dong Ping Zhang,

"Heterogeneous computing with OpenCL, 3rd Edition, Morgan Kauffman, 2015.
6. Nicholas Wilt, "CUDA Handbook: A Comprehensive Guide to GPU Programming, Addison - Wesley, 2013.
7. Jason Sanders, Edward Kandrot, "CUDA by Example: An Introduction to General Purpose

23CSP212 INTERNET OF THINGS AND ITS APPLICATIONS 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 PROTOC 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

TOTAL: 75 PERIODS

SUGGESTED ACTIVITIES:

1. Develop an application for LED Blink and Pattern using Arduino or

RaspberryPi

2. Develop an application for LED Pattern with Push Button Control using Arduino or RaspberryPi
3. Develop an application for LM35 Temperature Sensor to display temperature values using arduino or RaspberryPi
4. Develop an application for Forest fire detection end node using Raspberry Pi device and sensor
5. Develop an application for home intrusion detection webapplication
6. Develop an application for Smart parking application using python and Django for web application

COURSE OUTCOME:

- **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

REFERENCES:

a. Arshdeep Bahga, Vijay Madisetti, Internet of Things: A hands-on approach, Universities Press, 2015
b. Dieter Uckelmann, Mark Harrison, Florian Michahelles (Eds), Architecting the Internet of Things, Springer, 2011
c. Peter Waher, 'Learning Internet of Things', Packt Publishing, 2015
d. Ovidiu Vermesan Peter Friess, 'Internet of Things – From Research and Innovation to Market Deployment', River Publishers, 2014
e. N. Ida, Sensors, Actuators and Their Interfaces: A Multidisciplinary Introduction, 2nd Edition Scitech Publishers, 202014

Reese, G. (2009). Cloud Application Architectures: Building Applications and Infrastructure in the Cloud. Sebastopol, CA: O'Reilly Media, Inc. (2009)

23CSP213 ADVANCED OPERATING SYSTEMS L T P C
3 0 2 4

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

Lab Exercises

1. Writing your own system calls
2. Scheduling/Resource Allocation
3. Concurrency and Synchronization
4. Multicore OS
5. File Systems (Distributed, Big Data and Internet)
6. Virtualization

Text Books :

1. Thomas Anderson and Michael Dahlin Operating Systems: Principles and Practice, 2nd Edition Recursive books (August 21, 2014), ISBN: 0985673524
2. Daniel P. Bovet & Marco Cesati Understanding the Linux Kernel (3rd edition) O'Reilly & Associates, November 2005. ISBN: 0596005652

Reference Books :

1. RemziArpaci-Dusseau and Andrea Arpaci-Dusseau Operating Systems: Three Easy Pieces Arpaci-Dusseau Books August, 2018 (Version 1.00)
2. Jonathan Corbet; Alessandro Rubini; Greg Kroah-Hartman Linux Device Drivers (3rd edition) O'Reilly & Associates, February 2005. ISBN-13: 978-0-596-00590-0
3. Robert Love Linux Kernel Development (3nd Edition) Addison-Wesley Professional, 2010. ISBN: 0672329468
4. Ellen Siever, Stephen Figgins, Robert Love, and Arnold Robbins Linux in a Nutshell, 6th Edition O'Reilly & Associates, September 2009. ISBN: 978-0-596-15448-6

TOTAL: 30 PERIODS

TOTAL:45+30=75PERIODS

COURSE OUTCOME:

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, Niranjan 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.

23CSP222 ADVANCED SOFTWARE ENGINEERING LABORATORY

L T P C
0 0 4 2

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 COCOCMOII 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.