KCG

COLLEGE OF TECHNOLOGY

AFFILIATED TO ANNA UNIVERSITY | AUTONOMOUS

REGULATIONS - 2023

CURRICULUM AND SYLLABI

(2023-2024)

B.E. MECHATRONICS ENGINEERING

KCG College of Technology was founded in 1998 to fulfill the Founder-Chairman, Dr. KCG Verghese's vision of **"To Make Every Man a Success and No Man a Failure".** It is a Christian minority institution, affiliated to Anna University (Autonomous), Chennai and approved by AICTE, New Delhi.

VISION OF KCG

KCG College of Technology aspires to become a globally recognized centre of excellence for science, technology & engineering education, committed to quality teaching, learning and research while ensuring for every student a unique educational experience which will promote leadership, job creation, social commitment and service to nation building.

MISSION OF KCG

- Disseminate knowledge in a rigorous and intellectually stimulating environment.
- Facilitate socially responsive research, innovation and entrepreneurship.
- Foster holistic development and professional competency.
- Nurture the virtue of service and an ethical value system in the young minds.

VISION OF MECHATRONICS ENGINEERING

The department aims to be recognised as a global centre of excellence with interdisciplinary approach for technical education, automation and research catering to the needs of industry and society.

MISSION OF MECHATRONICS ENGINEERING

Provide quality education in the field of Mechatronics engineering & related domains

- Impart high quality education in Mechatronics engineering
- Establish state of the art facilities for innovation research and consultancy.
- Mentor the students to develop research and entrepreneurial capabilities and contribute to the needs of industry and society.
- Inculcate an interdisciplinary approach to system design.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOS)

The graduates will:

PEO 1	Engage in product development and applications in the field of Automation and Mechatronics systems using tools to enhance productivity
PEO 2	Execute their knowledge of basic engineering sciences in Interdisciplinary systems
PEO 3	Take active leadership roles with societal and environmental implications accompanied by ethical behaviour and pursue life long learning in emerging technologies.

PROGRAM OUTCOMES (POs)

Engineering graduates will be able to:

PO 01	Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO 02	Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 03	Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO 04	Use research based knowledge and methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 05	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO 06	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO 07	Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 08	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 09	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadcast context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO 01	Apply their knowledge in basic sciences and mechatronic systems for solving complex problems
PSO 02	Design and program the mechatronic systems for industrial automation with embedded systems, PLC and control systems with MEMS, sensors and actuators
PSO 03	Engage in lifelong learning and follow ethics in their profession

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KCG COLLEGE OF TECHNOLOGY
AUTONOMOUS
REGULATIONS 2023
B.E–MECHATRONICS ENGINEERING
CHOICE BASED CREDIT SYSTEM
CURRICULUM FOR SEMESTERS I TO VIII

SEMESTER–I

Sl. No.	Course Code	Course Title	Category	Periods Per Week			Total Contact Periods	Credits
				L	T	P		
	23IP101	Induction Programme		-	-	-	-	-
THEORY								
1	23HS101	Essential Communication	HSMC	3	0	0	3	3
2	23MA101	Matrices and Calculus	BSC	3	0	0	3	3
3	23AD101	Programming in Python	ESC	3	0	0	3	3
4	23HS102	Heritage of Tamils	HSMC	1	0	0	1	1
THEORY AND PRACTICALS								
5	23PH111	Engineering Physics	BSC	3	0	2	5	4
6	23CY111	Engineering Chemistry	BSC	3	0	2	5	4
PRACTICALS								
7	23AD121	Python Programming Laboratory	ESC	0	0	4	4	2
8	23HS121	Communication Skills Laboratory	HSMC	0	0	2	2	1
9	23HS122	General Clubs / Technical Clubs / NCC / NSS / Extension Activities	HSMC	0	0	2	2	1*
TOTAL				16	0	12	28	21

*** The grades earned by the students will be recorded in the Mark Sheet. However, the same shall not be considered for the computation of CGPA**

SEMESTER –II

Sl. No.	Course code	Course Title	Category	Periods Per Week L	T	P	Total Contact Periods	Credits
THEORY								
1	23HS201/ 23HS202	Professional English/ Foreign language	HSMC	3	0	0	3	3
2	23MA203	Statistics and Numerical Methods	BSC	3	1	0	4	4
3	23PH202	Applied Material Science	BSC	3	0	0	3	3
4	23ME201	Applied Mechanics	PCC	3	0	0	3	3
5	23HS203	Tamils and Technology	HSMC	1	0	0	1	1
THEORY AND PRACTICALS								
6	23EE283	Basic Electrical, Electronics Engineering and Measurements	ESC	2	0	2	4	3
7	23ME211	Engineering Graphics	ESC	3	0	2	5	4
PRACTICALS								
8	23ME221	Engineering Practices Laboratory	PCC	0	0	4	4	2
9	23HS221	Soft Skills	EEC	0	0	2	2	1*
TOTAL				**18**	**1**	**10**	**29**	**23**

*** The grades earned by the students will be recorded in the Mark Sheet. However, the same shall not be considered for the computation of CGPA**

SEMESTER-III

Sl. No.	Course code	Course Title	Category	Periods Per Week L	T	P	Total Contact Periods	Credits
THEORY								
1	23MA302	Transforms and Partial Differential Equations	BSC	3	1	0	4	4
2	23MT301	Manufacturing Technology	PCC	3	0	0	3	3
3	23MT311	Electrical Drives and Actuators	PCC	3	0	0	3	3
4	23HS301	Universal Human Values and Ethics	HSMC	3	0	0	3	3
THEORY AND PRACTICALS								
5	23MT312	Digital Electronics and Microprocessor	PCC	3	0	2	5	4
6	23MT302	Kinematics and Dynamics of Machinery	PCC	3	0	2	5	4
PRACTICALS								
7	23MT321	Manufacturing Technology Laboratory	PCC	0	0	4	4	2
8	23MT322	Electrical Drives and Actuators Laboratory	PCC	0	0	4	4	2
9	23ES391	Presentation Skills	EEC	0	0	2	2	1*
TOTAL				18	0	14	33	25

*** The grades earned by the students will be recorded in the Mark Sheet. However, the same shall not be considered for the computation of CGPA**

SEMESTER-IV

Sl. No.	Course code	Course Title	Category	Periods Per Week			Total Contact Periods	Credits
				L	T	P		
THEORY								
1	23MA401	Optimization Techniques	BSC	3	1	0	4	4
2	23MT401	Sensors and Instrumentation	PCC	3	0	0	3	3
3	23MT402	Fluid Mechanics and Thermal Systems	PCC	3	0	0	3	3
4		Department Elective 1	DEC	3	0	0	3	3
5		Department Elective 2	DEC	3	0	0	3	3
THEORY AND PRACTICALS								
6	23CE412	Strength of Materials	PCC	3	0	2	5	4
PRACTICALS								
7	23MT421	Fluid Mechanics Laboratory	PCC	0	0	4	4	2
8	23MT422	Sensors and Instrumentation Laboratory	PCC	0	0	4	4	2
9	23ES491	Aptitude and Logical Reasoning -1	EEC	0	0	2	2	*1
10	23MT423/ 23MT424	In-plant Training / Mini Project – 1	EEC	0	0	2	2	1
TOTAL				18	1	14	33	25

SEMESTER-V

Sl. No.	Course Code	Course Title	Category	Periods Per Week L	T	P	Total Contact Periods	Credits
THEORY								
1	23RE501	Research Methodology and Intellectual Property Rights	ESC	2	0	0	2	2
2	23MT501	Robotics	PCC	3	0	0	3	3
3	23MT502	Mechatronics System Design	PCC	3	0	0	3	3
4		Non-Department Elective-1 (Emerging Technology)	NEC	3	0	0	3	3
THEORY AND PRACTICALS								
5	23EE511	Control System Engineering	PCC	3	0	2	5	4
6	23MT511	Computer Aided Design and Manufacturing System	PCC	3	0	2	5	4
PRACTICALS								
7	23MT521	Robotics Laboratory	PCC	0	0	4	4	2
8	23MT522/ 23MT523	Mini Project – 2 /In Plant Training -2	EEC	0	0	4	4	2
9	23ES591	Aptitude and Logical Reasoning - 2	EEC	0	0	2	2	1*
TOTAL				17	0	12	29	22

*** The grades earned by the students will be recorded in the Mark Sheet. However, the same shall not be considered for the computation of CGPA**

SEMESTER VI

Sl. No.	Course Code	Course Title	Category	Periods Per Week			Total Contact Periods	credits
				L	T	P		
THEORY								
1		Department Elective – 3	DEC	3	0	0	3	3
2		Department Elective – 4	DEC	3	0	0	3	3
3		Open Elective – 2 (Management / Safety Courses)	OEC	3	0	0	3	3
THEORY AND PRACTICALS								
4	23CE611	Environmental Science and Engineering	ESC	3	0	2	5	4
5	23MT611	Industrial Automation	PCC	3	0	2	5	4
6	23MT612	Fluid Power Systems	PCC	3	0	2	5	4
PRACTICALS								
7	23MT621	Project Work - Phase 1	EEC	0	0	4	4	2
8	23MT622	Technical Training	EEC	0	0	2	2	1
TOTAL				**18**	**0**	**14**	**32**	**24**

SEMESTER -VII

Sl. No.	Course Code	Course Title	Category	periods Per Week L	T	P	Total Contact Periods	Credits
THEORY								
1		Open Elective - 3 (Management Courses)	OEC	3	0	0	3	3
2		Department Elective 5	DEC	3	0	0	3	3
3		Department Elective 6	DEC	3	0	0	3	3
THEORY AND PRACTICALS (INTEGRATED COURSE)								
4	23MT711	Machine Vision Systems	PCC	3	0	2	5	4
5	23MT712	Embedded Systems and Programming	PCC	3	0	2	5	4
PRACTICALS								
6	23MT721	Project Work Phase -2	EEC	0	0	6	6	3
7	23MT722	Technical Seminar	ESC	0	0	4	4	1
TOTAL				15	0	12	29	18

SEMESTER -VIII

Sl. No.	Course code	Course Title	Category	Periods Per Week L	T	P	Total Contact Periods	Credits
PRACTICALS								
1	23MT821 / 23MT822	Capstone Project / Internship cum Project	EEC	0	0	20	20	10
TOTAL				0	0	20	20	10

TOTALCREDITS: 172

DEPARTMENT ELECTIVE COURSES: VERTICALS

VERTICAL 1: APPLIED ROBOTICS

Sl. No.	Course Code	Course Title	Category	Periods Per Week			Total Contact periods	Credits
				L	T	P		
1	23MT031	Robots and Systems in Smart Manufacturing	DEC	3	0	0	3	3
2	23AE069	Drone Technologies	DEC	3	0	0	3	3
3	23MT032	Microrobotics	DEC	3	0	0	3	3
4	23MT033	Agricultural Robotics and Automation	DEC	3	0	0	3	3
5	23MT034	Collaborative Robotics	DEC	3	0	0	3	3
6	23MT035	Robot Operating Systems	DEC	3	0	0	3	3
7	23MT036	Medical Robotics	DEC	3	0	0	3	3
8	23MT037	Humanoid Robotics	DEC	3	0	0	3	3

VERTICAL 2 : DESIGN AND MANUFACTURING

Sl. No.	Course Code	Course Title	Category	Periods Per Week			Total Contact periods	Credits
				L	T	P		
1	23MT038	Design of Machine Elements and Robot Grippers	DEC	3	0	0	3	3
2	23MT039	Design for X	DEC	3	0	0	3	3
3	23MT040	CNC Machine Tools and Programming	DEC	3	0	0	3	3
4	23MT041	Computer Integrated Manufacturing	DEC	3	0	0	3	3
5	23MT042	Advanced Manufacturing Systems	DEC	3	0	0	3	3
6	23ME031	Additive Manufacturing	DEC	3	0	0	3	3
7	23MT043	Electronics Manufacturing Technology	DEC	3	0	0	3	3
8	23MT044	Computer Aided Inspection and Testing	DEC	3	0	0	3	3

VERTICAL 3 : SMART MOBILITY SYSTEMS

Sl. No.	Course Code	Course Title	Category	Periods Per Week			Total Contact periods	Credits
				L	T	P		
1	23MT045	Automotive Mechatronics	DEC	3	0	0	3	3
2	23MT046	Electric and Hybrid Vehicles	DEC	3	0	0	3	3
3	23MT047	Automobile Engineering	DEC	3	0	0	3	3
4	23MT048	Automotive System Modeling and Simulation	DEC	3	0	0	3	3
5	23MT049	Vehicle Dynamics and Controls	DEC	3	0	0	3	3
6	23MT050	Aircraft Mechatronics	DEC	3	0	0	3	3
7	23MT051	Smart Mobility and Intelligent Vehicles	DEC	3	0	0	3	3
8	23MT052	Advanced Driver Assistance Systems	DEC	3	0	0	3	3

VERTICAL 4 : INTELLIGENCE SYSTEMS

Sl. No.	Course Code	Course Title	Category	Periods Per Week			Total Contact periods	Credits
				L	T	P		
1	23MT053	Applied Signal Processing	DEC	3	0	0	3	3
2	23MT054	Applied Image Processing	DEC	3	0	0	3	3
3	23MT055	Machine Learning for Intelligent Systems	DEC	3	0	0	3	3
4	23MT056	Condition Monitoring and Fault Diagnostics	DEC	3	0	0	3	3
5	23MT057	Systems Modelling and Simulation Methods	DEC	3	0	0	3	3
6	23MT058	Fundamentals of UAV systems	DEC	3	0	0	3	3
7	23MT059	Immersive Technologies and Haptics	DEC	3	0	0	3	3
8	23MT060	Computer Vision and Deep Learning	DEC	3	0	0	3	3

VERTICAL 5 : AUTOMATION

Sl. No.	Course Code	Course Title	Category	Periods Per Week L	T	P	Total Contact periods	Credits
1	23MT061	Micro Electro Mechanical Systems	DEC	3	0	0	3	3
2	23EE501	Power Electronics	DEC	3	0	0	3	3
3	23CS404	Computer Architecture	DEC	3	0	0	3	3
4	23MT062	Virtual Instrumentation	DEC	3	0	0	3	3
5	23MT063	Industrial Network Protocols	DEC	3	0	0	3	3
6	23MT064	Motion Control System	DEC	3	0	0	3	3
7	23MT065	Total Integrated Automation	DEC	3	0	0	3	3
8	23ME061	Digital Twin and Industry 5.0	DEC	3	0	0	3	3

VERTICAL 6 : DIVERSIFIED GROUP

Sl. No.	Course Code	Course Title	Category	Periods Per Week			Total Contact periods	Credits
				L	T	P		
1	23MT066	Foundations of Linear Integrated Circuits	DEC	3	0	0	3	3
2	23MT067	Single Board Computers	DEC	3	0	0	3	3
3	23MT068	Reliability and Maintenance Engineering	DEC	3	0	0	3	3
4	23MT069	Medical Mechatronics	DEC	3	0	0	3	3
5	23MT070	Integrated Product Development	DEC	3	0	0	3	3
6	23AD301	Object Oriented Programming in C++ and Java	DEC	3	0	0	3	3
7	23ME035	Process Planning and Cost Estimation	DEC	3	0	0	3	3
8	23MT071	VLSI and FPGA	DEC	3	0	0	3	3

OPEN ELECTIVE – EMERGING TECHNOLOGIES

Sl. No.	Course Code	Course Title	Category	Periods Per Week			Total Contact periods	Credits
				L	T	P		
1	23OAD971	Artificial Intelligence and Machine Learning Fundamentals	OEC	3	0	0	3	3
2	23OCS971	Augmented Reality and Virtual Reality	OEC	3	0	0	3	3
3	23OCS972	Data Science and Fundamentals	OEC	3	0	0	3	3
4	23OEC971	IoT Concepts and Applications	OEC	3	0	0	3	3
5	23OEE971	Renewable Energy Technologies	OEC	3	0	0	3	3
6	23OEE973	Electric and Hybrid Vehicles	OEC	3	0	0	3	3
7	23OIT971	Block Chain Technology	OEC	3	0	0	3	3
8	23OME972	Introduction to Non-Destructive Testing	OEC	3	0	0	3	3
9	23OPH971	Resource Management Techniques	OEC	3	0	0	3	3
10	23OPH971	Quantum Technology	OEC	3	0	0	3	3
11	23OPH972	Nanotechnology	OEC	3	0	0	3	3

OPEN ELECTIVE – MANAGEMENT COURSES

Sl. No.	Course Code	Course Title	Category	Periods Per Week			Total Contact Periods	Credits
				L	T	P		
1	23OMG971	Total Quality Management	OEC	3	0	0	3	3
2	23OMG972	Engineering Economics and Financial Accounting	OEC	3	0	0	3	3
3	23OMG973	Engineering Management and Law	OEC	3	0	0	3	3
4	23OMG974	Knowledge Management	OEC	3	0	0	3	3
5	23OMG975	Industrial Management	OEC	3	0	0	3	3
6	23OMG976	Entrepreneurship and Business Opportunities	OEC	3	0	0	3	3
7	23OMG977	Modern Business Administration and Financing	OEC	3	0	0	3	3
8	23OMG978	Essentials of Management	OEC	3	0	0	3	3

OPEN ELECTIVE – SAFETY RELATED COURSES

Sl. No.	Course Code	Course Title	Category	Periods Per Week			Total Contact Periods	Credits
				L	T	P		
1	23OAU981	Automotive Safety	OEC	3	0	0	3	3
2	23OCE981	Disaster Management	OEC	3	0	0	3	3
3	23OME981	Industrial Safety	OEC	3	0	0	3	3

SEMESTER-WISE CREDIT DISTRIBUTION

SEMESTER	HSMC	BSC	ESC	PCC	DEC	OEC	EEC	Total
Semester I	**4**	**11**	**5**				**1**	**21**
Semester II	**4**	**7**	**9**	**3**				**23**
Semester III	**3**	**4**		**18**				**25**
Semester IV		**4**		**14**	**6**		**1**	**25**
Semester V			**2**	**16**		**3**	**2**	**23**
Semester VI			**4**	**8**	**6**	**3**	**3**	**24**
Semester VII			**1**	**8**	**6**	**3**	**3**	**21**
Semester VIII							**10**	**10**
Total	**11**	**26**	**21**	**67**	**18**	**9**	**20**	**172**

SEMESTER –I

23IP101	INDUCTION PROGRAMME	L	T	P	C
		-	-	-	0

COURSE OBJECTIVES:

- This is a mandatory 2 weeks Programme to be conducted as soon as the students enter the institution. Normal classes start only after the induction program is over.
- The induction Programme has been introduced by AICTE with the following objectives
- Engineering colleges were established to train graduates well in the branch/department of admission, have a holistic outlook, and have a desire to work for national needs and beyond. The graduating student must have knowledge and skills in the area of his/her study. However, he/she must also have broad understanding of society and relationships. Character needs to be nurtured as an essential quality by which he/she would understand and fulfill his/her responsibility as an engineer, a citizen and a human being. Besides the above, several meta-skills and underlying values are needed.
- One will have to work closely with the newly joined students in making them feel comfortable, allow them to explore their academic interests and activities, reduce competition and make them work for excellence, promote bonding within them, build relations between teachers and students, give a broader view of life, and build character
- Hence, the purpose of this Programme is to make the

students feel comfortable in their new environment, open them up, set a healthy daily routine, create bonding in the batch as well as between faculty and students, develop awareness, sensitivity and understanding of the self, people around them, society at large, and nature • **Physical Activity** This would involve a daily routine of physical activity with games and sports, yoga, gardening, etc., • **Life skills** Every student would choose one skill related to daily needs such as stitching, accounting, finance management, etc.,
Universal human values
This is the anchoring activity of the Induction Programme. It gets the student to explore oneself and allows one to experience the joy of learning, stand up to peer pressure, take decisions with courage, be aware of relationships with colleagues and supporting stay in the hostel and department, be sensitive to others, etc. A module in Universal Human Values provides the base. Methodology of teaching this content is extremely important. It must not be through dos and don'ts, but get students to explore and think by engaging them in a dialogue. It is best taught through group discussions and real-life activities rather than lecturing.
Club Activity
Students will be introduced to more than 20 Clubs available in the college-both technical and non-technical. The student can choose as to which club the student will enroll in.

Value Based Communication
This module will focus on improving the communication skills of students
Lectures by Alumni
Lectures by alumni are arranged to bring in a sense of belonging to the student towards the institution and also to inspire them to perform better
Visits to Local Area
A couple of visits to the landmarks of the city, or a hospital or orphanage could be organized. This would familiarize them with the area as well as expose them to the under privileged
Familiarization to Dept./Branch & Innovations
They should be told about what getting into a branch or department means what role it plays in society, through its technology. They should also be shown the laboratories, workshops & other facilities
Address by different heads
Heads of Placement, Training, Student affairs, counsellor, etc would be interacting with the students to introduce them to various measures taken in the institution for the betterment of students.
Induction Programme is totally an activity-based Programme and therefore there shall be no tests / assessments during this Programme.
REFERENCES:
Guide to Induction program from AICTE

<table>
<tr><td rowspan="2">23HS101</td><td rowspan="2">ESSENTIAL COMMUNICATION</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="6">COURSE OBJECTIVES:</td></tr>
<tr><td colspan="6">• To help learners extract information from short and simple correspondence
• To familiarize learners with different text structures by engaging them in reading, writing and grammar learning activities
• To help learners write coherent, short paragraphs and essays
• To enable learners to use language efficiently while expressing their opinions via various media.</td></tr>
<tr><td>UNIT I</td><td colspan="4">FORMATION OF SENTENCES</td><td>9</td></tr>
<tr><td colspan="6">Reading- Read pictures-notices- short comprehension passages and recognize main ideas and specific details. Writing- framing simple and compound sentences, completing sentences, developing hints, writing text messages. Language development- Parts of Speech, Wh- Questions, yes or no questions, direct and indirect questions. Vocabulary development– prefixes- suffixes- articles – countable and uncountable nouns</td></tr>
<tr><td>UNIT II</td><td colspan="4">NARRATION AND DESCRIPTION</td><td>9</td></tr>
<tr><td colspan="6">Reading – Read short narratives and descriptions from newspapers, dialogues and conversations. Reading strategies and practices. Language development – Tenses- simple present, present continuous, present perfect, simple past, past continuous, past perfect, simple future, future continuous, past participle, pronouns. Vocabulary development- guessing meanings of words in context. Writing – Write short narrative paragraphs, biographies of friends/relatives - writing- topic sentence- main ideas- free writing, short narrative descriptions using some suggested vocabulary and structures.</td></tr>
</table>

UNIT III	**COMPARING AND CONTRASTING**	**9**
Reading- short texts and long texts -understanding different types of text structures, -coherence-jumbled sentences. Language development- degrees of comparison, concord- Vocabulary development – single word substitutes- discourse markers- use of reference words Writing - comparative and contrast paragraphs writing- topic sentence- main idea, free writing, compare and contrast using some suggested vocabulary and structures.		
UNIT IV	**SOCIAL MEDIA COMMUNICATION**	**9**
Reading- Reading blogs, social media reviews, posts, comments, process description, Language development - relative clause, Vocabulary development- social media terms-words, abbreviations and acronyms Writing- -e-mail writing-conventions of personal email, descriptions for simple processes, critical online reviews, blog, website posts, commenting to posts.		
UNIT V	**ESSAY WRITING**	**9**
Reading- Close reading non-technical longer texts Language development - modal verbs, phrasal verbs- Vocabulary development - collocation. Writing- Writing short essays-brainstorming – developing an outline- identifying main and subordinate ideas.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
	After completion of the course, the students will be able to:
CO1:	Summarize simple, level-appropriate texts of around 300 words recognizing main ideas and specific details.
CO2:	Demonstrate the understanding of more complex grammatical structures and diction while reading and writing.

CO3:	Use appropriate expressions to describe, compare and contrast people, things, situations etc., in writing.
CO4:	Establish the ability to communicate effectively through emails.
CO5:	Determine the language use appropriate for different social media platforms.
CO6:	Use appropriate expressions for narrative descriptions and process descriptions.
TEXT BOOKS:	
1	Susan Proctor, Jack C. Richards, Jonathan Hull. Interchange Level 2. Cambridge University Press and Assessment
2	Susan Proctor, Jack C. Richards, Jonathan Hull. Interchange Level 3. Cambridge University Press and Assessment
REFERENCES:	
1	Dutt P. Kiranmai and Rajeevan Geeta. Basic Communication Skills, Foundation Books: 2013
2	Means,L. Thomas and Elaine Langlois. English & Communication for Colleges. Cengage Learning , USA: 2007

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	-	-	-	-	-	2	3	-	2	3	-	3	-	-	-
2	-	-	-	-	-	-	-	-	3	3	-	3	-	-	-
3	-	-	-	-	-	3	3	-	3	3	-	3	-	-	-
4	-	-	-	-	-	-	-	-	-	3	-	3	-	-	-
5	-	-	-	-	-	3	3	-	3	3	-	3	-	-	-
6	-	-	-	-	-	3	3	-	3	3	-	3	-	-	-
Overall Correlation	-	-	-	-	-	2	2	-	3	3	-	3	-	-	-

Recommended by Board of Studies	**02-08-2023**		
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23MA101	MATRICES AND CALCULUS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To develop the use of matrix algebra techniques that is needed by engineers for practical applications.
- To familiarize the students with differential calculus.
- To familiarize the student with functions of several variables. This is needed in many branches of engineering.
- To make the students understand various techniques of integration.
- To acquaint the student with mathematical tools needed in evaluating multiple integrals and their applications

UNIT I	MATRICES	9

Eigenvalues and Eigenvectors of a real matrix – Characteristic equation – Properties of Eigenvalues and Eigenvectors – Cayley - Hamilton theorem – Diagonalization of matrices by orthogonal transformation – Reduction of a quadratic form to canonical form by orthogonal transformation – Nature of quadratic forms – Applications: Stretching of an elastic membrane.

UNIT II	DIFFERENTIAL CALCULUS	9

Representation of functions - Limit of a function - Continuity - Derivatives - Differentiation rules (sum, product, quotient, chain rules) - Implicit differentiation - Logarithmic differentiation - Applications : Maxima and Minima of functions of one variable.

UNIT III	FUNCTIONS OF SEVERAL VARIABLES	9

Partial differentiation – Homogeneous functions and Euler's theorem – Total derivative – Change of variables – Jacobians – Partial differentiation of implicit functions – Taylor's series for functions of two variables – Applications: Maxima and minima of functions of two variables and Lagrange's method of undetermined multiplier.

UNIT IV	INTEGRAL CALCULUS	9

Definite and Indefinite integrals - Substitution rule - Techniques of

Integration: Integration by parts, Trigonometric integrals, Trigonometric substitutions, Integration of rational functions by partial fraction, Integration of irrational functions - Improper integrals.		
UNIT V	**MULTIPLE INTEGRALS**	**9**
Double integrals – Change of order of integration – Double integrals in polar coordinates – Area enclosed by plane curves – Triple integrals – Volume of solids – Change of variables in double and triple integrals.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Apply the matrix algebra techniques and applications in Engineering Problems.
CO2:	Make use of the concept of limits and rules of differentiation to differentiate functions
CO3:	Find the derivative of functions of several variables
CO4:	Examine the application of partial derivatives
CO5:	Compute integrals by different techniques of Integration.
CO6:	Apply the concept of integration to compute multiple integrals.
TEXT BOOKS:	
1	Kreyszig. E, "Advanced Engineering Mathematics", John Wiley and Sons, 10th Edition, New Delhi, 2016.
2	James Stewart, "Calculus: Early Transcendentals", Cengage Learning, 8th Edition, New Delhi, 2015.
REFERENCES:	
1	Dr.P.Sivaramakrishnadas, Dr.C.Vijayakumari., — Matrices and Calculus‖ Pearson Publications Andrews. L.C and Shivamoggi. B, "Integral Transforms for Engineers" SPIE Press, 1999.
2	Anton. H, Bivens. I and Davis. S, " Calculus ", Wiley, 10th Edition, 2016

3	Bali. N., Goyal. M. and Watkins. C., —Advanced Engineering Mathematics‖, Firewall Media (An imprint of Lakshmi Publications Pvt., Ltd.,), New Delhi, 7th Edition, 2009.
4	Narayanan. S. and Manicavachagom Pillai.T. K., —Calculus" Volume I and II, S. Viswanathan Publishers Pvt. Ltd., Chennai, 2009.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
2	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
3	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
4	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
5	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
6	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
Overall Correlation	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-

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23AD101	PROGRAMMING IN PYTHON	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To know the basics of Programming.
- To convert an algorithm into a Python program.
- To construct Python programs with control structures.
- To structure a Python Program as a set of functions.
- To use Python data structures-lists, tuples, dictionaries and files.

UNIT I	COMPUTATIONAL THINKING	9

Introduction to Computing and Problem Solving: Fundamentals of Computing –Computing Devices – Identification of Computational Problems – Pseudo Code and Flowcharts – Instructions – Algorithms – Building Blocks of Algorithms (statements, state, control flow, functions), notation (pseudo code, flow chart, programming language), algorithmic problem solving, simple strategies for developing algorithms (iteration, recursion).

UNIT II	INTRODUCTION TO PYTHON	9

Introduction to Python Programming: Python Interpreter and Interactive Mode– Variables and Identifiers – Arithmetic Operators – Values and Types – Statements, Reading Input, Print Output, Type Conversions, type () Function and Is Operator, Dynamic and Strongly Typed Language. Control Flow Statements: if, if…else, if…elif…else Decision Control Statements, Nested if Statement, while Loop, for Loop, continue and break Statements.

UNIT III	FUNCTIONS AND STRINGS	9

Functions: Built-In Functions, Commonly Used Modules, Function Definition and Calling the Function, The return Statement and void Function, Scope and Lifetime of Variables, Default Parameters, Keyword Arguments, *args and **kwargs, Command Line Arguments. Strings: Creating and Storing Strings, Basic String Operations, Accessing Characters in String by Index Number, String Slicing and Joining, String Methods, Formatting Strings.

UNIT IV	LISTS, TUPLES, DICTIONARIES AND FILES	9
Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list Parameters; Tuples: tuple assignment, tuple as return value; Dictionaries: operations and methods; advanced list processing - list comprehension. Files and exception: text files, reading and writing files, format operator; command line arguments, errors and exceptions, handling exceptions, modules, packages.		
UNIT V	**OBJECT-ORIENTED AND FUNCTIONAL PROGRAMMING**	**9**
Object-Oriented Programming: Classes and Objects, Creating Classes in Python,Creating Objects in Python, The Constructor Method, Classes with Multiple Objects, Class Attributes versus Data Attributes, Encapsulation, Inheritance, Polymorphism. Functional Programming: Lambda. Iterators, Generators, List Comprehensions.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Develop algorithmic solutions to simple computational problems.
CO2:	Develop and execute simple Python programs using Control Statements
CO3:	Develop simple Python programs for solving problems using Functions and Strings
CO4:	Build a Python program using lists, tuples, dictionaries and files.
CO5:	Construct a code related to Object-Oriented.
CO6:	Construct a code related to Functional Programming.

TEXT BOOKS:	
1	Allen B. Downey, ``Think Python: How to Think Like a Computer Scientist'', 2nd edition, Updated for Python 3, Shroff/O'Reilly Publishers, 2016 (http://greenteapress.com/wp/think- python/).

2	Karl Beecher, “Computational Thinking: A Beginner's Guide to Problem Solving and Programming”, 1st Edition, BCS Learning & Development Limited, 2017.
REFERENCES:	
1	Learning To Program with Python. Richard L. Halterman. Copyright © 2011
2	Python for Everybody, Exploring Data Using Python 3. Dr. Charles R. Severance. 2016.
3	Paul Deitel and Harvey Deitel, “Python for Programmers”, Pearson Education, 1st Edition, 2021.
4	G Venkatesh and Madhavan Mukund, “Computational Thinking: A Primer for Programmers and Data Scientists”, 1st Edition, Notion Press, 2021.
5	John V Guttag, "Introduction to Computation and Programming Using Python: With Applications to Computational Modeling and Understanding Data“, Third Edition, MIT Press , 2021
6	Eric Matthes, “Python Crash Course, A Hands - on Project Based Introduction to Programming”, 2nd Edition, No Starch Press, 2019.
7	https://www.python.org/
8	Martin C. Brown, “Python: The Complete Reference”, 4th Edition, Mc-Graw Hill, 2018.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	1	1	1	-	-	-	-	1	3	1	-
2	3	2	1	1	1	-	-	-	-	-	-	1	3	1	-
3	3	2	1	1	1	-	-	-	-	-	-	1	3	1	-
4	3	2	1	1	1	-	-	-	-	-	-	1	3	1	-
5	3	2	1	1	1	-	-	-	-	-	-	1	3	1	-
6	3	2	1	1	1	-	-	1	1	1	1	1	3	1	1
Overall Correlation	**3**	**2**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**3**	**1**	**1**

Recommended by Board of Studies	**02-08-2023**		
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23HS102	HERITAGE OF TAMILS	L	T	P	C
		1	0	0	1
COURSE OBJECTIVES:					
• Explain the classical literature of Tamil and highlight notable Tamil poets. • Explain the creation of traditional Tamil musical instruments. • Explain the sports and games associated with Tamil heritage. • Explore the education and literacy practices during the Sangam period. • Explain the contributions of Tamils to the Indian freedom struggle. • Explain the development and history of printing in Tamil Nadu.					
UNIT I	**LANGUAGE AND LITERATURE**				**3**
Language Families in India – Dravidian Languages – Tamil as a Classical Language – Classical Literature in Tamil – Secular Nature of Sangam Literature – Distributive Justice in Sangam Literature – Management Principles in Thirukural – Tamil Epics and Impact of Buddhism & Jainism in Tamil Land – Bakthi Literature Azhwars and Nayanmars – Forms of minor Poetry – Development of Modern literature in Tamil – Contribution of Bharathiyar and Bharathidhasan.					
UNIT II	**HERITAGE – ROCK ART PAINTINGS TO MODERN ART – SCULPTURE**				**3**
Hero stone to modern sculpture – Bronze icons – Tribes and their handicrafts – Art of temple car making – – Massive Terracotta sculptures, Village deities, Thiruvalluvar Statue at Kanyakumari, Making of musical instruments – Mridhangam, Parai, Veenai, Yazh and Nadhaswaram – Role of Temples in Social and Economic Life of Tamils.					

UNIT III	**FOLK AND MARTIAL ARTS**	**3**
Therukoothu, Karagattam, Villu Pattu, Kaniyan Koothu, Oyillattam, Leatherpuppetry, Silambattam, Valari, Tiger dance – Sports and Games of Tamils.		
UNIT IV	**THINAI CONCEPT OF TAMILS**	**3**
Flora and Fauna of Tamils & Aham and Puram Concept from Tholkappiyam and Sangam Literature – Aram Concept of Tamils – Education and Literacy during Sangam Age – Ancient Cities and Ports of Sangam Age – Export and Import during Sangam Age – Overseas Conquest of Cholas		
UNIT V	**CONTRIBUTION OF TAMILS TO INDIAN NATIONAL MOVEMENT AND INDIAN CULTURE**	**3**
Contribution of Tamils to Indian Freedom Struggle – The Cultural Influence of Tamils over the other parts of India – Self-Respect Movement – Role of Siddha Medicine in Indigenous Systems of Medicine – Inscriptions & Manuscripts – Print History of Tamil Books.		
		TOTAL: 15 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Explain the evolution of Tamil language and literature, focusing on its cultural, ethical, and secular themes.
CO2:	Outline the making of musical instruments related to Tamil heritage.
CO3:	Discuss the sports and games of Tamils
CO4:	Explain the education and literacy during Sangam age.
CO5:	Express the importance and contribution of Tamils to Indian Freedom Struggle
CO6:	Outline the print history of books in Tamil Nadu

TEXT BOOKS:	
1	தமிழக வரலாறு-மக்களும் பண்பாடும்-கே.கேபிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2	கணினித்தமிழ் – முனைவர் இல. சுந்தரம் (விகடன் பிரசுரம்).
REFERENCES:	
1	**கீழடி- வைகை நதிக்கரையில் சங்க கால நகர நாகரிகம்** (**தொல்லியல் துறை வெளியீடு)**
2	பொருனை- ஆற்றங்கரை **நாகரிகம்** (**தொல்லியல் துறை வெளியீடு)**

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	-	-	-	-	-	2	2	-	-	-	-	-	-	-	-
2	-	-	-	-	-	2	2	-	-	-	-	-	-	-	-
3	-	-	-	-	-	2	2	-	-	-	-	-	-	-	-
4	-	-	-	-	-	2	2	-	-	-	-	-	-	-	-
5	-	-	-	-	-	2	2	-	-	-	-	-	-	-	-
6	-	-	-	-	-	2	2	-	-	-	-	-	-	-	-
Overall Correlation		-	-	-	-	2	2	-	-	-	-	-	-	-	-

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<table>
<tr><td rowspan="2">23PH111</td><td rowspan="2">ENGINEERING PHYSICS</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>2</td><td>4</td></tr>
<tr><td colspan="6">COURSE OBJECTIVES:</td></tr>
<tr><td colspan="6">
To make the students effectively achieve an understanding of mechanics.
To enable the students to gain knowledge of electromagnetic waves and its applications.
To introduce the basics of optics and lasers.
To equip the students successfully understand the importance of quantum physics.
To motivate the students towards the applications of quantum mechanics.
</td></tr>
<tr><td>UNIT I</td><td colspan="4">MECHANICS</td><td>9</td></tr>
<tr><td colspan="6">Types of stress, Stress-strain diagram and its uses- factors affecting elastic modulus- tensile strength- Bending of beams, bending moment – theory and experiment: Uniform and non-uniform bending, Center of mass (CM) – CM of continuous bodies –rod, motion of the CM. Rotation of rigid bodies: Rotational kinematics – rotational kinetic energy and moment of inertia - theorems of M .I –moment of inertia of rod, disc, solid sphere – M.I of a diatomic molecule - torque -rotational energy state of a rigid diatomic molecule – M.I of disc by torsional pendulum</td></tr>
<tr><td>UNIT II</td><td colspan="4">ELECTROMAGNETIC WAVES</td><td>9</td></tr>
<tr><td colspan="6">Concept of field-introduction to gradient, divergence and curl of field – Stokes theorem (No proof)-Gauss divergence theorem (No proof) - The Maxwell's equations in integral form and differential form - wave equation; Plane electromagnetic waves in vacuum - properties of electromagnetic waves: speed, amplitude, phase, orientation and waves in matter - Energy and momentum in EM waves-Poynting's vector - Cell-phone reception.</td></tr>
<tr><td>UNIT III</td><td colspan="4">OPTICS AND LASERS</td><td>9</td></tr>
<tr><td colspan="6">Reflection and refraction of light waves - total internal reflection –</td></tr>
</table>

types of optical fiber, Numerical Aperture and acceptance angle - interference –Theory of air wedge and experiment. Theory of laser - characteristics - Spontaneous and stimulated emission - Einstein's coefficients(Qualitative) - population inversion - CO2 laser, semiconductor laser (Homo junction) - Applications of lasers in industry.		
UNIT IV	**BASIC QUANTUM MECHANICS**	**9**
Photons and light waves - Electrons and matter waves –Compton effect - The Schrodinger equation (Time dependent and time independent forms) - meaning of wave function - Normalization – Free particle - particle in a infinite potential well: 1D,2D and 3D Boxes- Normalization, probabilities and the correspondence principle.		
UNIT V	**ADVANCED QUANTUM MECHANICS**	**9**
The harmonic oscillator(qualitative)- Barrier penetration and quantum tunneling(qualitative)- Tunneling microscope - Resonant diode - Finite potential wells (qualitative)- Bloch's theorem for particles in a periodic potential –Basics of Kronig-Penney model and origin of energy bands.		
TOTAL: 45 PERIODS		
PRACTICAL EXERCISES: (Any Seven Experiments)		
1. Torsional pendulum - Determination of rigidity modulus of wire and moment of inertia of regular and irregular objects 2. Simple harmonic oscillations of cantilever 3. Non-uniform bending- Determination of Young's modulus 4. Uniform bending–Determination of Young's modulus 5. Laser-Determination of the wavelength of the laser using grating 6. Airwedge- Determination of thickness of a thinsheet /wire		

7. a) Optical fibre-Determination of Numerical Aperture and acceptance angle b) Compact disc-Determination of width of the groove using laser. 8. Acoustic grating-Determination of velocity of ultrasonic waves in liquids. 9. Ultrasonic interferometer–determination of the velocity of sound and compressibility of liquids 10. Post office box-Determination of Band gap of a semiconductor. 11. Photoelectric effect 12. Michelson Interferometer. 13. Melde's string experiment 14. Experiment with lattice dynamics kit.	
TOTAL: 30 PERIODS	
COURSE OUTCOMES:	
	After completion of the course, the students will be able to:
CO1:	Determine the mechanical properties of materials.
CO2:	Apply the principles of electromagnetic waves to real world system.
CO3:	Determine the thickness of thin wire and the characteristic parameter of an optical fiber.
CO4:	Apply the principles of lasers to real world application.
CO5:	Organize the quantum mechanical properties of particles and waves.
CO6:	Utilize the quantum mechanical principles towards the formation of energy bands.
TEXT BOOKS:	
1	D.Kleppner and R.Kolenkow, "An Introduction to Mechanics", McGraw Hill Education (Indian Edition), 2017.
2	Arthur Beiser, Shobhit Mahajan, S. Rai Choudhury, "Concepts of Modern Physics", McGraw-Hill (Indian Edition), 2017.

REFERENCES:	
1	R.Wolfson," Essential University Physics", Volume 1 & 2. Pearson Education (Indian Edition), 2009.
2	Paul A. Tipler, "Physic – Volume 1 & 2", CBS, (Indian Edition), 2004.
3	K.Thyagarajan and A.Ghatak,"Lasers: Fundamentals and Applications," Laxmi Publications, (Indian Edition), 2019.
4	D.Halliday, R.Resnick and J.Walker, "Principles of Physics", Wiley (Indian Edition), 2015.
5	N.Garcia, A.Damask and S.Schwarz, "Physics for Computer Science Students",Springer Verlag, 2016.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
2	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
3	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
4	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
5	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
6	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
Overall Correlation	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-

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<table>
<tr><td rowspan="2">23AD121</td><td rowspan="2">PYTHON PROGRAMMING LABORATORY</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>0</td><td>0</td><td>4</td><td>2</td></tr>
<tr><td colspan="6">COURSE OBJECTIVES:</td></tr>
<tr><td colspan="6">The main objective of this laboratory is to put into practice computational thinking. The students will be expected to write, compile, run and debug Python programs to demonstrate the usage of:
• Operators and Conditional Statements
• Control Structures and Functions (both recursive and iterative) and Recursion.
• String functions
• Lists, Sets, Dictionaries, Tuples and Files.
• Object-Oriented Programming</td></tr>
<tr><td>Exercise 1</td><td colspan="5">Programs to demonstrate the usage of operators and conditional statements.</td></tr>
<tr><td colspan="6">1. Write a program that takes two integers as command line arguments and prints the sum of two integers.
2. Program to display the information:
Your name, Full Address, Mobile Number, College Name, Course Subjects
3. Program that reads the URL of a website as input and displays contents of a webpage.</td></tr>
<tr><td>Exercise 2</td><td colspan="5">Programs to demonstrate usage of control structures.</td></tr>
<tr><td colspan="6">4. Program to find the sum of all prime numbers between 1 and 1000.
5. Program to find the product of two matrices.
6. Program to find the roots of a quadratic equation.</td></tr>
<tr><td>Exercise 3</td><td colspan="5">Programs to demonstrate the usage of Functions and Recursion</td></tr>
<tr><td colspan="6">7. Write both recursive and non-recursive functions for the following:
a. To find GCD of two integers
b. To find the factorial of positive integer
c. To print Fibonacci Sequence up to given number ‗n‘</td></tr>
</table>

	d. To convert decimal number to Binary equivalent 8. Program with a function that accepts two arguments: a list and a number ‗n‘. It should display all the numbers in the list that are greater than the given number ‗n‘. 9. Program with a function to find how many numbers are divisible by 2, 3,4,5,6 and 7 between 1 to 1000.
Exercise 4	**Programs to demonstrate the usage of String functions.**
	10. Program that accepts two strings S1, S2, and finds whether they are equal are not. 11. Program to count the number of occurrences of characters in each string. 12. Program to find whether a given string is palindrome or not.
Exercise 5	**Programs to demonstrate the usage of lists, sets, dictionaries, tuples and files.**
	13. Simple sorting, Histogram, Students marks statement, Retail bill preparation 14. Write a program that combines lists L1 and L2 into a dictionary. 15. Program to display a list of all unique words in a text file and word count, copy file, Voter‘s age validation, Marks range validation (0-100).
Exercise 6	**Programs to demonstrate the usage of Object-Oriented Programming**
	16. Program to implement the inheritance. 17. Program to implement polymorphism
	TOTAL: 60 PERIODS
COURSE OUTCOMES:	
	After completion of the course, the students will be able to:
CO1:	Develop algorithmic solutions to simple computational problems.
CO2:	Develop and execute simple Python programs.

CO3:	Construct programs in Python using conditionals and loops for solving problems.
CO4:	Utilize functions to decompose a Python program.
CO5:	Analyse compound data using Python data structures.
CO6:	Interpret data from/to files in Python Programs

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	1	1	1	-	-	-	-	1	3	1	-
2	3	2	1	1	1	-	-	-	-	-	-	1	3	1	-
3	3	2	1	1	1	-	-	-	-	-	-	1	3	1	-
4	3	2	1	1	1	-	-	-	-	-	-	1	3	1	-
5	3	3	2	2	1	-	-	-	-	-	-	1	3	1	-
6	2	1	-	-	1	-	-	1	1	1	1	1	3	1	1
Overall Correlation	**3**	**2**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**3**	**1**	**1**

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23HS121	**COMMUNICATION SKILLS LABORATORY**	**L**	**T**	**P**	**C**
		0	**0**	**2**	**1**

COURSE OBJECTIVES:

- To enable the students to comprehend the main idea and specific information of the listening passage
- To help students express themselves clearly, and communicate effectively with others.
- To introduce authentic language use and context-specific vocabulary that might not be encountered in textbooks.

Exercise : 1	Listening to conversations set in everyday social context and complete gap-filling exercise
Exercise : 2	Listening to a monologue in everyday social context. Diagram labelling and MCQ
Exercise : 3	Listening to a group conversation in academic setting and answer MCQ
Exercise : 4	Listening to a lecture and answer MCQ or gap filling
Exercise : 5	Listening to Ted Talks, podcasts, documentaries - discussion
Exercise : 6	Listening to a lecture and reading a text on the same subject- compare and contrast
Exercise : 7	Speaking Introducing oneself
Exercise : 8	Answering questions based on the introduction
Exercise : 9	Speaking on a given prompt for 2 mins.
Exercise : 10	Answering questions based on the topic spoken
Exercise : 11	Role play- Engaging in conversation
Exercise : 12	Engaging in Podcast Discussion
	TOTAL: 25 PERIODS

COURSE OUTCOMES:

After completion of the course, the students will be able to:

CO1:	Demonstrate fluency in speaking in variety of situations
CO2:	Express their knowledge by talking continuously for more than two minutes on a topic

CO3:	Develop active listening for more meaningful interactions and conversations
CO4:	Use a full range of structures naturally and appropriately
CO5:	Identify the specific information in conversations, interviews, talks and lectures
CO6:	Develop the ability to compare and analyse different forms of information, identifying key similarities and differences.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	-	-	-	-	-	3	3	-	3	3	-	2	-	-	-
2	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-
3	-	-	-	-	-	-	3	-	-	-	-	2	-	-	-
4	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-
5	-	-	-	-	-	-	3	-	-	-	-	2	-	-	-
6	-	-	-	-	-	3	3	-	3	3	-	-	-	-	-
Overall Correlation	-	-	-	-	-	**1**	**2**	-	**1**	**1**	-	**2**	-	-	-

Recommended by Board of Studies	**02-08-2023**		
Approved	**1st ACM**	**Date**	**09-09-2023**

SEMESTER - II

<table>
<tr><td rowspan="2">23HS201</td><td rowspan="2">PROFESSIONAL ENGLISH</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="6">COURSE OBJECTIVES:</td></tr>
<tr><td colspan="6">
• To help learners extract information from longer, technical and scientific texts
• To familiarize learners with different text structures by engaging them in reading, writing and grammar learning activities
• To help learners write coherent, extensive reports and essays.
• To enable learners to use language efficiently while expressing their opinions in professional and business situations
</td></tr>
<tr><td>UNIT I</td><td colspan="4">WORKPLACE COMMUNICATION</td><td>9</td></tr>
<tr><td colspan="6">Reading – Reading brochures (technical context), advertisements, telephone messages, gadget reviews social media messages, digital communication relevant to technical contexts and business. Writing – Writing emails -emails on professional contexts including introducing oneself, writing checklist, writing single sentence definition, product description- advertising or marketing slogans, Language Development– Tenses, Concord, Question types: Wh/ Yes or No/ and Tags, imperative sentences, complex sentences. Vocabulary - One-word substitutes; Abbreviations & Acronyms as used in technical contexts and social media.</td></tr>
<tr><td>UNIT II</td><td colspan="4">EXPRESSING CAUSE AND EFFECT</td><td>9</td></tr>
<tr><td colspan="6">Reading - Reading longer technical texts– Cause and Effect Essays, and emails of complaint. Writing - writing complaint emails (raising tickets) and responses to complaints, writing Cause and effect paragraphs and essays. Language Development– Active, Passive and Impersonal Passive Voice transformations, Infinitive and Gerunds Vocabulary – Synonyms- contextual meaning of</td></tr>
</table>

words, Same word acting as different parts of speech, causal expressions.		
UNIT III	**PROVIDING SOLUTIONS TO PROBLEMS**	**9**
Reading - Case Studies, editorials, news reports etc. Writing – Letter to the Editor, Writing instructions and recommendations, Problem solution essay / Argumentative Essay, Language Development – Error correction; If conditional sentences Vocabulary - Compound Words, discourse markers.		
UNIT IV	**INTERPRETATION OF GRAPHICS**	**9**
Reading - Reading newspaper articles, nonverbal communication (charts and graphs) Writing –Transferring information from nonverbal (chart, graph etc, to verbal mode) Process– description. Language development–Possessive & Relative pronouns, numerical adjectives Vocabulary Homonyms and Homophones, sequence words.		
UNIT V	**REPORT WRITING AND RESUME WRITING**	**9**
Reading – Company profiles, journal reports. Language Development– Reported Speech Vocabulary-reporting words and phrases. Writing - Writing accident report, survey report and progress report, project proposal, minutes of the meeting, writing statement of purpose, internship application and resume		
		TOTAL: 45 PERIODS
COURSE OUTCOMES:		
	After completion of the course, the students will be able to:	
CO1:	Summarize long technical and scientific text of not less than 500 words recognizing main ideas and specific details	
CO2:	Demonstrate the understanding of more complex grammatical structures and diction while reading and writing	
CO3:	Use appropriate expressions to describe process and product, compare and contrast data, analyze problems, provide solutions and prove an argument in writing	

CO4:	Establish the ability to communicate effectively in professional environment through emails and reports
CO5:	Determine the language use appropriate for different social media platforms used for digital marketing
CO6:	Convert skills to assets and position themselves in job market through their own professional narratives
TEXT BOOKS:	
1	V. Chellammal, Deepa Mary Francis, K N Shoba, P R Sujatha Priyadharshini, Veena Selvam, English for Science & Technology I, Cambridge University Press and Assessment
2	V. Chellammal, Deepa Mary Francis, K N Shoba, P R Sujatha Priyadharshini, Veena Selvam, English for Science & Technology II, Cambridge University Press and Assessment
REFERENCES:	
1	Business Correspondence and Report Writing by Prof. R.C. Sharma & Krishna Mohan, Tata McGraw Hill & Co. Ltd., 2001, New Delhi.
2	Developing Communication Skills by Krishna Mohan, Meera Bannerji- Macmillan India Ltd. 1990, Delhi.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	-	-	-	-	-	1	1	-	2	3	-	2	-	-	-
2	-	-	-	-	-	-	-	-	2	3	-	2	-	-	-
3	-	-	-	-	-	-	1	-	2	3	-	2	-	-	-
4	-	-	-	-	-	-	-	-	2	3	-	2	-	-	-
5	-	-	-	-	-	-	1	-	2	3	-	2	-	-	-
6	-	-	-	-	-	-	-	-	2	3	-	3	-	-	-
Overall Correlation	-	-	-	-	-	1	1	-	2	3	-	3	-	-	-

Recommended by Board of Studies	**02-08-2023**		
Approved	**1st ACM**	**Date**	**09-09-2023**

23MA203	STATISTICS AND NUMERICAL METHODS	L	T	P	C
		3	1	0	4

COURSE OBJECTIVES:

- This course aims at providing the necessary basic concepts of a few statistical and numerical methods and give procedures for solving numerically different kinds of problems occurring in engineering and technology.
- To acquaint the knowledge of testing of hypothesis for small and large samples which plays an important role in real life problems.
- To introduce the basic concepts of solving algebraic and transcendental equations.
- To introduce the numerical techniques of interpolation in various intervals and numerical techniques of differentiation and integration which plays an important role in engineering and technology.
- To acquaint the knowledge of various techniques and methods of solving ordinary differential equations.

UNIT I	TESTING OF HYPOTHESIS	9+3

Sampling distributions – Standard error-Large sample test for single mean, proportion, difference of means -Small sample Tests– T Test for single mean and difference of means-F test for equality of variance – Chi square test for single variance- Independence of attribute-Goodness of fit (Binomial Distribution, Poisson Distribution).

UNIT II	DESIGN OF EXPERIMENTS	9+3

One way and two way classifications - Completely randomized design – Randomized block design – Latin square design.

UNIT III	SOLUTION OF EQUATIONS AND EIGENVALUE PROBLEMS	9+3

Solution of algebraic and transcendental equations - Fixed point iteration method – Newton Raphson method- Solution of linear system of equations - Gauss elimination method – Pivoting - Gauss Jordan method – Iterative methods of Gauss Jacobi and Gauss

Seidel - Eigenvalues of a square matrix by Power method		
UNIT IV	**INTERPOLATION, NUMERICAL DIFFERENTIATION AND NUMERICAL INTEGRATION**	**9+3**
Interpolation - Newton's forward and backward difference interpolation -Lagrange's and Newton's divided difference interpolations –– Approximation of derivative using interpolation polynomials – Numerical single integration and double using Trapezoidal and Simpson's 1/3 rules.		
UNIT V	**NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS**	**9+3**
Single step methods: Taylor's series method - Euler's method - Modified Euler's method - Fourth order Runge- Kutta method for solving first order differential equations - Multi step methods: Milne's and Adam's Bashforth method.		
		TOTAL: 60 PERIODS
COURSE OUTCOMES:		
After completion of the course, the students will be able to:		
CO1:	Examine the given data for large and small samples problems.	
CO2:	Examine the problems involving design of experiments.	
CO3:	Find the numerical solutions for nonlinear (algebraic or transcendental) equations, large system of linear equations and Eigen value problem of a matrix, when analytical methods fail to give solution.	
CO4:	Determine the intermediate values of the experimental data, using Newton's forward, backward, divided difference and Lagrange's methods.	
CO5:	Find the solutions for the problems involving numerical differentiation and integration.	
CO6:	Solve numerically, ordinary differential equations which is used to solve different kinds of problems occurring in engineering and technology.	

TEXT BOOKS:	
1	Grewal. B.S. and Grewal. J.S., "Numerical Methods in Engineering and Science ", 10th Edition, Khanna Publishers, New Delhi, 2015.
2	Johnson, R.A., Miller, I and Freund J., "Miller and Freund's Probability and Statistics for Engineers", Pearson Education, Asia, 8th Edition, 2015.
REFERENCES:	
1	P. Sivarama Krishna Das "A Text Book of Statistics and Numerical Methods" Viji's Academy.
2	Burden, R.L. and Faires, J.D. "Numerical Analysis" 9th Edition, Cengage Learning, 2016.
3	Devore.J.L " Probability and Statistics for Engineering and the Sciences", Cengage Learning, New Delhi, 8th Edition, 2014
4	Gerald.C.F. and Wheatley.P.O. "Applied Numerical Analysis" Pearson Education, Asia, New Delhi, 7th Edition, 2007

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
2	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
3	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
4	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
5	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
6	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
Overall Correlation	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-

Recommended by Board of Studies	28-07-2023		
Approved by Academic	1st ACM	Date	09-09-2023

23PH202	APPLIED MATERIALS SCIENCE	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To make the students to understand the basics of crystallography and its importance in studying material properties.
- To inculcate the knowledge of phase relationships for the understanding of material properties.
- To understand the electrical properties of materials including free electron theory, applications of quantum mechanics and magnetic materials.
- To instill knowledge on physics of semiconductors, determination of charge carriers and device applications.
- To establish a sound grasp of knowledge on different optical properties of materials, optical displays and applications.

UNIT I	CRYSTALLOGRAPHY	9

Crystal structures: BCC, FCC and HCP- directions and Planes- linear and planar densities – crystal imperfections- edge and screw dislocations- grain and twin boundaries- Burgers vector and elastic strain energy- Slip systems, plastic deformation of materials – Polymorphism.

UNIT II	PHASE DIAGRAMS	9

Phase equilibrium – solubility limit – solid solution (interstitial and substitution) – intermediate phases – intermetallics – electron compound – Gibbs phase rule – Unary phase diagram (iron) – Binary phase diagrams: Isomorphous systems (Cu-Ni) – determination of phase composition and phase amounts – tie line and lever rule – binary eutectic diagram with no solid solution and limited solid solution (Pb-Sn) – eutectoid and peritectic reactions – other invariant reactions – microstructural development during the slow cooling: eutectic, hypereutectic and hypoeutectic compositions

UNIT III	**ELECTRICAL AND MAGNETIC PROPERTIES OF MATERIALS**	**9**
Classical free electron theory - Expression for electrical conductivity – Thermal conductivity, expression - Quantum free electron theory: Tunneling – degenerate states – Fermi- Dirac statistics – Density of energy states. Magnetic materials: Dia, para and ferromagnetic effects – Domain theory of ferromagnetism and hysteresis – exchange interaction and ferromagnetism – quantum interference devices – GMR devices.		
UNIT IV	**SEMICONDUCTOR AND TRANSPORT PHYSICS**	**9**
Intrinsic Semiconductors – Energy band diagram – direct and indirect band gap semiconductors – Carrier concentration in intrinsic semiconductors – extrinsic semiconductors - Carrier concentration in N-type & P-type semiconductors – Variation of carrier concentration with temperature – Carrier transport in Semiconductors: Drift, mobility and diffusion (qualitative) – Hall effect and devices – Ohmic contacts – Schottky diode – Introduction to solid state drive (SSD)		
UNIT V	**OPTICAL PROPERTIES OF MATERIALS**	**9**
Classification of optical materials – Optical processes in semiconductors: optical absorption and emission, charge injection and recombination, optical absorption, loss and gain. Optical processes in quantum wells – Optoelectronic devices: light detectors and solar cells – light emitting diode – laser diode - optical processes in organic semiconductor devices –excitonic state.		
		TOTAL: 45 PERIODS
COURSE OUTCOMES:		
After completion of the course, the students will be able to:		
CO1:	Apply the basics of crystallography and its importance in studying materials properties	

CO2:	Develop the knowledge of phase relationships for the understanding of material properties.
CO3:	Apply the electrical properties of materials using classical and quantum free electron theory
CO4:	Apply the knowledge of magnetic properties of materials in devices.
CO5:	Develop the knowledge on physics of semiconductors, determination of charge carriers and device applications.
CO6:	Build a sound grasp of knowledge on different optical properties of materials, optical displays and applications.
TEXT BOOKS:	
1	V.Raghavan. Materials Science and Engineering: A First Course, Prentice Hall India Learning Private Limited, 2015.
2	Safa Kasap, Principles of Electronic Materials and Devices, Mc-Graw Hill, 2018.
3	Jasprit Singh, Semiconductor Devices: Basic Principles, Wiley (India), 2007.
4	Jasprit Singh, Semiconductor Optoelectronics: Physics and Technology, Mc-Graw Hill India (2019)
5	Safa kasap, Optoelectronics & Photonics: Principles and Practices, Pearson, 2013.
REFERENCES:	
1	R.Balasubramaniam, Callister's Materials Science and Engineering. Wiley (Indian Edition), 2014.
2	Wendelin Wright and Donald Askeland, Essentials of Materials Science and Engineering, CL Engineering, 2013.
3	Robert F.Pierret, Semiconductor Device Fundamentals, Pearson, 2006.
4	Simon Sze and Ming-kwei Lee, Semiconductor Devices: Physics and Technology, Wiley, 2015.
5	Pallab Bhattacharya, Semiconductor Optoelectronic Devices, Pearson, 2017

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
2	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
3	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
4	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
5	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
6	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
Overall Correlation	**3**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**3**	**-**	**-**
Recommended by Board of Studies	**02-08-2023**														
Approved	**1st ACM**				**Date**							**09.09.2023**			

23ME201	APPLIED MECHANICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- Inculcate the ability to analyze any problem in a simple and logical manner.
- Learn the use of scalar and vector analytical techniques for analyzing forces in staticallydeterminate structures.
- Introduce the equilibrium of rigid bodies, vector methods and free body diagram.
- Learn the principles of friction, forces and to determine and apply the concepts offrictional forces at the contact surfaces of various engineering systems.
- To develop basic dynamics concepts such as force, momentum, work and energy.
- To apply the well understood basic principles for the real time.

UNIT I	BASICS AND STATICS OF PARTICLES	9

Introduction – Laws of Mechanics – Lami's theorem, Parallelogram and triangular Law of forces - vector representation of forces – Vector operations of forces -additions, subtraction, dot product, cross product - Coplanar Forces - rectangular components - Equilibrium of a particle – Forces in space – Equilibrium of a particle in space - Equivalent systems of forces, Free body diagram

UNIT II	EQUILIBRIUM OF RIGID BODIES	9

Principle of transmissibility - Varignon's theorem -Types of supports - Action and reaction forces - stable equilibrium - Moment of a force about a point and about an axis – Single equivalent force - Equilibrium of rigid bodies in two dimensions - Equilibrium of rigid bodies in three dimensions, Analysis of Trusses – Method of Joints and Method of sections

UNIT III	PROPERTIES OF SURFACES AND SOLIDS	9

Centroids and centre of mass - Centroids of lines and areas - Rectangular, circular, triangular areas by integration - T section, I

section, Angle section, Hollow section by using standard formula - Theorems of Pappus - Area moments of inertia of plane areas - rectangular, circular, triangular areas by integration - T section, I section, Angle section, Hollow section by using standard formula - Parallel axis theorem and Perpendicular axis theorem - Principal moments of inertia of plane areas - Principal axes of inertia-Mass moment of inertia - mass moment of inertia for prismatic, cylindrical and spherical solids from first principle – Relation to area moments of inertia.		
UNIT IV	**FRICTION**	**9**
Friction force - Ladder Friction, Wedge friction, Screw friction - Rolling resistance, Square threaded Screws, Journal Bearings, Thrust Bearings, Disc friction, Wheel friction, Rolling resistance		
UNIT V	**DYNAMICS OF PARTICLES**	**9**
Newton's laws of motion - Principle of Work and Energy, Applications of the Principle of Work and Energy, Power and Efficiency, Conservation of Energy, Principle of Impulse and Momentum, Impacts of bodies - Work Energy Equation - Impulse and Momentum equation		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Apply law of forces on particles.
CO2:	Calculate forces on rigid bodies.
CO3:	Determine reaction forces at the support
CO4:	Calculate area moment of inertia of planar body and mass moment of inertia of rigid bodies.
CO5:	Determine friction and its effects at the surfaces of contact for ladder, wedge, belt and bearings.
CO6:	Calculate dynamic forces on rigid bodies.

TEXT BOOKS:	
1	Beer, F.P and Johnston Jr. E.R., ―Vector Mechanics for Engineers (In SI Units): Statics and Dynamics‖, 8th Edition, Tata McGraw-Hill Publishing company, New Delhi (2004).
2	Bhavikatti, S.S and Rajashekarappa, K.G., ―Engineering Mechanics‖, New Age International (P) Limited Publishers, 1998.
REFERENCES:	
1	Hibbeller, R.C and Ashok Gupta, ―Engineering Mechanics: Statics and Dynamics‖, 11th Edition, Pearson Education 2010.
2	Irving H. Shames and Krishna Mohana Rao. G., ―Engineering Mechanics – Statics and Dynamics‖, 4th Edition, Pearson Education 2006.
3	Meriam J.L. and Kraige L.G., ― Engineering Mechanics- Statics - Volume 1, Dynamics - Volume 2‖, Third Edition, John Wiley and amp; Sons, 1993.
4	Rajasekaran S and Sankarasubramanian G., ―Engineering Mechanics Statics and Dynamics‖, 3rd Edition, Vikas Publishing House Pvt. Ltd., 2005.

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	1	1	2	-	-	1	-	-	-	2	3	1	1
2	3	2	1	1	2	-	-	1	-	-	-	2	3	1	1
3	3	2	1	1	2	-	-	1	-	-	-	2	3	1	2
4	3	2	1	1	2	-	-	1	-	-	-	2	3	1	2
5	3	2	1	1	2	-	-	1	-	-	-	2	3	1	2
6	3	2	1	1	2	-	-	1	-	-	-	2	3	1	2
Overall Correlation	**3**	**2**	**1**	**1**	**2**	**-**	**-**	**1**	**-**	**-**	**-**	**2**	**3**	**1**	**2**

Recommended by Board of Studies	**02-08-2023**		
Approved	**1st ACM**	**Date**	**09-09-2023**

23HS203	TAMILS AND TECHNOLOGY	L	T	P	C
		1	0	0	1

COURSE OBJECTIVES:

- To summarize the weaving industry and ceramic technology during Sangam Age
- To explain the design and construction of houses during Sangam Age and the sculptures and temples of Chola,Pallava and Pandya period
- To Explain about the water bodies of Sangam age and relate it to the agricultural usage
- To Outline to students the agriculture and irrigation technology during the Chola Period
- To help students Interpret and explain the digitalization of Tamil books and development of Tamil software

UNIT I	WEAVING AND CERAMIC TECHNOLOGY	3

Weaving Industry during Sangam Age – Ceramic technology – Black and Red Ware Potteries (BRW) – Graffiti on Potteries.

UNIT II	DESIGN AND CONSTRUCTION TECHNOLOGY	3

Designing and Structural construction House & Designs in household materials during Sangam Age - Building materials and Hero stones of Sangam age – Details of Stage Constructions in Silappathikaram - Sculptures and Temples of Mamallapuram – Great Temples of Cholas and other worship places - Temples of Nayaka Period - Type study (Madurai Meenakshi Temple)- Thirumalai Nayakar Mahal - Chetti Nadu Houses, Indo - Saracenic architecture at Madras during British Period.

UNIT III	MANUFACTURING TECHNOLOGY	3

Art of Ship Building - Metallurgical studies - Iron industry - Iron smelting, steel -Copper and gold- Coins as source of history - Minting of Coins – Beads making-industries Stone beads - Glass beads - Terracotta beads -Shell beads/ bone beats - Archeological evidences – Gem stone types described in Silappathikaram.

UNIT IV	**AGRICULTURE AND IRRIGATION TECHNOLOGY**	**3**
Dam, Tank, ponds, Sluice, Significance of Kumizhi Thoompu of Chola Period, Animal Husbandry - Wells designed for cattle use - Agriculture and Agro Processing - Knowledge of Sea - Fisheries – Pearl - Conche diving - Ancient Knowledge of Ocean - Knowledge Specific Society.		
UNIT V	**SCIENTIFIC TAMIL & TAMIL COMPUTING**	**3**
Development of Scientific Tamil - Tamil computing – Digitalization of Tamil Books –Development of Tamil Software – Tamil Virtual Academy – Tamil Digital Library – Online Tamil Dictionaries – Sorkuvai Project.		
		TOTAL: 15 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Summarize the weaving industry and ceramic technology during Sangam Age
CO2:	Explain the design and construction of houses during Sangam Age
CO3:	Explain the sculptures and temples of Chola,Pallava and Pandya period.
CO4:	Explain about the water bodies of Sangam age and relate it to the agricultural usage
CO5:	Outline the agriculture and irrigation technology during the Chola Period.
CO6:	Interpret and explain the digitalization of tamil books and development of Tamil software
TEXT BOOKS:	
1	Dr.K.K.Pillay ,"Social Life of Tamils", A joint publication of TNTB & ESC and RMRL

REFERENCES:

1. Dr.S.Singaravelu ,"Social Life of the Tamils - The Classical Period", Published by: International Institute of Tamil Studies.
2. Dr.S.V.Subatamanian , Dr.K.D. Thirunavukkarasu, "Historical Heritage of the Tamils", Published by: International Institute of Tamil Studies

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	-	-	-	-	-	1	1	1	-	-	-	-	-	-	-
2	-	-	-	-	-	1	1	1	-	-	-	-	-	-	-
3	-	-	-	-	-	1	1	1	-	-	-	-	-	-	-
4	-	-	-	-	-	1	1	1	-	-	-	-	-	-	-
5	-	-	-	-	-	1	1	1	-	-	-	-	-	-	-
6	-	-	-	-	-	1	1	1	-	-	-	-	-	-	-
Overall Correlation	-	-	-	-	-	**1**	**1**	**1**	-	-	-	-	-	-	-

Recommended by Board of Studies	**26-07-2023**		
Approved	**1st ACM**	**Date**	**09-09-2023**

<table>
<tr><td rowspan="2">23EE283</td><td rowspan="2">BASIC ELECTRICAL, ELECTRONICS ENGINEERING AND MEASUREMENTS</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>2</td><td>0</td><td>2</td><td>3</td></tr>
<tr><td colspan="6">COURSE OBJECTIVES:</td></tr>
<tr><td colspan="6">To introduce the basics of electric circuits and analysis
To impart knowledge in the basics of working principles and application of electrical machines
To introduce analog devices and their characteristics
To educate on the fundamental concepts of linear integrated circuits
To introduce the functional elements and working of measuring instruments.</td></tr>
<tr><td>UNIT I</td><td colspan="4">ELECTRICAL CIRCUITS</td><td>6</td></tr>
<tr><td colspan="6">DC Circuits: Circuit Components: Conductor, Resistor, Inductor, Capacitor–Ohm's Law-Kirchhoff's Laws -Nodal Analysis, Mesh analysis within dependent sources only (Steady state)-Introduction to AC Circuits–Steady state analysis of RL, RC, and RL Circuits(Simple problems only).</td></tr>
<tr><td>UNIT II</td><td colspan="4">ELECTRICAL MACHINES</td><td>6</td></tr>
<tr><td colspan="6">Construction and Working principle of DC Generators, EMF equation, Types and Applications. Working Principle of DC motors, Torque Equation, Types and Applications -Construction, Working principle and Applications of Single- Phase Transformer.</td></tr>
<tr><td>UNIT III</td><td colspan="4">ANALOG ELECTRONICS</td><td>6</td></tr>
<tr><td colspan="6">PN Junction Diodes, Zener Diode –characteristics Applications – Bipolar Junction Transistor- JFET, SCR - I-V Characteristics and Applications- Rectifier.</td></tr>
<tr><td>UNIT IV</td><td colspan="4">LINEAR INTEGRATED CIRCUITS</td><td>6</td></tr>
<tr><td colspan="6">Ideal OP-AMP characteristics, Basic applications of op-amp – Inverting and Non-inverting Amplifiers, D/A converter (R- 2R ladder), A/D converters (Flash type) - ADC using OP-AMPS.</td></tr>
</table>

UNIT V	MEASUREMENTS AND INSTRUMENTATION	6
Functional elements of an instrument, Standards and calibration, Operating Principle, types-Moving Coil and Moving Iron meters, Instrument Transformers- CT and PT, DSO-Block diagram-Data acquisition.		
		Total : 30 PERIODS

LAB COMPONENT

1. Verification of ohms and Kirchhoff's Laws.
2. Load test on DC Shunt Motor.
3. Load test on Single phase Transformer
4. Experiment on Operational Amplifier based Inverting and non-inverting amplifier
5. Experiments on ADC and 555 Timer
6. Measurement of Amplitude, Frequency, Time, Phase Measurement using DSO

Total : 30 + 30 = 60 Periods

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Apply fundamental laws to DC electric circuits and demonstrate it experimentally.
CO2:	Explain the steady state AC circuits with RL, RC, and RLC circuits.
CO3:	Identify the working principle and applications of electrical machines with experimental results.
CO4:	Demonstrate the characteristics of various analog electronic devices.
CO5:	Make use of Op-amps to build Operational Amplifier based Inverting and non- inverting amplifier.
CO6:	Illustrate the operating principles of measuring instruments and demonstrate DSO for the basic measurements.

TEXT BOOKS:	
1	D P Kothari and I.J Nagrath, "Basic Electrical and Electronics Engineering", McGraw Hill Education, Second Edition, 2020.
2	Allan S Moris, "Measurement and Instrumentation Principles", Third Edition, Butterworth Heinemann, 2001.
3	S.K. Bhattacharya, Basic Electrical Engineering, Pearson Education, 2019
4	James A .Svoboda, Richard C. Dorf, "Dorf's Introduction to Electric Circuits", Wiley,2018
REFERENCES:	
1	Thomas L. Floyd, 'Electronic Devices', 10th Edition, Pearson Education, 2018.
2	A.K. Sawhney, Puneet Sawhney 'A Course in Electrical & Electronic Measurements & Instrumentation', Dhanpat Rai and Co, New Delhi, January 2015.
3	Albert Malvino, David Bates, 'Electronic Principles, McGraw Hill Education; 7th edition, 2017

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	-	-	-	1	1	1	-	1	3	-	1
2	2	1	-	-	-	-	-	1	1	1	-	1	2	-	1
3	3	2	1	1	-	1	1	1	1	1	-	1	3	-	1
4	2	1	-	-	-	1	1	1	1	1	-	1	2	-	1
5	3	2	1	1	-	-	-	1	1	1	-	1	3	-	1
6	2	1	-	-	-	-	-	1	-	-	-	-	3	-	1
Overall Correlation	**3**	**2**	**1**	**1**	**-**	1	1	1	1	1	-	1	**3**	**-**	1

Recommended by Board of Studies	**26-07-2023**		
Approved	**1st ACM**	**Date**	**09-09-2023**

<table>
<tr><td rowspan="2">23ME211</td><td rowspan="2">ENGINEERING GRAPHICS</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>2</td><td>4</td></tr>
<tr><td colspan="6">COURSE OBJECTIVES:</td></tr>
<tr><td colspan="6">
• Gain a solid foundation in the fundamental principles and concepts of engineering graphics, including conic sections, orthographic projection, isometric projection, section views and development of surfaces, perspective projection, and dimensioning.
• Develop graphic skills for communication of concepts, ideas and design of engineering products.
• Gain knowledge on drafting software to construct part models.
• Familiarize with existing national standard practices and conventions related to technical drawings.
• Enhance the ability to visualize objects in three dimensions and translate them into 2D representations.
</td></tr>
<tr><td>UNIT I</td><td colspan="4">PLANE CURVES</td><td>9+6</td></tr>
<tr><td colspan="6">Basic Geometrical constructions, Curves used in engineering practices: Conics - Construction of ellipse, parabola and hyperbola by eccentricity method - Construction of cycloid - construction of involutes of square and circle - Drawing of tangents and normal to the above curves.
LIST OF EXERCISES:
1. Drawing of a title block with necessary text, projection symbol and lettering using drafting software
2. Drafting of Conic curves - Ellipse, Parabola and Hyperbola</td></tr>
<tr><td>UNIT II</td><td colspan="4">PROJECTION OF POINTS, LINES AND PLANE SURFACE</td><td>9+6</td></tr>
<tr><td colspan="6">Orthographic projection - principles - Principal planes - First angle projection - projection of points. Projection of straight lines (only First angle projections) inclined to both the principal planes - Determination of true lengths and true inclinations by rotating line method. Projection of planes (hexagonal and pentagonal planes</td></tr>
</table>

only) inclined to both the principal planes by rotating object method.

LIST OF EXERCISES:

1. Draw the projection of points when it is placed in different quadrants
2. Draw the projection of lines when it is placed in first quadrant
3. Draw the planes when it is placed in first quadrant.

UNIT III	PROJECTION OF SOLIDS AND FREE HAND SKETCHING	9+6

Projection of simple solids - hexagonal prism, pentagonal pyramid and cone inclined to the horizontal plane by rotating object method. Free Hand sketching: Visualization principles - Representation of Three Dimensional objects - Layout of views - Free hand sketching of multiple views from pictorial views of objects

LIST OF EXERCISES:

1. Practicing three dimensional modelling of simple objects.
2. Drawing of orthographic views from the given pictorial diagram

UNIT IV	PROJECTION OF SECTIONED SOLIDS AND DEVELOPMENT OF SURFACES	9+6

Sectioning of hexagonal prism, pentagonal pyramid and cone when the cutting plane is inclined to the horizontal plane, Development of lateral surfaces of simple and sectioned solids – hexagonal prism and cone cut by a plane inclined to horizontal plane only.

LIST OF EXERCISES:

1. Draw the sectioned views of prisms and pyramids
2. Draw the development of hexagonal prism cut by a section plane inclined to the horizontal plane

UNIT V	ISOMETRIC PROJECTION	9+6
Principles of isometric projection - Isometric scale – Isometric view - Isometric projections of simple solids and truncated solids - Prisms, pyramids, cylinders, cones- combination of two solid objects in simple vertical positions. **LIST OF EXERCISES:** 1. Drawing Isometric view and projection of simple solids. 2. Drawing three dimensional modeling of isometric projection of combination of solids.		
		TOTAL: 75 PERIODS
COURSE OUTCOMES:		
After completion of the course, the students will be able to:		
CO1:	Construct the conic curves, involutes and cycloids.	
CO2:	Develop and Sketch the orthographic projections of points, lines and plane surfaces.	
CO3:	Develop and Sketch the orthographic projections of simple solids.	
CO4:	Construct the projections of sectioned solids and development of the lateral surfaces of solids.	
CO5:	Develop and Sketch the isometric sections of solids.	
CO6:	Develop and Sketch the orthographic projection 2D and 3D objects using Auto CAD.	
TEXT BOOKS:		
1	Bhatt N.D. and Panchal V.M., ―Engineering Drawing‖, Charotar Publishing House, 53rd Edition, 2019.	
2	Basant Agarwal and Agarwal C.M.,―Engineering Drawing‖, McGraw Hill, 2nd Edition, 2019	
REFERENCES:		
1	Natrajan K.V., ―A Text Book of Engineering Graphics‖, Dhanalakshmi Publishers, Chennai, 2018.	
2	Gopalakrishna K.R., ―Engineering Drawing‖ (Vol. I and II combined), Subhas Publications, Bangalore, 27th Edition, 2017.	

3	Luzzader, Warren.J. and Duff, John M., ―Fundamentals of Engineering Drawing with an introduction to Interactive Computer Graphics for Design and Production, Eastern Economy Edition, Prentice Hall of India Pvt. Ltd, New Delhi, 2005.
4	Parthasarathy N. S. and Vela Murali, ―Engineering Graphics‖, Oxford University, Press, New Delhi, 2015. 5. Shah M.B., and Rana B.C., ―Engineering Drawing‖, Pearson Education India, 2nd Edition, 2009.
5	Venugopal K. and Prabhu Raja V., ―Engineering Graphics", New Age International (P) Limited, 2008.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	2	-	-	1	-	3	2	2	2	2	-
2	3	2	1	1	2	-	-	1	-	3	2	2	2	2	-
3	3	2	1	1	2	-	-	1	-	3	2	2	2	2	-
4	3	2	1	1	2	-	-	1	-	3	2	2	2	2	-
5	3	2	1	1	2	-	-	1	-	3	2	2	2	2	-
6	3	2	1	1	2	-	-	1	-	3	2	2	2	2	-
Overall Correlation	3	2	1	1	2	-	-	1	-	3	2	2	2	2	-

Recommended by Board of Studies	**26-07-2023**		
Approved	**1st ACM**	**Date**	**09-09-2023**

23ME221	ENGINEERING PRACTICES LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES:

- Familiarize students with basic engineering tools and equipment.
- Educate students on the importance of safety practices, including proper handling of equipment, adherence to safety protocols, and understanding potential hazards in the laboratory environment. Develop basic manufacturing and fabrication skills.
- Provide hands on training to the students in plumbing and woodworking.
- Provide hands on training to the students in welding various joints in steel plates using arc welding work; Machining various simple processes like turning, drilling, tapping in parts; Assembling simple mechanical assembly of common household equipment; Making a tray out of metal sheet using sheet metal work.
- Demonstrate the wiring and measurement methods in common household electrical applications.
- Study the basic electronic components, gates and provide hands on training in soldering.

GROUP A (CIVIL and MECHANICAL)

PART I	CIVIL ENGINEERING PRACTICES	15

PLUMBING WORK

a) Connecting various basic pipe fittings like valves, taps, coupling, unions, reducers, elbows and other components which are commonly used in households.
b) Preparation of plumbing line sketches.
c) Laying pipe connection to the suction side of a pump
d) Laying pipe connection to the delivery side of a pump.
e) Connecting pipes of different materials: Metal, plastic and flexible pipes used in household appliances.

WOOD WORK

a) Sawing
b) Planning
c) Making of T-Joint, Mortise joint and Tenon joint and Dovetail joint.

WOOD WORK STUDY

a) Study of joints in door panels and wooden furniture
b) Study of common industrial trusses using models.

PART II	MECHANICAL ENGINEERING PRACTICES	15

WELDING WORK

a) Study of Welding and its tools.
b) Welding of Butt Joints, Lap Joints and Tee Joints by metal arc welding.
c) Study of Gas Welding.

BASIC MACHINING PRACTICE

a) Facing and Plain Turning
b) Taper Turning
c) Drilling and Tapping

SHEET METAL WORK

a) Forming and Bending
b) Making of a square Tray

MACHINE ASSEMBLY WORK

a) Study of Centrifugal Pump
b) Study of Air Conditioner

FOUNDRY PRACTICE

Demonstration on Foundry operations like mould preparation.

TOTAL: 30 PERIODS

GROUP B (ELECTRICAL & ELECTRONICS)

PART III	ELECTRICAL ENGINEERING PRACTICES	15

1. Residential House wiring using Switches, Fuse, Indicators, Lamp and Energy Meter.
2. Staircase Wiring.

3. Fluorescent Lamp Wiring with Introduction to CFL and LED Types. 4. Measurement of Energy using Single Phase Energy Meter. 5. Study of Iron Box Wiring and Assembly **6.** Study of Fan Regulator – Electronic Type		
PART IV	**ELECTRONICS ENGINEERING PRACTICES**	**15**
1. Study of Electronic components and equipment – Resistors, Colour coding measurement of AC signal parameter (peak-peak, RMS period, frequency) using CRO. 2. Study of logic gates AND, OR, EX-OR and NOT. 3. Generation of Clock Signal. 4. Soldering simple electronic circuits and checking continuity. 5. Study the elements of smart phone 6. Study of LED TV (Block diagram		

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Plan the pipeline layout for common household plumbing work.
CO2:	Make use of welding equipment and carpentry tool for making joints.
CO3:	Demonstrate on centrifugal pump, air conditioner and foundry operations.
CO4:	Demonstrate the electrical wiring connections for household applications and study the working of iron box and fan regulator.
CO5:	Identify the basic electronic components and explain the gates and soldering methods.
CO6:	Examine the performance and operation of CRO, LED TV and Smart phone.

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	1	1	1	1	1	-	-	2	2	2	2	1	-
2	3	2	1	1	1	1	1	-	-	2	2	2	2	1	-
3	3	2	1	1	1	1	1	-	-	2	2	2	2	1	-
4	3	2	1	1	1	1	1	-	-	2	2	2	2	1	-
5	3	2	1	1	1	1	1	-	-	2	2	2	2	1	-
6	3	2	1	1	1	1	1	-	-	2	2	2	2	1	-
Overall Correlation	**3**	**2**	**1**	**1**	**1**	**1**	**1**	**-**	**-**	**2**	**2**	**2**	**2**	**1**	**-**
Recommended by Board of Studies	**26-07-2023**														
Approved	**1st ACM**			**Date**						**09-09-2023**					

<table>
<tr><td rowspan="2">23HS221</td><td rowspan="2" colspan="2">SOFT SKILLS</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>0</td><td>0</td><td>2</td><td>1</td></tr>
<tr><td colspan="7">COURSE OBJECTIVES:</td></tr>
<tr><td colspan="7">• To help learners improve their interpersonal skills and critical thinking
• To familiarize learners with the attributes of a leader to enhance team performance
• To prepare students to face job interviews
• To help learners to know the importance of ethics in work place</td></tr>
<tr><td>UNIT I</td><td colspan="5">INTERPERSONAL COMMUNICATION</td><td>5</td></tr>
<tr><td colspan="7">Basic communication- verbal and non-verbal communication; passive, assertive and aggressive communication; presentation skills; giving feedback and responding to feedback.</td></tr>
<tr><td>UNIT II</td><td colspan="5">TEAM WORK AND LEADERSHIP</td><td>5</td></tr>
<tr><td colspan="7">Vision- setting realistic goals and objectives, collaboration, cooperation, dependability, empathy, sympathy, motivation, delegation of responsibilities, open mindedness, creativity, flexibility, adaptability, cross cultural communication and group dynamics.</td></tr>
<tr><td>UNIT III</td><td colspan="5">TIME MANAGEMENT AND STRESS MANAGEMENT</td><td>5</td></tr>
<tr><td colspan="7">Effective Planning, Planning activities at macro and micro levels, setting practical deadlines and realistic limits/targets, punctuality, prioritizing activities, spending the right time on the right activity, positive attitude, emotional intelligence, self- awareness and regulation.</td></tr>
<tr><td>UNIT IV</td><td colspan="5">CRITICAL THINKING AND WORK ETHICS</td><td>5</td></tr>
<tr><td colspan="7">Questioning, analysing, inferencing, interpreting, evaluating, solving problems, explaining, self-regulation, open-mindedness, conflict management- ethical dilemmas, appearance, attendance, attitude, character, organizational skills, productivity, respect.</td></tr>
</table>

UNIT V	INTERVIEW SKILLS AND RESUME BUILDING TECHNIQUES	5
Telephonic interview, online interviews, f2f interviews, FAQ soft skills interview questions, drafting error-free CVs/ Resumes and Cover Letters, selecting the ideal format for resume, content drafting along with sequencing, art of representing one's qualifications and most relevant work history, video resume, website resume.		
		TOTAL: 25 PERIODS

COURSE OUTCOMES:	
	After completion of the course, the students will be able to:
CO1:	Express their thoughts, opinions and ideas confidently to one or more people in spoken form
CO2:	Develop evolving competences required for professional success
CO3:	Demonstrate knowledge and skills in a group as team player and leader
CO4:	Compose a comprehensive resume reflecting qualifications, exposure and achievements
CO5:	Exhibit knowledge and skills confidently during job interviews
CO6:	Demonstrate ethical and professional behaviour at workplace in all situations
TEXT BOOKS:	
1	Soft Skills: Key to Success in Workplace and Life by Meenakshi Raman & Shalini Upadhyay. Cengage
REFERENCES:	
1	English for Job Seekers (Language and Soft Skills for the Aspiring) by Geetha Rajeevan, C.L.N. Prakash) Cambridge University Press pvt, Ltd.
2	Business Benchmark by Norman Whitby. Cambridge University Press pvt, Ltd

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	-	-	-	-	-	-	-	-	2	2	-	-	-	-	-
2	-	-	-	-	-	2	2	2	3	3	2	2	-	-	2
3	-	-	-	-	-	-	-	-	3	3	-	-	-	-	-
4	-	-	-	-	-	-	-	-	3	3	-	-	-	-	-
5	-	-	-	-	-	-	-	-	3	3	-	-	-	-	-
6	-	-	-	-	-	-	-	3	3	3	-	-	-	-	3
Overall Correlation	**-**	**-**	**-**	**-**	**-**	**2**	**2**	**2**	**3**	**3**	**2**	**2**	**-**	**-**	**2**

Recommended by Board of Studies	**26-07-2023**		
Approved	**1st ACM**	**Date**	**09-09-2023**

SEMESTER –III

23MA302	TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS	L	T	P	C
		3	1	0	4

COURSE OBJECTIVES:

- To introduce the basic concepts of PDE for solving standard partial differential equations.
- To introduce Fourier series analysis which is central to many applications in engineering apart from its use in solving boundary value problems.
- To acquaint the student with Fourier series techniques in solving heat flow problems used in various situations.
- To acquaint the student with Fourier transform techniques used in wide variety of situations.
- 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

UNIT I	PARTIAL DIFFERENTIAL EQUATIONS	9+3

Formation of partial differential equations –Solutions of standard types of first order partial differential equations - Lagrange's linear equation - Linear partial differential equations of second and higher order with constant coefficients of both homogeneous and non-homogeneous types.

UNIT II	FOURIER SERIES	9+3

Dirichlet's conditions – General Fourier series – Odd and even functions – Half range sine series and cosine series – Root mean square value – Parseval's identity – Harmonic analysis.

UNIT III	APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS	9+3

Classification of second order Quasi Linear PDE – Method of separation of variables - Fourier series solutions of one dimensional wave equation – One dimensional equation of Heat

conduction – Steady state solution of two dimensional equation of heat conduction (Infinite) (Cartesian coordinates only)		
UNIT IV	**FOURIER TRANSFORMS**	**9+3**
Statement of Fourier integral theorem– Fourier transform pair – Fourier sine and cosine transforms – Properties – Transforms of simple functions – Convolution theorem (Without proof) – Parseval's identity.		
UNIT V	**Z-TRANSFORMS AND DIFFERENCE EQUATIONS**	**9+3**
Z-transforms - Elementary properties – Convergence of Z-transforms – Initial and final value theorems - Inverse Z-transform using partial fraction and convolution theorem - Formation of difference equations – Solution of difference equations using Z - transforms.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
	After completion of the course, the students will be able to:
CO1:	Solve the given standard partial differential equations.
CO2:	Compute the general Fourier series which plays a vital role in engineering applications.
CO3:	Examine the half range Fourier series and harmonic analysis
CO4:	Find the physical significance of Fourier series techniques in solving one and two dimensional heat flow problems, one dimensional wave equations.
CO5:	Apply the mathematical principles on Fourier transforms to solve some of the physical problems of engineering.
CO6:	Apply the effective mathematical tools for the solutions of difference equations by using Z transform techniques for discrete time systems.
TEXT BOOKS:	
1	Kreyszig.E, "Advanced Engineering Mathematics", John Wiley and Sons, 10th Edition, New Delhi, 2016.
2	Grewal.B.S., "Higher Engineering Mathematics", Khanna

	Publishers, New Delhi, 44th Edition, 2018.
3	P.Sivaramakrishna Das and C.Vijayakumari "A Text Book on TPDE" Pearson Publications
REFERENCES:	
1	Narayanan. S., Manicavachagom Pillay. T.K. and Ramanaiah. G "Advanced Mathematics for Engineering Students", Vol. II & III, S.Viswanathan Publishers Pvt. Ltd, Chennai, 1998
2	Ramana. B.V., "Higher Engineering Mathematics", McGraw Hill Education Pvt. Ltd, New Delhi, 2018.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
2	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
3	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
4	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
5	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
6	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
Overall Correlation	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-

Recommended by Board of Studies	**08-04-2024**		
Approved	**2nd ACM**	**Date**	**25-05-2024**

23MT301	MANUFACTURING TECHNOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To study the concepts and basic mechanics of metal cutting and the factors affecting machinability.
- To learn working of basic and advanced turning machines.
- To teach the basics of machine tools with reciprocating and rotating motions and abrasive finishing processes.
- To study the basic concepts of CNC of machine tools and constructional features of CNC.
- To learn the basics of CNC programming concepts to develop the part program for Machine centre and turning centre.

UNIT I	MECHANICS OF METAL CUTTING	9

Mechanics of chip formation, forces in machining, Types of chips, cutting tools – single point cutting tool nomenclature, orthogonal and oblique metal cutting, thermal aspects, cutting tool materials, tool wear, tool life, surface finish, cutting fluids and Machinability.

UNIT II	TURNING MACHINES	9

Centre lathe, constructional features, specification, operations – taper turning methods, thread cutting methods, special attachments, surface roughness in turning, machining time and power estimation. Special lathes - Capstan and turret lathes- tool layout – automatic lathes: semi- automatic – single spindle: Swiss type, automatic screw type – multi spindle.

UNIT III	RECIPROCATING MACHINE TOOLS	9

Reciprocating machine tools: shaper, planer, slotter: Types and operations- Hole making: Drilling, reaming, boring, tapping, type of milling operations-attachments- types of milling cutters– machining time calculation - Gear cutting, gear hobbing and gear shaping – gear finishing methods Abrasive processes: grinding wheel – specifications and selection, types of grinding process –

cylindrical grinding, surface grinding, centreless grinding, internal grinding - micro finishing methods.		
UNIT IV	**CNC MACHINES**	**10**
Computer Numerical Control (CNC) machine tools, constructional details, special features – Drives, Recirculating ball screws, tool changers; CNC Control systems – Open/closed, point-to-point/continuous - Turning and machining centres – Work holding methods in Turning and machining centres, Coolant systems, Safety features.		
UNIT V	**PROGRAMMING OF CNC MACHINE TOOLS**	**8**
Coordinates, axis and motion, Absolute vs Incremental, Interpolators, Polar coordinates, Program planning, G and M codes, Manual part programming for CNC machining centres and Turning centres – Fixed cycles, Loops and subroutines, Setting up a CNC machine for machining.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
	After completion of the course, the students will be able to:
CO1:	Explain the mechanism of metal removal process and to identify the factors involved in improving machinability
CO2:	Explain the constructional and operational features of centre lathe and other special purpose lathes.
CO3:	Explain the working and operational features of reciprocating machine tools.
CO4:	Explain the constructional features and working principles of CNC machine tools
CO5:	Construct CNC manual part program for turning center.
CO6:	Construct CNC manual part program for machining center.
TEXT BOOKS:	
1	Kalpakjian. S, “Manufacturing Engineering and Technology”, Pearson Education India 8th Edition, 2020.

2	Michael Fitzpatrick, Machining and CNC Technology, McGraw-Hill Education; 4th edition, 2019.
REFERENCES:	
1	Roy. A. Lindberg, Processes and materials of manufacture, PHI / Pearson education, 3rd edition 2015.
2	Geofrey Boothroyd, “Fundamentals of Metal Machining and Machine Tools”, McGraw Hill, 3rd edition 2005.
3	Rao. P.N “Manufacturing Technology,” Metal Cutting and Machine Tools, Tata McGraw- Hill, New Delhi, 4th Edition 2018.
4	A. B. Chattopadhyay, Machining and Machine Tools, Wiley, 2nd edition, 2017.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1		-	-	-	3	-	1	3	2	2	3	3	2
2	2	1		-	-	-	3	-	2	3	1	2	3	2	2
3	2	1		-	-	-	3	-	1	2	1	2	3	2	2
4	2	1		-	-	-	3	-	1	3	2	2	3	2	2
5	3	2	1	1	-	-	3	-	1	3	1	2	3	2	3
6	3	2	1	1	-	-	3	-	1	3	1	2	3	2	3
Overall Correlation	2	1	1	1	-	-	3	-	1	3	1	2	3	2	3

Recommended by Board of Studies	**25-03-2024**		
Approved	**2nd ACM**	**Date**	**25-05-2024**

23MT311	ELECTRICAL DRIVES AND ACTUATORS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To familiarize a relay and power semiconductor devices
- To get a knowledge on drive characteristics
- To obtain the knowledge on DC motors and drives.
- To obtain the knowledge on AC motors and drives.
- To obtain the knowledge on Stepper and Servo motor.

UNIT I RELAY AND POWER SEMI-CONDUCTOR DEVICES 9

Study of Switching Devices- Relay and its Types, Switching characteristics -BJT, SCR, TRIAC, GTO, MOSFET, IGBT and IGCT. Introduction to Triggering, Commutation Driver and snubber circuits.

UNIT II DRIVE CHARACTERISTICS 9

Electric drive – Equations governing motor load dynamics – steady state stability – multi quadrant Dynamics: acceleration, deceleration, torque, and Direction starting & stopping – Selection of motor.

UNIT III DC MOTORS AND DRIVES 9

DC motor - Types of PMDC & BLDC motors - principle of operation- emf and torque equations - characteristics and control – Drives- H bridge (Single Phase) – 4 quadrant operation – Applications.

UNIT IV AC MOTORS AND DRIVES 9

Introduction – Induction motor drives – Speed control of 3-phase induction motor – Stator voltage control – Stator frequency control – Stator voltage and frequency control – Stator current control – Static rotor resistance control – Slip power recovery control.

UNIT V STEPPER AND SERVO MOTORS 9

Stepper Motor: Classifications- Construction and Principle of

Operation – Modes of Excitation- Drive System-Logic Sequencer - Applications. Servo Mechanism – DC Servo motor-AC Servo motor – Applications.	
	TOTAL: 45 PERIODS
COURSE OUTCOMES:	
	After completion of the course, the students will be able to:
CO1:	Illustrate the working principle of relays, and the switching Characteristics of Various Power Semiconductor Devices.
CO2:	Explain the characteristics of drives & Selection of Motors.
CO3:	Explain the various types of DC Motors and Drives.
CO4:	Identify the various applications of DC motor drives in single phase 4 quadrant operation.
CO5:	Explain the Various types of AC Motors and Drives
CO6:	Explain the construction and working principle of Stepper Motor and Servo motor
TEXT BOOKS:	
1	Bimbhra B.S., "Power Electronics", 5th Edition, Kanna Publishers, New Delhi, 2012.
2	Mehta V.K. & Rohit Mehta, "Principles of Electrical Machines", 2nd Edition, S.Chand& Co. Ltd., New Delhi, 2016.
REFERENCES:	
1	Gobal K. Dubey, "Fundamentals of Electrical Drives", 2nd Edition, Narosal Publishing House, New Delhi, 2001.
2	Theraja B.L. &Theraja A.K., "A Text Book of Electrical Technology", 2nd Edition, S.Chand& Co. Ltd., New Delhi, 2012.
3	Singh M.D. &Kanchandhani K.B., "Power Electronics", McGraw Hill, New Delhi, 2007.
4	Andre Veltman , Duco W.J. Pulle , R.W. de Doncker , * Fundamentals of Electrical Drives (Power Systems)",Springer International Publishing AG; Softcover reprint of the original 2nd ed. 2016 edition.

COs	POs												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	-	-	-	-	-	2	-	-	-	2	1	-	3
2	2	1	-	-	-	-	-	2	-	-	-	2	1	-	3
3	2	1	-	-	-	-	-	2	-	-	-	2	1	-	3
4	3	2	1	1		-	-	2	-	-	-	2	1	-	3
5	2	1	-	-	-	-	-	2	-	-	-	2	1	-	3
6	2	1	-	-	-	-	-	2	-	-	-	2			
Overall Correlation	2	1	1	1	1	-	-	2	-	-	-	2	1	-	3
Recommended by Board of Studies							**25-03-2024**								
Approved							**2nd ACM**			**Date**			**25-05-2024**		

23HS301	UNIVERSAL HUMAN VALUES AND ETHICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To develop a holistic perspective based on self-exploration about themselves (human being), family, society and nature/existence.
- To understand (or developing clarity) the harmony in the human being, family, society and nature/existence.
- To strengthen the self-reflection.
- To develop commitment and courage to act.

UNIT I	COURSE INTRODUCTION	9

Need, Basic Guidelines, Content and Process for Value Education - Understanding the need, basic guidelines, content and process for Value Education -Self Exploration–what is it? - its content and process; 'Natural Acceptance' and Experiential Validation- as the mechanism for self exploration - Continuous Happiness and Prosperity- A look at basic Human Aspirations -Right understanding, Relationship and Physical Facilities- the basic requirements for fulfilment of aspirations of every human being with their correct priority -Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario - Method to fulfil the above human aspirations: understanding and living in harmony at various levels.

UNIT II	UNDERSTANDING HARMONY IN THE HUMAN BEING	9

Harmony in Myself- Understanding human being as a co-existence of the sentient 'I' and the material 'Body' -Understanding the needs of Self ('I') and 'Body' - Sukh and Suvidha- Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer) -Understanding the characteristics and activities of 'I' and harmony in 'I' -Understanding the harmony of I with the Body: Sanyam and Swasthya; correct appraisal of Physical needs, meaning of Prosperity.

UNIT III	**UNDERSTANDING HARMONY IN THE FAMILY AND SOCIETY**	**9**
Harmony in Human-Human Relationship -Understanding Harmony in the family – the basic unit of human interaction - Understanding values in human-human relationship; meaning of Nyaya and program for its fulfilment to ensure satisfaction; Trust(Vishwas) and Respect as the foundational values of relationship -Understanding the meaning of Vishwas; Difference between intention and competence -Understanding the meaning of Samman, Difference between respect and differentiation; the other salient values in relationship -Understanding the harmony in the society (society being an extension of family)-Visualizing a universal harmonious order in society- Undivided Society (Akhand Samaj), Universal Order- from family to world family.		
UNIT IV	**ENGINEERING ETHICS**	**9**
Senses of ‗Engineering Ethics„ – Variety of moral issues – Types of inquiry – Moral dilemmas – Moral Autonomy – Kohlberg's theory – Gilligan's theory – Consensus and Controversy – Models of professional roles - Theories about right action – Self-interest – Customs and Religion – Uses of Ethical Theories.		
UNIT V	**SAFETY, RESPONSIBILITY AND RIGHTS**	**9**
Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis and Reducing Risk - Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) – Discrimination-Moral Leadership –Code of Conduct – Corporate Social Responsibility.		
		TOTAL: 45 PERIODS
COURSE OUTCOMES:		
After completion of the course, the students will be able to:		
CO1:	Explain the need of value education.	
CO2:	Interpret the difference between self and body.	

CO3:	Demonstrate the need to exist as a unit of Family and society.
CO4:	Classify Harmony at all levels.
CO5:	Apply the values acquired in the professional front.
CO6:	Identify appropriate technologies for ecofriendly production systems.
TEXT BOOKS:	
1	R R Gaur, R Sangal, G P Bagaria,Human Values and Professional Ethics, Excel Books, New Delhi, 2010 3.
2	Mike W. Martin and Roland Schinzinger, ―Ethics in Engineering‖, Tata McGraw Hill, New Delhi, 2003.
3	Govindarajan M, Natarajan S, Senthil Kumar V. S, ―Engineering Ethics‖, Prentice Hall of India, New Delhi, 2004
REFERENCES:	
1	Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
2	Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3	The Story of Stuff (Book).
4	The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi AICTE Model Curriculum in Humanities, Social Science and Management Courses (UG Engineering & Technology) 169 | Page .
5	Small is Beautiful - E. F Schumacher.
6	Slow is Beautiful - Cecile Andrews.
7	Economy of Permanence - J C Kumarappa 8. Bharat Mein Angreji Raj – Pandit Sunderlal.
8	Rediscovering India - by Dharampal.
9	Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi.
10	India Wins Freedom - Maulana Abdul Kalam Azad.
11	Vivekananda - Romain Rolland (English) 13. Gandhi - Romain Rolland (English).
12	Charles B. Fleddermann, ―Engineering Ethics‖, Pearson Prentice Hall, New Jersey, 2004.

13	Charles E. Harris, Michael S. Pritchard and Michael J. Rabins, ―Engineering Ethics – Concepts and Cases‖, Cengage Learning, 2009.

WEB SOURCES:	
1	www.onlineethics.org
2	www.nspe.org
3	www.globalethics.org

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	-	-	-	-	-	3	3	3	3	3	-	-	-	-	3
2	-	-	-	-	-	3	3	3	3	3	-	-	-	-	3
3	-	-	-	-	-	3	3	3	3	3	-	-	-	-	3
4	-	-	-	-	-	3	3	3	3	3	-	-	-	-	3
5	-	-	-	-	-	3	3	3	3	3	-	-	-	-	3
6	-	-	-	-	-	3	3	3	3	3	-	-	-	-	3
Overall Correlation	**-**	**-**	**-**	**-**	**-**	**3**	**3**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**3**
Recommended by Board of Studies	**08-04-2024**														
Approved	**2nd ACM**			**Date**				**25-05-2024**							

<table>
<tr><td rowspan="2">23MT312</td><td rowspan="2">DIGITAL ELECTRONICS AND MICROPROCESSOR</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>2</td><td>4</td></tr>
<tr><td colspan="6">COURSE OBJECTIVES:</td></tr>
<tr><td colspan="6">• To present the Digital fundamentals, Boolean algebra and its applications in digital systems.
• To familiarize with the design of various combinational digital circuits using logic gates.
• To introduce the analysis and design procedures for synchronous and asynchronous sequential circuits.
• To explain the various semiconductor memories and related technology.
• To introduce the electronic circuits involved in the making of logic gate.</td></tr>
<tr><td>UNIT I</td><td colspan="4">DIGITAL FUNDAMENTALS</td><td>9</td></tr>
<tr><td colspan="6">Number Systems – Decimal, Binary, Octal, Hexadecimal, 1‘s and 2‘s complements, Codes – Binary, BCD, Excess 3, Gray, Alphanumeric codes, Boolean theorems, Logic gates, Universal gates, Sum of products and products of sums, Mini terms and Maxterms, Karnaugh map Minimization and Quine McCluskey method of minimization.</td></tr>
<tr><td>UNIT II</td><td colspan="4">COMBINATIONAL & SYNCHRONOUS SEQUENTIAL CIRCUITS</td><td>9</td></tr>
<tr><td colspan="6">Design of Half and Full Adders, Half and Full Subtractors, Binary Parallel Adder -Multiplexer, Demultiplexer, Decoder, Priority Encoder. Flip flops – SR, JK, T, D, design of clocked sequential circuits – Design of Counters- Shift registers, Universal Shift Register.</td></tr>
<tr><td>UNIT III</td><td colspan="4">ASYNCHRONOUS SEQUENTIAL CIRCUITS AND MEMORY DEVICES</td><td>9</td></tr>
<tr><td colspan="6">Stable and Unstable states, output specifications, cycles and races, state reduction, race free assignments, Hazards, Essential Hazards, Pulse mode sequential circuits, Design of Hazard free circuits. Basic memory structure – ROM -PROM – EPROM – EEPROM – EAPROM, RAM – Static and dynamic RAM - Programmable Logic Devices – Programmable Logic Array (PLA) - Programmable Array</td></tr>
</table>

Logic (PAL) – Field Programmable Gate Arrays (FPGA).		
UNIT IV	**8085 PROCESSOR**	**9**
Hardware Architecture, pin diagram – Functional Building Blocks of Processor – Memory organization – I/O ports and data transfer concepts– Timing Diagram – Interrupts.		
UNIT V	**PROGRAMMING PROCESSOR**	**9**
Instruction - format and addressing modes – Assembly language format – Data transfer, data manipulation& control instructions – Programming: Loop structure with counting & Indexing – Look up table - Subroutine instructions – stack -8255 architecture and operating modes.		
		TOTAL: 30 PERIODS
PRACTICAL EXERCISES:		
1. Truth Table Verification of Logic gates. 2. Implementation of Boolean expression using K-map and logic gates. 3. Design and implementation of code converters. 4. Design of Full adders using logic gates. 5. Design of Full subtractors using logic gates. 6. Design and Implementation of Shift Registers. 7. Design and implementation of counters using flip-flops. 8. Simple arithmetic operations: Multi precision addition / subtraction /multiplication / division. 9. Programming with control instructions: Increment / Decrement, Ascending / Descending. 10. Program with subroutines.		
		TOTAL:30 PERIODS
COURSE OUTCOMES:		
After completion of the course, the students will be able to:		
CO1:	Analyze Boolean functions using Karnaugh maps and quine Mccluskey method.	
CO2:	Apply the flip flops and gates to create clocked sequential circuits.	
CO3:	Apply the concepts of asynchronous sequential circuits, identify stable and unstable states, and design hazard free circuits .	

CO4:	Explain the instruction format and addressing modes of the 8085 proecessor.
CO5:	Explain the architecture, modes and operation of peripheral devices like the 8255.
CO6:	

TEXT BOOKS:

1	M.Morris Mano and Michael D.Ciletti, “Digital Design”, 5th Edition, Pearson, 2014.
2	Krishna Kant, “Microprocessor and Microcontrollers”, Eastern Company Edition, Prentice Hall of India, New Delhi, 2007.

REFERENCES:

1	Charles H.Roth. “Fundamentals of Logic Design”, 6th Edition, Thomson Learning, 2013.
2	Thomas L. Floyd, “Digital Fundamentals”, 10th Edition, Pearson Education Inc, 2011.
3	Muhammad Ali Mazidi & Janice Gilli Mazidi, R.D.Kinely ‘The 8051 Micro Controller and Embedded Systems’, PHI Pearson Education, 5th Indian reprint, 2003.
4	R.S. Gaonkar, ‘Microprocessor Architecture Programming and Application’, with 8085, Wiley Eastern Ltd., New Delhi, 2013.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	3	2	2	1	2	2	1	2	1	1	1	3	2	2
2	3	2	1	1	1	2	2	1	2	1	1	1	3	2	2
3	3	2	1	1	1	2	2	1	2	1	1	1	3	2	2
4	3	2	1	1	1	2	2	1	2	1	1	1	3	2	2
5	2	1	-	-	-	2	2	1	2	1	1	1	3	2	2
6	2	1	-	-	-										
Overall Correlation	3	2	1	1	1	2	2	1	2	1	1	1	3	2	2

Recommended by Board of Studies	**25-03-2024**		
Approved	**2nd ACM**	**Date**	**25-05-2024**

23MT302	KINEMATICS AND DYNAMICS OF MACHINERY	L	T	P	C
		3	0	2	4

COURSE OBJECTIVES:

- To understand the basic components and layout of linkages in the assembly of a system/ machine and also learn about the mechanisms.
- To understand the basic concepts of toothed gearing and kinematics of gear trains and the effects of friction in motion transmission and in machine components.
- To learn about the concepts in friction.
- To understand the principles in force analysis.
- To learn about the basic concept of static and dynamic balancing and vibration

UNIT I	KINEMATICS OF MACHINES	10

Mechanisms – Terminology and definitions – kinematics inversions of 4 bar and slider crank chain kinematics analysis in simple mechanisms – velocity and acceleration polygons (Relative velocity method) - Coriolis component of Acceleration.

UNIT II	GEARS AND GEAR TRAINS	9

Spur gear – law of toothed gearing – involute gearing – Interchangeable gears – Gear tooth action interference and undercutting – nonstandard teeth – gear trains – parallel axis gears trains – epicyclic gear trains.

UNIT III	CAM AND FRICTION DRIVES	9

Cams – classifications – displacement diagrams - layout of plate cam profiles –derivatives of follower motion – circular arc and tangent cams. Sliding and Rolling Friction angle – friction in threads – Friction Drives – Belt and rope drives.

UNIT IV	FORCE ANALYSIS	8

Static Force analysis in simple machine members – Dynamic Force Analysis Inertia Forces and Inertia Torque – D'Alembert's principle

– superposition principle – dynamic Force Analysis in simple machine members.		
UNIT V	**BALANCING AND VIBRATION**	**9**
Static and Dynamic balancing – Balancing of revolving and reciprocating masses – Balancing machines – free vibrations – Equations of motion – natural Frequency – Damped Vibration – critical speed of simple shaft.		
TOTAL: 45 PERIODS		
PRACTICAL EXERCISES:		
1. Coriolis Component of Acceleration 2. Determination of Mass moment of inertia of Fly wheel and Axle system. 3. Cams – Cam profile drawing, Motion curves and study of jump phenomenon 4. Determination of torsional natural frequency of single and Double Rotor systems. - Undamped Natural frequencies. 5. Vibration of Equivalent Spring mass system – undamped vibration. 6. Whirling of shafts – Determination of critical speeds of shafts with concentrated loads. 7. Transverse vibration of Free-Free beam – with and without concentrated masses.		
TOTAL:30 PERIODS		
COURSE OUTCOMES:		
After completion of the course, the students will be able to:		
CO1:	Construct the linkage and kinematic analysis of simple components.	
CO2:	Analyze the toothed gearing and kinematics of gear trains.	
CO3:	Apply the concepts in friction and draw the profile CAM mechanism.	
CO4:	Apply the principles in static and dynamics force analysis in machine members.	
CO5:	Apply the basic concepts of static and dynamic balancing.	

CO6:	Apply the basic concepts of free and damped vibration.
TEXT BOOKS:	
1	Rattan, S.S, “Theory of Machines”, 4th Edition, Tata McGraw-Hill, 2014.
2	Bansal R.K., “Theory of Machines”, Laxmi Publications Pvt Ltd., New Delhi, 20th edition,2009
REFERENCES:	
1	Thomas Bevan, “Theory of Machines”, CBS Publishers and Distributors, 1984.
2	Ghosh. A, and A.K. Mallick, “Theory and Machine”, Affiliated East-West Pvt. Ltd., New Delhi,1988.
3	Ramamurthi, Mechanisms of Machine, Narosa Publishing House, 2002.
4	Ambekar A. G., “Mechanism and Machine Theory” Prentice Hall of India,New Delhi, 2007.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	2	2	-	-	-	-	-	1	2	1	3
2	3	3	2	2	2	2	-	-	-	-	-	1	2	1	3
3	3	2	1	1	2	2	-	-	-	-	-	1	2	1	3
4	3	2	1	1	2	2	-	-	-	-	-	1	2	1	3
5	3	2	1	1	2	2	-	-	-	-	-	1	2	1	3
6	3	2	1	1	2	2	-	-	-	-	-	1	2	1	3
Overall Correlation	3	2	1	1	2	2	-	-	-	-	-	1	2	1	3

Recommended by Board of Studies	**25-03-2024**		
Approved	**2nd ACM**	**Date**	**25-05-2024**

23MT321	MANUFACTURING TECHNOLOGY LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES:

- To Selecting appropriate tools, equipment's and machines to complete a given job.
- To Performing various welding process using GMAW and fabricating gears using gear making machines.
- To Performing various machining process such as rolling, drawing, turning, shaping, drilling, milling and analyzing the defects in the cast and machined components.

LIST OF EXPERIMENTS:

1. Fabricating simple structural shapes using Gas Metal Arc Welding machine.
2. Preparing green sand moulds with cast patterns.
3. Taper Turning and Eccentric Turning on circular parts using lathe machine.
4. Knurling, external and internal thread cutting on circular parts using lathe machine.
5. Shaping – Square and Hexagonal Heads on circular parts using shaper machine.
6. Drilling and Reaming using vertical drilling machine.
7. Milling contours on plates using vertical milling machine.
8. Cutting spur and helical gear using milling machine.
9. Generating gears using gear Hobbing machine.
10. Generating gears using gear shaping machine.
11. Grinding components using cylindrical and centerless grinding machine.
12. Grinding components using surface grinding machine.
13. Cutting force calculation using dynamometer in milling machine
14. Cutting force calculation using dynamometer in lathe machine.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

After completion of the course, the students will be able to:

CO1:	Construct the various types of joints using metal arc welding.
CO2:	Construct the green sand molding for the given cast pattern.
CO3:	Apply concepts of metal cutting process and operation to make the given sample as per given dimension using lathe machine tool.
CO4:	Apply concepts of reciprocating tool to machine the given sample as per the dimension using shaper machine.
CO5:	Construct the drilling and reaming operation to the given sample as per dimension using drilling machine.
CO6:	Construct spur gear using various milling machine tools

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	-	-	1	-	2	-	-	1	1	1	1
2	3	2	1	1	-	-	1	-	2	-	-	1	1	1	1
3	3	2	1	1	-	-	1	-	2	-	-	1	1	1	1
4	3	2	1	1			1	-	2	-	-	1	1	1	1
5	3	2	1	1			1	-	2	-	-	1	1	1	1
6	3	2	1	1			1	-	2	-	-	1	1	1	1
Overall Correlation	3	2	1	1	-	-	1	-	2	-	-	1	1	1	1

Recommended by Board of Studies	**01-04-2024**		
Approved	**2nd ACM**	**Date**	**05-05-2024**

23MT322	ELECTRICAL DRIVES AND ACTUATORS LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES:

- To impart knowledge on Performance of the fundamental control practices associated with AC and DC machines (starting, reversing, braking, plugging, etc.) using power electronics To impart industry-oriented learning
- To evaluate the use of computer-based analysis tools to review the major classes of machines and their physical basis for operation

LIST OF EXPERIMENTS:

1. Load test on DC Motor.
2. Load test on 3-phase Induction Motor.
3. Load test on 3-Phase Synchronous Motor.
4. Rheostat-based Speed control of motors (AC and DC).
5. Switching circuits of MOSFET, IGBT, SCR and TRAIC.
6. Gate pulsation generation using PWM signals.
7. Speed control of DC motor using Power Electronic Drive.
8. Position, Direction, and speed control of stepper Motor.
9. Position and direction control DC servomotor.
10. VFD controls single-phase and three-phase induction motors using Power Electronic Drive.
11. Position, direction, and speed control of BLDC and PMDC motors using Power Electronic drive.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

After completion of the course, the students will be able to:

CO1:	Apply the load test on AC and DC motors.
CO2:	Construct switching circuits of MOSFET, IGBT, SCR and TRAIC.

CO3:	Analyze the performance of speed control of DC motor using Power Electronic Drive.
CO4:	Analyze Position, Direction, and speed control of stepper Motor.
CO5:	Analyze Position and direction control DC servomotor.
CO6:	Analyze Position, direction, and speed control of BLDC and PMDC motors using Power Electronic drive.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	-	-	1	-	2	-	-	1	1	1	1
2	3	2	1	1	-	-	1	-	2	-	-	1	1	1	1
3	3	2	1	1	-	-	1	-	2	-	-	1	1	1	1
4	3	2	1	1			1	-	2	-	-	1	1	1	1
5	3	2	1	1			1	-	2	-	-	1	1	1	1
6	3	2	1	1			1	-	2	-	-	1	1	1	1
Overall Correlation	3	2	1	1	-	-	1	-	2	-	-	1	1	1	1

Recommended by Board of Studies	**01-04-2024**		
Approved	**2nd ACM**	**Date**	**05-05-2024**

23ES391	PRESENTATION SKILLS	L	T	P	C
		0	0	2	1*

COURSE OBJECTIVES:

- To help learners use brainstorming techniques for generating, organizing and outlining ideas.
- To familiarize learners with different speech structures by engaging them in watching speeches with great opening and closing
- To give practice on voice modulation and use of body language and eye contact for making captivating presentations
- To give hands on training on preparing presentation slides and using remote presentation tools
- To train students on responding to question and feedback with confidence.

UNIT I	BRAINSTORMING AND OUTLINING	6

Mind Mapping based on prior knowledge, collecting additional information from external resources, giving prompts to Generative AI tools seeking information, organizing ideas generated, knowing your audience.

UNIT II	STRUCTURING THE PRESENTATION	6

3 Ts of a presentation, writing effective introduction- Beginning the introduction with a hook (question, data, storytelling) and closing the introduction with the objective of the presentation. Structuring the body paragraphs -Choosing key ideas from the list of ideas generated during brainstorming. Substantiating ideas with examples, data, reasons and anecdotes. Summarizing the ideas for conclusion.

UNIT III	DELIVERY TECHNIQUES	6

Vocal variety, intonation, reducing filler words and improving articulation, inflection, engaging the audience. Body language- eye

contact, gestures, movement on stage.		
UNIT IV	**USE OF TECHNOLOGICAL AIDS**	**6**
Use of presentation software like MS Power Point, Google Slides etc, incorporating images, graphs, charts and videos, using interactive tools like quizzes and polls, using remote presentation tools like zoom, MS Teams, WebEx for screen sharing, virtual whiteboards and chat functionalities, incorporating AR/VR for more immersive presentations.		
UNIT V	**HANDLING QUESTIONS AND FEEDBACK**	**6**
Audience engagement through questions, PAR (Point, Answer, Redirect) strategy for structuring responses to questions. Understanding feedback process - Receiving, interpreting and evaluating constructively, active listening techniques for processing feedback, responding to feedback- acknowledging, clarifying and appreciating, Dealing with challenging feedback.		
		TOTAL: 30 PERIODS

COURSE OUTCOMES:

After completion of the course, the students will be able to:

CO1:	Construct ideas for presentation through mind mapping techniques
CO2:	Organize ideas and structure the presentation with captivating introduction, body paragraphs illustrated with examples and reasons and compelling conclusion
CO3:	Apply vocal variety and body language techniques to enhance delivery
CO4:	Prepare engaging presentations by integrating multimedia elements
CO5:	Demonstrate proficiency in delivering presentations in remote platforms utilizing various technological tools and strategies to engage audience in Virtual environments
CO6:	Exhibit active listening skills by responding to questions with clarity and confidence and incorporating constructive feedback for professional development

TEXT BOOKS:	
1	Nancy Duarte "Slide:ology: The Art and Science of Creating Great Presentations" O' Reilly Media.
2	Garr Reynolds "The Naked Presenter: Delivering Powerful Presentations with or Without Slides" New Riders.
REFERENCES:	
1	Talk Like TED: The 9 Public-Speaking Secrets of the World's Top Minds" by Carmine Gallo.

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	2	1	1	-	-	-	1	1	1	-	1	2	2	1
2	2	2	1	1	-	-	-	1	1	1	-	1	2	2	1
3	2	2	1	1	-	-	-	1	1	1	-	1	2	2	1
4	2	2	1	1	-	-	-	1	1	1	-	1	2	2	1
5	2	2	1	1	-	-	-	1	1	1	-	1	2	2	1
6	2	2	1	1	-	-	-	1	1	1	-	1	2	2	1
Overall Correlation	**2**	**2**	**1**	**1**	**-**	**-**	**-**	**1**	**1**	**1**	**-**	**1**	**2**	**2**	**1**

Recommended by Board of Studies	**01-04-2024**		
Approved	**2nd ACM**	**Date**	**05-05-2024**

SEMESTER –IV

23MA401	OPTIMIZATION TECHNIQUES	L	T	P	C
		3	1	0	4

COURSE OBJECTIVES:

- Formulate and solve linear programming problems (LPP).
- Evaluate Transportation and Assignment Problems.
- Manage purchasing/manufacturing policies.
- Obtain solution to network problems using CPM and PERT techniques.
- Optimize the function subject to the constraints.

UNIT I	**LINEAR PROGRAMMING MODELS**	**9+3**

Introduction of Operations Research - mathematical formulation of LPP- Graphical Methods to solve LPP- Simplex Method- Big M method, Two phase method.

UNIT II	**TRANSPORTATION PROBLEMS AND ASSIGNMENT PROBLEMS**	**9+3**

Transportation problem (TP) - finding basic feasible solution of TP using North-West Corner Rule, Least Cost and Vogel's Approximation Method - MODI method for finding optimal solution for TP - Assignment problem - Hungarian method for solving Assignment problem - Travelling salesman problem as assignment problem – Production Scheduling problem – Introduction, Problems in single machine scheduling.

UNIT III	**INVENTORY CONTROL**	**9+3**

Introduction, Models – Problems in Purchase and Production (Manufacturing) models with and without shortages – Theory on types of inventory control systems: P& Q, ABC, VED, FNS, XYZ, SDE and HML.

UNIT IV	**PROJECT MANAGEMENT**	**9+3**

Project definition - Gantt chart - Project network - Diagram representation – Floats - Critical path method (CPM) – PERT- Cost considerations in PERT and CPM.

UNIT V	**CLASSICAL OPTIMIZATION THEORY**	**9+3**

Unconstrained problems – necessary and sufficient conditions -

Newton-Raphson method, Constrained problems – equality constraints – inequality constraints - Kuhn-Tucker conditions.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

After completion of the course, the students will be able to:

CO1:	Solve linear programming problems.
CO2:	Examine Transportation Problems.
CO3:	Examine Assignment Problems.
CO4:	Plan the purchase/ manufacturing policies to meet customer demands.
CO5:	Find solutions to network problems using CPM and PERT techniques.
CO6:	Optimize the function subject to the constraints.

TEXT BOOKS:

1	Hamdy A Taha, Operations Research: An Introduction, Pearson, 10th Edition, 2017 .
2	R. Pannerselvan, Operations Research, 2nd Edition, PHI Publications, 2006.

REFERENCES:

1	Dontzig G.B, Linear Programming and extensions, Princeton University Press.
2	ND Vohra, Quantitative Techniques in Management, Tata McGraw Hill, 4th Edition, 2011.
3	J. K. Sharma, Operations Research Theory and Applications, Macmillan, 5th Edition, 2012.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
2	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
3	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
4	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
5	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
6	3	2	1	1	-	-	-	-	-	-	-	1	3		
Overall Correlation	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-

Recommended by Board of Studies	**08-04-2024**		
Approved	**2nd ACM**	**Date**	**25-05-2024**

<table>
<tr><td rowspan="2">23MT401</td><td rowspan="2">SENSORS AND INSTRUMENTATION</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="6">COURSE OBJECTIVES:</td></tr>
<tr><td colspan="6">
• To understand the concepts of measurement technology.
• To learn the various sensors used to measure various physical parameters.
• To learn the fundamentals of signal conditioning, data acquisition and communicationsystems used in mechatronics system development.
• To learn about the optical, pressure and temperature sensor.
• To understand the signal conditioning and DAQ systems.
</td></tr>
<tr><td>UNIT I</td><td colspan="4">INTRODUCTION</td><td>9</td></tr>
<tr><td colspan="6">Basics of Measurement – Classification of errors – Error analysis – Static and dynamic characteristics of transducers – Performance measures of sensors – Classification of sensors – Sensor calibration techniques – Sensor Output Signal Types.</td></tr>
<tr><td>UNIT II</td><td colspan="4">MOTION, PROXIMITY AND RANGING SENSORS</td><td>9</td></tr>
<tr><td colspan="6">Motion Sensors – Potentiometers, Resolver, Encoders – Optical, Magnetic, Inductive, Capacitive, LVDT – RVDT – Synchro – Microsyn, Accelerometer – GPS, Bluetooth, Range Sensors – RF beacons, Ultrasonic Ranging, Reflective beacons, Laser Range Sensor (LIDAR).</td></tr>
<tr><td>UNIT III</td><td colspan="4">FORCE, MAGNETIC AND HEADING SENSORS</td><td>9</td></tr>
<tr><td colspan="6">Strain Gage, Load Cell, Magnetic Sensors –types, principle, requirement and advantages: Magneto resistive – Hall Effect – Current sensor Heading Sensors – Compass, Gyroscope, Inclinometers.</td></tr>
</table>

UNIT IV	**OPTICAL, PRESSURE AND TEMPERATURE SENSORS**	**9**
Photo conductive cell, photo voltaic, Photo resistive, LDR – Fiber optic sensors – Pressure – Diaphragm, Bellows, Piezoelectric – Tactile sensors, Temperature – IC, Thermistor, RTD, Thermocouple. Acoustic Sensors – flow and level measurement, Radiation Sensors - Smart Sensors - Film sensor, MEMS & Nano Sensors, LASER sensors.		
UNIT V	**SIGNAL CONDITIONING AND DAQ SYSTEMS**	**9**
Amplification – Filtering – Sample and Hold circuits – Data Acquisition: Single channel and multi- channel data acquisition – Data logging - applications - Automobile, Aerospace, Home appliances, Manufacturing, Environmental monitoring.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
	After completion of the course, the students will be able to:
CO1:	Explain with various calibration techniques and signal types of sensors.
CO2:	Explain the working principle and characteristics of motion sensor, encoders, accelometers and range sensor.
CO3:	Explain the working principal and characteristics of force magnetics and heading sensor heading sensors.
CO4:	Explain the working principal and characteristics of optical, pressure and temperature sensors.
CO5:	Explain the working principal and characteristics of smart sensors
CO6:	Develop the signals from different sensors using data acquisition systems.
TEXT BOOKS:	
1	Ernest O Doebelin, "Measurement Systems – Applications and Design", Tata McGraw-Hill, 2009.

2	Sawney A K and Puneet Sawney, “A Course in Mechanical measurements and Instrumentation and Control”, 12th edition, Dhanpat Rai & Co, New Delhi, 2013.
REFERENCES:	
1	C. Sujatha ... Dyer, S.A., Survey of Instrumentation and Measurement, John Wiley & Sons, Canada, 2001.
2	Hans Kurt Tönshoff (Editor), Ichiro, “Sensors in Manufacturing” Volume 1, Wiley-VCH April 2001.
3	John Turner and Martyn Hill, “Instrumentation for Engineers and Scientists”, Oxford Science Publications, 1999.
4	Patranabis D, “Sensors and Transducers”, 2nd Edition, PHI, New Delhi, 2011.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	-	-	-	-	-	2	-	-	-	2	2	1	3
2	2	1	-	-	-	-	-	2	-	-	-	2	2	1	3
3	3	2	1	1	1	1	-	2	-	-	-	2	2	1	3
4	2	1	-	-	-	-	-	2	-	-	-	2	2	1	3
5	3	2	1	1	1	1	-	2	-	-	-	2	2	1	3
6	2	2	1	1	1	1	-	2	-	-	-	2	2	1	3
Overall Correlation	2	1	-	-	-	-	-	2	-	-	-	2	2	1	3

Recommended by Board of Studies	**25-03-2024**		
Approved	**2nd ACM**	**Date**	**25-05-2024**

23MT402	FLUID MECHANICS AND THERMAL SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To knowledge in Fluid Properties and Statics
- To understand the concept of fluid kinematics and Dynamics.
- To learn about the flows in fluid, Viscous flows and flow through pipes
- To understand the basics laws of thermodynamics
- To understand the second law of thermodynamics and entropy

UNIT I	FLUID PROPERTIES AND FLUID STATICS	9

Fluid Definition and Classification – Properties of fluids: Density, Specific Weight, Specific Volume, Specific Gravity, Viscosity, Compressibility, Bulk Modulus, Capillary and Surface Tension – Fluid statics: Concept of fluid static pressure – Pascal's law – Absolute and Gauge pressures – Manometers: Types and Pressure measurement.

UNIT II	FLUID KINEMATICS AND FLUID DYNAMICS	9

Fluid Kinematics: Types of fluid flow – Continuity equation in two and three dimensions – Velocity and Acceleration of fluid particle – Velocity potential function and Stream function. Fluid dynamics: Euler's equation along a streamline –Bernoulli's equation and applications – Venturi meter, Orifice meter and Pitot tube.

UNIT III	BASICS OF THERMODYNAMICS AND FIRST LAW OF THERMODYNAMICS	9

Thermodynamics – Microscopic and macroscopic point of view – Systems, properties, process, path, cycle. Thermodynamic equilibrium – Zeroth law of Thermodynamics – internal energy, enthalpy, specific heat capacities CV and CP, Relationship between CV and CP. First law of Thermodynamics – Application to closed and open systems – Steady Flow Energy Equation (SFEE) – Simple problems.

UNIT IV	**SECOND LAW OF THERMODYNAMICS AND ENTROPY**	**9**
Second Law of thermodynamics – Kelvin Planck and Clausius Statements – Equivalents of Kelvin Planck and Clausius statements. Reversibility – Irreversibility, reversible cycle – Heat engine, heat pump and refrigerator. Carnot cycle and Clausius theorem, the property of entropy, the inequality of Clausius – Entropy principle – General expression for entropy – Simple problems in entropy.		
UNIT V	**HEAT TRANSFER**	**9**
Introduction to heat transfer Modes of Heat Transfer- Conduction, Convection Radiation, Heat exchangers, Boiling and Condensation, Thermal insulation and heat loss, Introduction to computational heat transfer.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
	After completion of the course, the students will be able to:
CO1:	Solve the fluid properties and fluid under static conditions
CO2:	Apply the problems related to kinematics and dynamics of fluids
CO3:	Apply the basics concepts and first laws of thermodynamics.
CO4:	Solve the Problem based on second laws of thermodynamics
CO5:	Apply the concepts of conduction in heat transfer system.
CO6:	Apply the concepts of Convection in heat transfer system.
TEXT BOOKS:	
1	Bansal R.K., ―Fluid Mechanics and Hydraulic Machines‖, 9th Edition, Laxmi Publications, New Delhi, 2015.
2	Nag P.K., ― Engineering Thermodynamics, 5th Edition, Tata McGraw Hill Publishing Company, New Delhi, 2013.

REFERENCES:	
1	Cengel Yunus A. and Boles Michael A., ―Thermodynamics: An Engineering Approach,b7th Edition, McGraw-Hill, New York, 2011.
2	Frank M. White., ―Fluid Mechanics‖, 7th Edition, Tata McGraw Hill Publishing Company, New Delhi, 2009.
3	Heat Transfer by J.P. Holman
4	Fundamentals of Heat and Mass Transfer by Frank P. Incropera and David P. DeWitt

COs	POs												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	1	1	-	2	-	-	1	1	2	2	1
2	3	2	1	1	1	1	-	2	-	-	1	1	2	2	1
3	3	2	1	1	1	1	-	2	-	-	1	1	3	3	1
4	3	2	1	1	1	1	-	2	-	-	1	1	3	3	1
5	3	2	1	1	1	1	-	2	-	-	1	1	2	2	1
6	3	2	1	1	1	1	-	2	-	-	1	1	2	2	1
Overall Correlation	3	2	1	1	1	1	-	2	-	-	1	1	2	2	1

Recommended by Board of Studies	**25-03-2024**		
Approved	**2nd ACM**	**25-05-2024**	

<table>
<tr><td rowspan="2">23CE412</td><td rowspan="2">STRENGTH OF MATERIALS</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>2</td><td>4</td></tr>
<tr><td colspan="6">COURSE OBJECTIVES:</td></tr>
<tr><td colspan="6">• To understand the concepts of stress, strain, principal stresses and principal planes.
• To study the concept of shearing force and bending moment due to external loads in determinate beams and their effect on stresses.
• To determine stresses and deformation in circular shafts and helical spring due to torsion.
• To compute slopes and deflections in determinate beams by various methods.
• To study the stresses and deformations induced in thin and thick shells.</td></tr>
<tr><td>UNIT I</td><td colspan="4">STRESS, STRAIN AND DEFORMATION OF SOLIDS</td><td>9</td></tr>
<tr><td colspan="6">Rigid bodies and deformable solids – Tension, Compression and Shear Stresses – Deformation of simple and compound bars – Thermal stresses – Elastic constants, Poisson's ratio – Volumetric strains – Stresses on inclined planes – principal stresses and principal planes – Mohr's circle for plane stress.</td></tr>
<tr><td>UNIT II</td><td colspan="4">TRANSVERSE LOADING ON BEAMS AND STRESSES IN BEAMS</td><td>9</td></tr>
<tr><td colspan="6">Beams – types transverse loading on beams – Shear force and bending moment in beams – Cantilevers – Simply supported beams and over – hanging beams. Theory of simple bending– bending stress distribution – Load carrying capacity – Proportioning of sections– Shear stress distribution.</td></tr>
<tr><td>UNIT III</td><td colspan="4">DEFLECTION OF BEAMS</td><td>9</td></tr>
<tr><td colspan="6">Double Integration method – Macaulay's method – Area moment method- Conjugate beam method for computation of slopes and deflections in determinate beams.</td></tr>
<tr><td>UNIT IV</td><td colspan="4">TORSION, SPRINGS AND COLUMNS</td><td>9</td></tr>
</table>

Theory of Torsion - Stresses and deformations in solid and hollow circular shafts – Stepped shafts – Power transmitted by a shaft. Helical springs – Differences between closely coiled and open coiled helical springs – Closely coiled helical springs – Calculation of shear stress, deflection and stiffness. Columns – Euler's theory – Calculation of crippling load for different end conditions for a long column.		
UNIT V	**THIN CYLINDERS, SPHERES AND THICK CYLINDERS**	**9**
Stresses in thin and thick cylindrical shell, deformation in thin and thick cylinders – spherical shells subjected to internal pressure – Deformation in spherical shells.		
		TOTAL: 45 PERIODS
PRACTICAL EXERCISES:		
1. Tension test on mild steel rod 2. Double shear test on mild steel rod 3. Torsion test on mild steel rod 4. Izod Impact test on metal specimen 5. Charpy Impact test on metal specimen 6. Rockwell Hardness test on metals 7. Brinell Hardness test on metals 8. Compression test on helical spring. 9. Heat Treatment Processes- Annealing, Normalizing, Quenching and Tempering 10. Jominy End Quench Test		
		TOTAL:30 PERIODS
COURSE OUTCOMES:		
After completion of the course, the students will be able to:		
CO1:	Calculate the different stresses developed in the solids when subjected to different loading conditions.	
CO2:	Analyse the shear force and bending moment diagrams of the beams under the various loading conditions.	
CO3:	Examine the bending stress and shear stress distribution of various sections of the beam.	
CO4:	Calculate the slope and deflection of beams using different methods.	

CO5:	Apply the basic equations to design shafts, springs and columns.
CO6:	Calculate the stresses developed in the thin cylinder, thick cylinder, and spherical shells.

TEXT BOOKS:

1	Bansal, R.K., "Strength of Materials", Laxmi Publications (P) Ltd., 2016.
2	Rattan S.S., "Strength of Materials", Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2017.

REFERENCES:

1	Rajput R.K. "Strength of Materials (Mechanics of Solids)", S.Chand & company Ltd., New Delhi, 7th edition, 2018.
2	Egor P Popov, "Engineering Mechanics of Solids", 2nd edition, PHI Learning Pvt. Ltd., New Delhi, 2015.
3	Beer. F.P. & Johnston. E.R. "Mechanics of Materials", Tata McGraw Hill, 8th Edition, New Delhi 2019.
4	Subramanian R., "Strength of Materials", Oxford University Press, Oxford Higher Education Series, 2010.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	1	1	-	-	2	-	-	-	3	1	-
2	3	2	1	1	1	1	-	-	2	-	-	-	3	1	-
3	3	2	1	1	1	1	-	-	2	-	-	-	3	1	-
4	3	2	1	1	1	1	-	-	2	-	-	-	3	1	-
5	3	2	1	1	1	1	-	-	2	-	-	-	3	1	-
6	3	2	1	1	1	1	-	-	2	-	-	-	3	1	-
Overall Correlation	3	2	1	1	1	1	-	-	2	-	-	-	3	1	-

Recommended by Board of Studies	**25-03-2024**		
Approved	**2nd ACM**	**Date**	**25-05-2024**

23MT421	FLUID MECHANICS LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES:

- To enable students to comprehend and apply the principles of fluid flow measurement using devices like orifice meters, Venturi meters, and rotameters.
- To develop the ability to analyze fluid friction in pipes and determine friction factors for various flow conditions.
- To facilitate the understanding of the working principles and performance evaluation of different types of pumps, including centrifugal, reciprocating, and gear pumps.
- To provide hands-on experience in the operation and analysis of hydraulic turbines like the Pelton wheel and enable students to interpret performance curves.
- To strengthen students' ability to apply theoretical knowledge to real-world problems, analyze experimental data, and draw meaningful conclusions.

LIST OF EXPERIMENTS:

1. Determination of the Coefficient of discharge of given Orifice meter.
2. Determination of the Coefficient of discharge of given Venturi meter.
3. Calculation of the rate of flow using Rotometer.
4. Determination of friction factor for a given set of pipes.
5. Conducting experiments and drawing the characteristic curves of centrifugal pump.
6. Conducting experiments and drawing the characteristic curves of reciprocating pump.
7. Conducting experiments and drawing the characteristic curves of Gear pump.
8. Conducting experiments and drawing the characteristic curves of Pelton wheel.

TOTAL : 60 PERIODS

COURSE OUTCOMES:	
	After completion of the course, the students will be able to:
CO1:	Calculate and measure the flow rates using devices such as orifice meters, Venturi meters, and rotameters with precision.
CO2:	Determine and analyze the friction factor for different pipe systems, thereby understanding the effect of flow rate, pipe material, and diameter.
CO3:	Analyze the performance characteristics of centrifugal, reciprocating, and gear pumps through characteristic curves.
CO4:	Apply the concepts of Pelton wheel turbines and evaluate efficiency, flow rates, and other performance parameters.
CO5:	Analyze, and interpret experimental data using appropriate tools and present the results effectively.
CO6:	Apply fluid mechanics principles to practical engineering problems, and prepare comprehensive technical reports.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	1	1	-	2	-	-	1	2	2	2	2
2	3	3	2	2	1	1	-	2	-	-	1	2	2	2	2
3	3	3	2	2	2	2	-	2	-	-	1	2	3	3	2
4	3	2	1	1	1	1	-	2	-	-	1	2	3	3	2
5	3	2	1	1	1	1	-	2	-	-	1	2	2	2	2
6	3	2	1	1	1	1	-	2	-	-	1	2			2
Overall Correlation	3	2	1	1	1	1	-	2	-	-	1	2	2	2	2

Recommended by Board of Studies	**01-04-2024**		
Approved	**2nd ACM**	**Date**	**05-05-2024**

23MT422	SENSORS AND INSTRUMENTATION LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES:

- To enable students to understand the working principles and characteristics of various sensors used for measuring load, torque, force, displacement, pressure, temperature, and light.
- To develop the skills to utilize advanced sensors like ultrasonic, laser, gyroscopes, accelerometers, and magnetometers for distance, velocity, vibration, and direction measurement..
- To provide practical experience in acquiring, processing, and analyzing sensor signals for accurate measurement and control.
- To impart knowledge on the calibration and characterization of sensors for precise measurements in diverse engineering applications.
- To foster students' ability to conduct experiments, analyze data, and solve real-world engineering problems using sensor-based instrumentation systems.

LIST OF EXPERIMENTS:

1. Determination of Load, Torque and Force using Strain Gauge.
2. Determination of the characteristics of Pressure Sensor and Piezoelectric Force Sensor.
3. Determination of Displacement using LVDT.
4. Determine the Characteristics of Various Temperature Sensors.
5. Determine the Characteristics of Various Light Detectors (Optical Sensors).
6. Distance Measurement using Ultrasonic and Laser Sensor.
7. Determine angular velocity of gyroscope.
8. Vibration measurement using Accelerometer.
9. Direction measurement using Magnetometer.

10. Speed, Position and Direction Measurement Using Encoders.
11. Force measurement using 3 axis force sensor.
12. Force Measurement using tactile sensors.
13. Data acquisition, visualization and analysis of signals.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

After completion of the course, the students will be able to:

CO1:	Apply load, torque, and force using strain gauges, and analyze the corresponding sensor output.
CO2:	Determine the characteristics of pressure sensors, piezoelectric force sensors, temperature sensors, and optical sensors, and understand their behavior under different conditions..
CO3:	Determine displacement and distances using LVDTs, ultrasonic and laser sensors.
CO4:	Apply and measure angular velocity using gyroscopes, vibration using accelerometers, and determine direction using magnetometers.
CO5:	Analyze data from various sensors, and perform sensor calibration to ensure accuracy and reliability of measurements.
CO6:	Design and conduct experiments involving sensor-based systems, work effectively in teams, and prepare clear and concise technical reports.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	1	1	-	2	-	-	-	2	2	1	3
2	3	3	2	2	2	2	-	2	-	-	-	2	2	1	3
3	3	3	2	2	2	2	-	2	-	-	-	2	2	1	3
4	3	2	1	1	1	1		2				2	2	1	3
5	3	3	2	2	2	2		2				2	2	1	3
6	3	3	2	2	2	2		2				2	2	1	3
Overall Correlation	3	3	2	2	2	2	-	2	-	-	-	2	2	1	3

Recommended by Board of Studies	**01-04-2024**		
Approved	**2nd ACM**	**Date**	**05-05-2024**

23ES491	APTITUDE AND LOGICAL REASONING – 1	L	T	P	C
		0	0	2	1

COURSE OBJECTIVES:

- To improve the problem solving and logical thinking ability of the students.
- To acquaint student with frequently asked questions and patterns in quantitative aptitude and logical reasoning.

UNIT I		**4**
Numbers, LCM, HCF, Averages, Ratio & Proportion, Mixtures & Allegation.		
UNIT II		**4**
Percentages, Time and work, Pipes and Cistern, coding and decoding.		
UNIT III		**4**
Time Speed Distance, Train, Boats and Streams, Analogy.		
UNIT IV		**4**
Data Interpretation (BAR,PIE,LINE), Seating arrangement.		
UNIT V		**4**
Simple Interest and Compound Interest, Profit loss and Discount, Partnership.		
		TOTAL: 20 PERIODS

COURSE OUTCOMES:

After completion of the course, the students will be able to:

CO1:	Analyse and solve complex problems, and foster critical thinking and logical reasoning skills.
CO2:	Solve fundamental mathematical problems, and enhance their computational skills and numerical ability.
CO3:	Develop strategies for tackling a variety of problem types, and encourage the use of multiple approaches to solve problems efficiently.
CO4:	Analyse and solve different data analysis problems for time and distance, and interpret data analysis for a case study.
CO5:	Derive information from graphs, and solve questions based on mathematical operations such as ratios, proportions, basic algebra, and statistical estimation.
CO6:	Solve questions in a fraction of a minute using shortcut methods

TEXT BOOK:	
1	Smith, John. "APTIPEDIA." 2nd ed., Wiley Publishers, 2020.
2	Agarwal, R.S. "Quantitative Aptitude." 2nd ed., S. Chand Publishing.
REFERENCES:	
1	Agarwal, R.S. "A Modern Approach to Verbal & Non-Verbal Reasoning." 2nd ed., S. Chand Publishing

Cos	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	3	2	-	-	2	1	1	2	1	2	3	1	-	3
2	2	3	3	-	-	2	-	1	3	2	2	3	2	1	3
3	3	3	3	-	-	2	-	1	2	2	2	3	2	-	3
4	2	3	2	3	-	2	1	2	3	3	2	3	1	2	3
5	3	2	2	-	1	3	-	2	2	3	3	3	3	1	3
6	3	3	3	3	2	3	1	3	3	2	3	3	3	1	3
Overall Correlation	3	3	3	1	1	3	1	2	3	3	3	3	2	1	3

Recommended by Board of Studies	**08-04-2024**		
Approved	**2nd ACM**	**Date**	**25-05-2024**

23MT423	MINI PROJECT -1	L	T	P	C
		0	0	2	1

COURSE OBJECTIVES:

- Encourage students to apply foundational theoretical knowledge to practical engineering problems.
- Develop collaborative and project management skills through teamwork and effective communication.
- Train students in basic research methodology, technical documentation, and presentation techniques to articulate project outcomes clearly.
- Enhance students' ability to systematically design, analyze, and evaluate simple prototypes or models.
- Prepare students for real-world engineering challenges and lay the foundation for multidisciplinary teamwork and problem-solving in advanced projects.

COURSE DESCRIPTION:

This course serves as an introductory platform for students to apply the foundational knowledge acquired from their core and interdisciplinary subjects in a practical setting. This course enables students to work on small-scale, department-relevant projects that focus on problem identification, basic design, and preliminary prototype development. With limited prior expertise, students will explore the process of translating theoretical concepts into tangible solutions, fostering creativity, teamwork, and critical thinking. The course emphasizes hands-on learning, communication, and project documentation, laying a strong foundation for advanced projects and professional challenges in later semesters.

PROJECT OUTLINE:

Week 1	Course Orientation and Topic Selection
Week 2	Problem Definition and Objective Setting

Week 3	Literature Review and Research
Week 4	First Review and Feedback
Week 5	Problem Refinement and Research Gap Identification
Week 6	Conceptual Design and Initial Approach
Week 7	Methodology and Project Planning
Week 8	Second Review and Project Evaluation
Week 9	Design Refinement and Testing
Week 10	Resource Identification and Budget Estimation
Week 11	Report Writing and Presentation Preparation
Week 12	Third Review Presentation and Submission of Thesis

EVALUATION:

- The progress of the mini project will be evaluated through three reviews, conducted by a committee appointed by the Head of the Department. A final project report must be submitted at the end of the semester. Evaluation will be based on oral presentation and the written report, assessed by internal examiners designated by the Head of the Department.
- The project should focus on topics from first three or four semester (whichever is applicable) subjects / industry demand topics, or futuristic technologies. It is recommended for Faculty of Aeronautical Engineering, Civil Engineering, and Mechanical Engineering students, the project should demonstrate an understanding of first principles of engineering.
- Similarly for students of Faculty of Computer Science Engineering, the project may involve programming using Python or C language. For Faculty of Electronics and Communication Engineering, the student project shall

	incorporate appropriate techniques and systems relevant to the field. For the students of Faculty of Fashion Technology, the project based on material innovations, or technology in fashion is recommended. • The evaluation will focus on how well the project is structured, including clarity and logical flow in both oral presentations and written texts. • The relevance and innovation of the project will be assessed, particularly its potential to contribute to sustainability, innovation, and SDG-aligned goals. • The accuracy of English usage, including grammar, clarity, and coherence, will be reviewed in both oral and written communication to ensure effective delivery of technical content.
COURSE OUTCOMES:	
	After completion of the course, the students will be able to:
CO1:	Apply basic engineering principles to solve simple problems.
CO2:	Choose relevant sources to understand the current knowledge and identify areas to improve.
CO3:	Utilise basic tools and techniques to test simple solutions.
CO4:	Interpret the impact of engineering solutions on society and the environment.
CO5:	Combine in teams to plan and complete projects within given constraints.
CO6:	Develop comprehensive technical reports and deliver structured presentations to effectively convey project outcomes.

COs	POs												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	1	1	1	3	2	2	2	1	3	1	3
2	3	2	1	1	1	1	1	3	2	2	2	1	3	1	3
3	3	2	1	1	1	1	1	3	2	2	2	1	3	1	3
4	3	2	1	1	1	1	1	3	2	2	2	1	3	1	3
5	3	2	1	1	1	1	1	3	2	2	2	1	3	1	3
6	3	2	1	1	1	1	1	3	2	2	2	1	3	1	3
Overall Correlation	3	2	**1**	**1**	**1**	**1**	**1**	**3**	**2**	**2**	**2**	**1**	**3**	**1**	**3**
Recommended by Board of Studies								**01-04-2024**							
Approved								**2nd ACM**			**Date**			**25-05-2024**	

SEMESTER -V

<table>
<tr><td rowspan="2">23RE501</td><td rowspan="2">RESEARCH METHODOLOGY AND INTELLECTUAL PROPERTY RIGHTS</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>2</td><td>0</td><td>0</td><td>2</td></tr>
<tr><td colspan="6">COURSE OBJECTIVES:</td></tr>
<tr><td colspan="6">• To provide an overview on selection of research problem based on the Literature review
• To enhance knowledge on the Data collection and Analysis
• To outline the importance of ethical principles to be followed in Research work and IPR</td></tr>
<tr><td>UNIT I</td><td colspan="4">INTRODUCTION TO RESEARCH FORMULATION</td><td>6</td></tr>
<tr><td colspan="6">Meaning of research problem, Sources of research problem, Criteria- good research problem, and selecting a research problem, Scope and objectives of research problem. Defining and formulating the research problem - Necessity of defining the problem - Importance of literature review in defining a problem</td></tr>
<tr><td>UNIT II</td><td colspan="4">LITERATURE REVIEW</td><td>6</td></tr>
<tr><td colspan="6">Literature review – Primary and secondary sources – reviews, treatise, monographs-patents – web as a source – searching the web - Critical literature review – Identifying gap areas from literature review - Development of working hypothesis</td></tr>
<tr><td>UNIT III</td><td colspan="4">DATA ANALYSIS</td><td>6</td></tr>
<tr><td colspan="6">Execution of the research - Data Processing and Analysis strategies - Data Analysis with Statistical Packages - Generalization and Interpretation</td></tr>
<tr><td>UNIT IV</td><td colspan="4">REPORT, THESIS PAPER, AND RESEARCH PROPASAL WRITING</td><td>6</td></tr>
<tr><td colspan="6">Structure and components of scientific reports - Types of report – Technical reports and thesis – Significance – Different steps in the preparation – Layout, structure and Language of typical reports –</td></tr>
</table>

Illustrations and tables - Bibliography, types of referencing, citations- index and footnotes, how to write report- Paper Developing- Plagiarism- Research Proposal- Format of research proposal- a presentation - assessment by a review committee		
UNIT V	**INTELLECTUAL PROPERTY AND PATENT RIGHTS**	**6**
Ethical principles- Plagiarism, Nature of Intellectual Property - Patents, Designs, Trade and Copyright- patent search, Process of Patenting and Development: technological research, innovation, patenting, and development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of Patent Rights – Scope of Patent Rights, Geographical Indications		
		TOTAL: 30 PERIODS

COURSE OUTCOMES:	
	After completion of the course, the students will be able to:
CO1:	Analyze the literature to identify the research gap in the given area of research.
CO2:	Identify and formulate the research Problem
CO3:	Analyze and synthesize the data using research methods and knowledge to provide scientific interpretation and conclusion.
CO4:	Prepare research reports and proposals by properly synthesizing, arranging the research documents to provide comprehensive technical and scientific report
CO5:	Conduct patent database search in various countries for the research problem identified.
CO6:	Apply ethical principles in research and reporting to promote healthy scientific practice

TEXT BOOKS:	
1	Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An Introduction to Research Methodology, RBSA Publishers.
2	Kothari, C.R., 1990. Research Methodology: Methods and Techniques. New Age International. 418p.

3	Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, Ess Ess Publications. 2 volumes.
4	Trochim, W.M.K., 2005. Research Methods: the concise knowledge base, Atomic Dog Publishing. 270p.
5	Wadehra, B.L. 2000. Law relating to patents, Trade Marks, Copy right designs and Geographical indications. Universal Law Publishing
REFERENCES:	
1	Anthony, M., Graziano, A.M. and Raulin, M.L., 2009. Research Methods: A Process of Inquiry, Allyn and Bacon.
2	Carlos, C.M., 2000. Intellectual property rights, the WTO and developing countries: the TRIPS agreement and policy options. Zed Books, New York.
3	Coley, S.M. and Scheinberg, C. A., 1990, "Proposal Writing", Sage Publications.
4	Day, R.A., 1992.How to Write and Publish a Scientific Paper, Cambridge University Press.
5	Fink, A., 2009. Conducting Research Literature Reviews: From the Internet to Paper. Sage Publications
6	Leedy, P.D. and Ormrod, J.E., 2004 Practical Research: Planning and Design, Prentice Hall.
7	Satarkar, S.V., 2000. Intellectual property rights and copy right. ESS Publications.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	1	-	-	1	1	2	-	1	3	2	1
2	3	2	1	1	1	-	-	1	1	2	-	1	3	2	1
3	3	2	1	1	1	-	-	1	1	2	-	1	3	2	1
4	3	2	1	1	1	-	-	1	1	2	-	1	3	2	1
5	3	2	1	1	1	-	-	1	1	2	-	1	3	2	1
6	2	2	1	1	1	-	-	1	1	2	-	1	3	2	1
Overall Correlation	3	2	**1**	**1**	**1**	**-**	**-**	**1**	**1**	2	**-**	**1**	**3**	**2**	**1**

Recommended by Board of Studies	**07-11-2024**		
Approved	**3rd ACM**	**Date**	**30-11-2024**

23MT501	ROBOTICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To learn about basics of robots and their classifications
- To understand the robot kinematics and dynamics in various planar mechanisms
- To learn about the robot operating systems
- To understand the concepts in trajectory planning and programming
- To know about the basics of image processing

UNIT I	BASICS OF ROBOTICS	10

Introduction- Basic components of robot-Laws of robotics-classification of robot- robot architecture, workspace-accuracy-resolution –repeatability of robot. Robot end effectors & Grippers: types & classification- Mechanical gripper- gripper force analysis-other types & special purpose grippers

UNIT II	ROBOT KINEMATICS AND DYNAMICS	11

Robot kinematics: Introduction- Matrix representation- rigid motion & homogeneous transformation- D-H, forward & inverse kinematics of 2DOF and 3 DOF planar and spatial mechanisms. Manipulator dynamics – Lagrange - Euler formulation- Newton - Euler formulation

UNIT III	ROBOT OPERATING SYSTEM	9

ROS Concepts, Writing ROS Nodes, ROS Tools; Messages, Classes and Servers in ROS; Simulation and Visualization in ROS

UNIT IV	TRAJECTORY, PATH PLANNING AND PROGRAMMING	9

Trajectory Planning- Joint space and Cartesian space technique, Introduction to robot control, Robot programming and Languages

UNIT V	ROBOT CASE STUDY	9

Robot Applications – Welding, Palletizing, Deburring, Assembly-

material handling and processing applications, recent trends in industrial robots- Building of grippers	
	TOTAL: 45 PERIODS
COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Explain the basic concepts and terminologies of robots
CO2:	Apply the Procedures for Forward and Inverse Kinematics of Robots.
CO3:	Apply the procedures for Dynamics for Various Robots
CO4:	Construct the different concepts of robots using ROS
CO5:	Apply the various programming techniques.
CO6:	Explain the use of Robots in Industry
TEXT BOOKS:	
1	John.J.Craig, " Introduction to Robotics: Mechanics & control", Pearson Publication, Fourth edition, 2018.
2	K.S.Fu, R.C.Gonzalez, C.S.G.Lee, "Robotics: Sensing, Vision & Intelligence", Tata McGraw-Hill Publication, First Edition, 1987.
REFERENCES:	
1	M.P.Groover, M.Weiss ,R.N. Nagal, N.G.Odrey, "Industrial Robotics - Technology, programming and Applications" Tata , McGraw-Hill Education Pvt Limited 2ndEdition, 2012.
2	Jazar, "Theory of Applied Robotics: Kinematics, Dynamics and Control", Springer, 2ndEdition, 2010
3	S K Saha, Introduction to Robotics, Tata McGraw-Hill, ISBN: 9789332902800, Second Edition, 9789332902800
4	Sathya Ranjan Deb, "Robotics Technology & flexible Automation" Second edition, Tata McGraw-Hill Publication, 2009.
5	Lentin Joseph, “Mastering ROS for Robotic Programming”, Packt Publishing, 2015.
6	Francisco Martín Rico, “A Concise Introduction to Robot Programming with ROS2”, 1st Edition, CRC Press, 2023.

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	1	-	-	-	-	-	1	-	-	-	1	2	1	3
2	3	2	1	1	-	-	-	1	-	-	-	1	2	1	3
3	3	2	1	1	-	-	-	1	-	-	-	1	2	1	2
4	3	2	1	1	-	-	-	1	-	-	-	1	2	1	3
5	3	2	1	1	-	-	-	1	-	-	-	1	2	2	3
6	2	1	-	-	-	-	-	1	-	-	-	1	2	2	3
Overall Correlation	3	2	1	1	-	-	-	1	-	-	-	1	2	1	3

Recommended by Board of Studies	**07-11-2024**		
Approved	**3rd ACM**	**Date**	**30-11-2024**

<table>
<tr><td rowspan="2">23MT502</td><td colspan="2" rowspan="2">MECHATRONICS SYSTEM DESIGN</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="7">COURSE OBJECTIVES:</td></tr>
<tr><td colspan="7">
• To learn about Mechatronics system design and simulation, ergonomics and safety
• To understand theoretical and practical aspects of interfacing, real time data acquisitionand control
• Design of motion converter, Pneumatic and Hydraulic Controller.
• To learn the real time interfacing software and man machine interface
• To know about the various applications in this system
</td></tr>
<tr><td>UNIT I</td><td colspan="5">INTRODUCTION TO DESIGN OF MECHATRONICS SYSTEM</td><td>9</td></tr>
<tr><td colspan="7">Key elements – Mechatronics design process – design parameters – mechatronics and traditional design – Advanced approaches in mechatronics design – Introduction to industrial design, modelling, simulation and analysis.</td></tr>
<tr><td>UNIT II</td><td colspan="5">BASIC SYSTEM MODELLING</td><td>9</td></tr>
<tr><td colspan="7">Introduction – model categories – model development – Simulation using software's – verification and validation – Mathematical modelling: Basic system modelling.</td></tr>
<tr><td>UNIT III</td><td colspan="5">MECHATRONIC SYSTEM MODELLING</td><td>9</td></tr>
<tr><td colspan="7">Engineering systems: Rotational – translational, electro-mechanical, pneumatic-mechanical, hydraulic-mechanical – Dynamic response of the system – first order, second order – performance measure..</td></tr>
<tr><td>UNIT IV</td><td colspan="5">REAL TIME INTERFACING</td><td>9</td></tr>
<tr><td colspan="7">Introduction – Selection of interfacing standards- elements of data acquisition and control systems. – Overview of I/O process – general purpose I/O cards and its installation – Data conversion</td></tr>
</table>

process – Application software – Man machine interface.		
UNIT V	**CASE STUDIES ON DESIGN OF MECHATRONICS SYSTEM**	**9**
Motion control using DC Motor, AC Motor and Servomotor - Temperature control of hot/cold reservoir – Pick and place robot – Car parking barriers – Motion and temperature control of washing machine.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:

After completion of the course, the students will be able to:

CO1:	Explain the basic and key elements of mechatronics design process.
CO2:	Solve basic system modelling
CO3:	Solve the concept of engineering system and dynamic response of system
CO4:	Explain the concept of Real Time interfacing and Data acquisition.
CO5:	Explain the simulation concepts of Mechatronics system.
CO6:	Explain the concepts of design of mechatronics system through case studies.

TEXT BOOKS:

1	Devdas Shetty, Richard A. Kolk, “Mechatronics System Design”, 2nd Edition, Cengage Learning 2012.
2	Georg pelz, "Mechatronic Systems: Modeling and simulation" with HDL’s, John wiley and sons Ltd, 2003.

REFERENCES:

1	Bishop, Robert H, "Mechatronics Hand book", CRC Press, 2002.
2	Bradley, D.Dawson, N.C. Burd and A.J. Loader, "Mechatronics: Electronics in Products and Processes", CRC Press 1991, First Indian print 2010.
3	De Silva, "Mechatronics: A Foundation Course", Taylor & Francis, Indian Reprint, 2013.

COs	POs												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	-	-	-	-	-	1	-	-	-	2	3	2	3
2	3	2	1	1	-	-	-	1	-	-	-	2	3	2	3
3	3	2	1	1	-	-	-	1	-	-	-	2	3	2	3
4	3	2	1	1	-	-	-	1	-	-	-	2	3	2	3
5	2	1	-	-	-	-	-	1	-	-	-	2	3	2	3
6	2	1	-	-	-	-	-	1	-	-	-	2	3	2	3
Overall Correlation	3	2	1	1	-	-	-	1	-	-	-	2	3	2	3
Recommended by Board of Studies	**07-11-2024**														
Approved	**3rd ACM**						**Date**						**30-11-2024**		

<table>
<tr><td rowspan="2">23EE511</td><td colspan="2" rowspan="2">CONTROL SYSTEM ENGINEERING</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>2</td><td>4</td></tr>
<tr><td colspan="7">COURSE OBJECTIVES:</td></tr>
<tr><td colspan="7">
• To make the students to familiarize with various representations of systems.
• To make the students to analyze the stability of linear systems in the time domain and frequency domain.
• To make the students to analyze the stability of linear systems in the frequency domain.
• To make the students to design compensator based on the time and frequency domain specifications.
• To develop linear models: mainly state variable model and Transfer function model
</td></tr>
<tr><td>UNIT I</td><td colspan="5">MODELING OF LINEAR TIME INVARIANT SYSTEM (LTIV)</td><td>9</td></tr>
<tr><td colspan="7">Control system: Open loop and Closed loop – Feedback control system characteristics – First principle modeling: Mechanical, Electrical and Electromechanical systems – Transfer function representations: Block diagram and Signal flow graph.</td></tr>
<tr><td>UNIT II</td><td colspan="5">TIME DOMAIN ANALYSIS</td><td>9</td></tr>
<tr><td colspan="7">Standard test inputs – Time response – Time domain specifications – Stability analysis: Concept of stability – Routh Hurwitz stability criterion – Root locus: Construction and Interpretation. Effect of adding poles and zeros.</td></tr>
<tr><td>UNIT III</td><td colspan="5">FREQUENCY DOMAIN ANALYSIS</td><td>9</td></tr>
<tr><td colspan="7">Bode plot, Polar plot and Nyquist plot: – Frequency domain specifications Introduction to closed loop Frequency Response.</td></tr>
<tr><td>UNIT IV</td><td colspan="5">DESIGN OF FEEDBACK CONTROL SYSTEM</td><td>9</td></tr>
<tr><td colspan="7">Introduction and design specifications – Lead, Lag and Lag-lead compensators using Bode plot techniques – Introduction to P, PI, and PID controller.</td></tr>
</table>

UNIT V	STATE VARIABLE ANALYSIS	9
State variable formulation – Non uniqueness of state space model – State transition matrix –Eigen values – Eigen vectors – Controllability – Observability.		
TOTAL: 45 PERIODS		

PRACTICAL EXERCISES:

1. Mathematical modeling and simulation of physical systems in at least two fields. (a) Mechanical (b)Electrical
2. Stability analysis using Pole zero maps and Routh Hurwitz Criterion in simulation platform.
3. Root Locus based analysis in simulation platform.
4. Determination of transfer function of a physical system using frequency response and Bode's asymptotes in simulation platform.
5. Design of Lag, lead compensators and evaluation of closed loop performance in simulation platform.
6. Test of controllability and observability in continuous and discrete domain in simulation platform.

TOTAL:30 PERIODS

COURSE OUTCOMES:

After completion of the course, the students will be able to:

CO1:	Develop the mathematical model for the given mechanical, electrical and electromechanical systems and derive its transfer function
CO2:	Identify the time responses of the given system from the mathematical model.
CO3:	Analyze the system stability in time domain using Routh Hurwitz and Root locus methods.
CO4:	Analyze the system performance in frequency domain in terms of the key characteristics of the models.
CO5:	Analyze the system stability and design a suitable compensator for a closed loop system.
CO6:	Develop the state variable form of the system.

TEXT BOOKS:	
1	Benjamin C. Kuo, “Automatic Control Systems”, 7th edition PHI Learning Private Ltd, 2010.
2	M Nagarath, I.J. and Gopal, M., “Control Systems Engineering”, New Age International Publishers,2017

REFERENCES:	
1	Richard C.Dorf and Bishop, R.H., “Modern Control Systems”, Pearson Education, 2009.
2	John J.D., Azzo Constantine, H. and HoupisSttuart, N Sheldon, “Linear Control System Analysis and Design with MATLAB”, CRC Taylor& Francis Reprint 2009.
3	Katsuhiko Ogata, “Modern Control Engineering”, PHI Learning Private Ltd, 5th Edition, 2010
4	NPTEL Video Lecture Notes on “Control Engineering “by Prof. S. D. Agashe, IIT Bombay

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	1	-	-	-	-	1	-	-	3	1	-
2	3	2	1	1	1	1	1	1	-	1	-	-	3	1	1
3	3	3	2	2	1	1	1	2	-	1	-	2	3	1	2
4	3	3	2	2	1	1	1	1	-	1	-	2	3	1	1
5	3	3	2	2	1	1	1	2	-	1	-	2	3	1	2
6	3	2	1	1	1	1	1	2	-	1	-	2	3	1	2
Overall Correlation	**3**	**3**	**2**	**2**	**1**	**1**	**1**	**2**	-	**1**	-	**2**	**3**	**1**	**2**

Recommended by Board of Studies	**07-11-2024**		
Approved	**3rd ACM**	**Date**	**30-11-2024**

23MT511	COMPUTER AIDED DESIGN AND MANUFACTURING SYSTEM	L	T	P	C
		3	0	2	4

COURSE OBJECTIVES:

- To educate students by covering different aspects of computer Aided Design and Manufacturing.
- To interpret geometric modeling of curves surfaces and solids
- To create strong skills of writing CNC programs.
- To educate students to understand different advances in manufacturing systems like: GT, CAPP and FMS.
- To educate students by covering different integrated production management systems.

UNIT I	INTRODUCTION	9

Product cycle- Design process- sequential and concurrent engineering- Computer aided design – CAD system architecture- Computer graphics – co-ordinate systems- 2D and 3D transformations homogeneous coordinates - Line drawing - Clipping- viewing transformation-Brief introduction to CAD and CAM – Manufacturing Planning, Manufacturing control- Introduction to CAD/CAM –CAD/CAM concepts ––Types of production - Manufacturing models and Metrics – Mathematical models of Production Performance.

UNIT II	GEOMETRIC MODELING	9

Representation of curves- Hermite curve- Bezier curve- B-spline curves-rational curves-Techniques for surface modeling – surface patch- Coons and bicubic patches- Bezier and B-spline surfaces. Solid modeling techniques- CSG and B-rep.

UNIT III	NC AND CNC PART PROGRAMMING	9

Introduction to NC systems and CNC - Machine axis and Co-ordinate system- CNC machine tools- Principle of operation CNC- Construction features including structure- Drives and CNC controllers- 2D and 3D machining on CNC- Introduction of Part Programming, types - Detailed Manual part programming

(FANUC) on Lathe & Milling machines using G codes and M codes- Cutting Cycles, Loops, Sub program and Macros-Introduction of CAM package.		
UNIT IV	**COMPUTER INTEGRATED MANUFACTURING SYSTEM**	**9**
Computer Integrated manufacturing system, Group Technology, Flexible Manufacturing System, Computer aided process Planning-Retrieval and Generative System. Manufacturing Execution System; Overview, Components and Functionality, Relationship between MES and ERP, Benefits of MES		
UNIT V	**SMART MANUFACTURING**	**9**
Introduction to additive manufacturing, IoT, Smart Sensing, Smart Machines, Data Visualization and Analysis, Augmented Reality, Automated material handling and Cobots. Overview of 3D printing Technology, Materials used in 3D printing, Cyber-security for manufacturing.		
		TOTAL: 45 PERIODS
LIST OF EXPERIMENTS:		
1. Modelling of a part using any CAD package. 2. Modelling and assembling of the mechanical assembly using any CAD package. 3. Structural analysis using FEA software – any analysis package. 4. Beam deflection analysis using FEA software – any analysis package. 5. Modelling and tool path simulation – turning using any CAM package. 6. Modelling and tool path simulation – milling using any CAM package. 7. NC code generation for milling using any CAM package. 8. NC code generation for turning using any CAM package.		
		TOTAL: 30 PERIODS

COURSE OUTCOMES:	
	After completion of the course, the students will be able to:
CO1:	Explain the 2D and 3D transformations, clipping algorithm, Manufacturing models and Metrics
CO2:	Explain the fundamentals of parametric curves, surfaces and Solids
CO3:	Apply NC & CNC programming concepts to develop part programme for Lathe & Milling Machines.
CO4:	Explain the computer integrated manufacturing systems
CO5:	Explain the concepts of smart manufacturing.
CO6:	Construct the design and analysis of structural components and construct the part programming for basic industrial components using CAD/CAM software.
TEXT BOOKS:	
1	Ibrahim Zeid "Mastering CAD CAM" Tata McGraw-Hill PublishingCo.2007
2	Mikell. P. Groover "Automation, Production Systems and Computer Integrated Manufacturing", Prentice Hall of India, 2008.
REFERENCES:	
1	Radhakrishnan P, Subramanyan S. and Raju V., "CAD/CAM/CIM", 2nd Edition, New Age International (P) Ltd, New Delhi,2000.
2	Chris McMahon and Jimmie Browne "CAD/CAM Principles", "Practice and Manufacturing management "Second Edition, Pearson Education, 1999.
3	Donald Hearn and M. Pauline Baker "Computer Graphics"'. Prentice Hall, Inc,1992.
4	Foley, Wan Dam, Feiner and Hughes - "Computer graphics principles & practice" Pearson Education -2003
5	William M Neumann and Robert F. Sproul "Principles of Computer Graphics", McGraw Hill Book Co. Singapore, 1989.

COs	POs												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	-	-	-	-	-	1	-	-	-	1	2	1	1
2	2	1	-	-	-	-	-	1	-	-	-	1	2	1	1
3	3	2	1	1	1	-	-	2	-	-	-	2	2	1	2
4	2	1	-	-	-	-	-	1	-	-	-	1	2	1	1
5	2	1	-	-	-	-	-	1	-	-	-	1	2	1	2
6	3	2	1	1	1	-	-	2	-	-	-	1	2	1	3
Overall Correlation	3	1	1	1	1	-	-	1	-	-	-	1	2	1	2

Recommended by Board of Studies	07-11-2024		
Approved	**3rd ACM**	**Date**	**30-11-2024**

23MT521	ROBOTICS LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES:

- To introduce different types of robotics and demonstrate them to identify different parts and components.
- To write programming for simple operations.
- To gather the practical exposure on machine vision elements, lighting technique, processing software and algorithms

LIST OF EXPERIMENTS:

1. Robot programming and simulation for pick and place with conveyor motion
2. Robot programming and simulation for pick and place with conveyor motion and linear rail.
3. Robot programming and simulation for Colour identification
4. Robot programming and simulation for Shape identification
5. Robot programming and simulation for writing practice
6. Robot programming and simulation for welding
7. Modelling and simulation of vehicle body
8. Modelling and simulation of vehicle engine
9. Modelling and simulation of a 2 DOF robot - Forward and inverse kinematics.
10. Modelling and simulation of a 2 DOF robot - Polynomial and Trapezoidal functions.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

After completion of the course, the students will be able to:

CO1:	Construct the Programme for robots in pick and place operation
CO2:	Construct the Programme for robots in colour and shape identification.

CO3:	Construct the Programme to perform the robots in writing operation
CO4:	Create a machine vision setup for various industrial tasks.
CO5:	Construct the programs for robot simulation
CO6:	Construct programs for robot kinematics.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	1	-	-	3	-	-	-	3	2	2	3
2	3	2	1	1	1	-	-	3	-	-	-	3	2	2	3
3	3	2	1	1	1	-	-	3	-	-	-	3	2	2	3
4	3	3	3	3	3	-	-	3	-	-	-	3	2	2	3
5	3	2	1	1	1	-	-	3	-	-	-	3	2	2	3
6	3	2	1	1	1	-	-	3	-	-	-	3	2	2	3
Overall Correlation	3	2	2	2	2	-	-	3	-	-	-	3	2	2	3

Recommended by Board of Studies	**07-11-2024**		
Approved	**3rd ACM**	**Date**	**30-11-2024**

23MT522	MINI PROJECT -2	L	T	P	C
		0	0	2	1

COURSE OBJECTIVES:

- Encourage students to apply foundational theoretical knowledge to practical engineering problems.
- Develop collaborative and project management skills through teamwork and effective communication.
- Train students in basic research methodology, technical documentation, and presentation techniques to articulate project outcomes clearly.
- Enhance students' ability to systematically design, analyze, and evaluate simple prototypes or models.
- Prepare students for real-world engineering challenges and lay the foundation for multidisciplinary teamwork and problem-solving in advanced projects.

COURSE DESCRIPTION:

This course serves as an introductory platform for students to apply the foundational knowledge acquired from their core and interdisciplinary subjects in a practical setting. This course enables students to work on small-scale, department-relevant projects that focus on problem identification, basic design, and preliminary prototype development. With limited prior expertise, students will explore the process of translating theoretical concepts into tangible solutions, fostering creativity, teamwork, and critical thinking. The course emphasizes hands-on learning, communication, and project documentation, laying a strong foundation for advanced projects and professional challenges in later semesters.

PROJECT OUTLINE:

Week 1	Course Orientation and Topic Selection
Week 2	Problem Definition and Objective Setting

Week 3	Literature Review and Research
Week 4	First Review and Feedback
Week 5	Problem Refinement and Research Gap Identification
Week 6	Conceptual Design and Initial Approach
Week 7	Methodology and Project Planning
Week 8	Second Review and Project Evaluation
Week 9	Design Refinement and Testing
Week 10	Resource Identification and Budget Estimation
Week 11	Report Writing and Presentation Preparation
Week 12	Third Review Presentation and Submission of Thesis

EVALUATION:

- The progress of the mini project will be evaluated through three reviews, conducted by a committee appointed by the Head of the Department. A final project report must be submitted at the end of the semester. Evaluation will be based on oral presentation and the written report, assessed by internal examiners designated by the Head of the Department.
- The project should focus on topics from first three or four semester (whichever is applicable) subjects / industry demand topics, or futuristic technologies. It is recommended for Faculty of Aeronautical Engineering, Civil Engineering, and Mechanical Engineering students, the project should demonstrate an understanding of first principles of engineering.
- Similarly for students of Faculty of Computer Science Engineering, the project may involve programming using Python or C language. For Faculty of Electronics and Communication Engineering, the student project shall

	incorporate appropriate techniques and systems relevant to the field. For the students of Faculty of Fashion Technology, the project based on material innovations, or technology in fashion is recommended. • The evaluation will focus on how well the project is structured, including clarity and logical flow in both oral presentations and written texts. • The relevance and innovation of the project will be assessed, particularly its potential to contribute to sustainability, innovation, and SDG-aligned goals. • The accuracy of English usage, including grammar, clarity, and coherence, will be reviewed in both oral and written communication to ensure effective delivery of technical content.
COURSE OUTCOMES:	
	After completion of the course, the students will be able to:
CO1:	Apply basic engineering principles to solve simple problems.
CO2:	Choose relevant sources to understand the current knowledge and identify areas to improve.
CO3:	Utilise basic tools and techniques to test simple solutions.
CO4:	Interpret the impact of engineering solutions on society and the environment.
CO5:	Combine in teams to plan and complete projects within given constraints.
CO6:	Develop comprehensive technical reports and deliver structured presentations to effectively convey project outcomes.

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	1	1	1	1	1	3	2	2	2	1	3	1	3
2	3	2	1	1	1	1	1	3	2	2	2	1	3	1	3
3	3	2	1	1	1	1	1	3	2	2	2	1	3	1	3
4	3	2	1	1	1	1	1	3	2	2	2	1	3	1	3
5	3	2	1	1	1	1	1	3	2	2	2	1	3	1	3
6	3	2	1	1	1	1	1	3	2	2	2	1	3	1	3
Overall Correlation	3	2	**1**	**1**	**1**	**1**	**1**	**3**	**2**	**2**	**2**	**1**	**3**	**1**	**3**
Recommended by Board of Studies	**01-04-2024**														
Approved	**2nd ACM**			**Date**									**25-05-2024**		

23ES591	APTITUDE AND LOGICAL REASONING –2	L	T	P	C
		0	0	2	1

COURSE OBJECTIVES:

- To improve the problem solving and logical thinking ability of the students.
- To acquaint the student with frequently asked patterns in quantitative aptitude and logical reasoning during various examinations and campus interviews

UNIT I		**4**
Probability, Permutation & Combination, Algebra, Problems on ages		
UNIT II		**4**
Mensuration, Logarithms, inequalities and modulus, Syllogism		
UNIT III		**4**
Directions, logical sequence words, number series, Analytical Reasoning		
UNIT IV		**4**
Blood relation, Clock and Calendar, Picture puzzles		
UNIT V		**4**
Data sufficiency, cube and cuboids, odd man out		
		TOTAL: 20 PERIODS

COURSE OUTCOMES:

After completion of the course, the students will be able to:

CO1:	Apply concepts of probability, permutation, and combination to solve real-world problems.
CO2:	Solve algebraic problems and age-related problems using logical approaches and techniques.
CO3:	Analyze and solve problems in mensuration, logarithms, and inequalities.
CO4:	Interpret and solve problems related to directions, logical sequence, and number series.
CO5:	Identify and solve problems in logical reasoning such as syllogism, blood relations, clock and calendar.
CO6:	Identify and solve problems in logical reasoning such as syllogism, blood relations, clock and calendar.

TEXT BOOK:	
1	Smith, John. "APTIPEDIA." 2nd ed., Wiley Publishers, 2020.
2	Agarwal, R.S. "Quantitative Aptitude." 2nd ed., S. Chand Publishing.
REFERENCES:	
1	Agarwal, R.S. "A Modern Approach to Verbal & Non-Verbal Reasoning." 2nd ed., S. Chand Publishing.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	2	1	3	2	2	2	1	3	1	2	3	2	2
2	3	2	2	2	3	2	3	2	1	2	1	2	3	2	3
3	3	3	2	2	2	2	2	2	1	3	1	2	3	3	2
4	2	3	2	1	2	3	1	2	3	3	2	3	2	2	3
5	2	3	3	2	2	2	2	3	2	2	2	3	3	3	3
6	3	3	2	2	3	2	3	3	2	2	1	2	3	3	2
Overall Correlation	3	3	3	2	3	3	3	3	2	3	2	3	3	3	3

Recommended by Board of Studies	**13-11-2024**		
Approved	**3rd ACM**	**Date**	**30-11-2024**

SEMESTER –VI

23CE611	**ENVIRONMENTAL SCIENCE AND ENGINEERING**	**L**	**T**	**P**	**C**
		3	**0**	**1**	**4**

COURSE OBJECTIVES:

- To provide basic knowledge on environment impact assessment
- To create an awareness on the pollutants in the environment
- To familiarize the student with the technology for restoring the environment.
- Applying the technology for producing ECO safe products
- To develop simple climate models and evaluate climate changes using models

UNIT I	**INTRODUCTION TO ENVIRONMENT IMPACT ASSESSMENT**	**9**

Impacts of Development on Environment – Rio Principles of Sustainable Development- Environmental Impact Assessment (EIA) – Objectives – Historical development – EIA Types – EIA in project cycle –EIA Notification and Legal Framework

UNIT II	**MOVEMENT OF POLLUTANTS IN ENVIRONMENT**	**9**

Concepts of diffusion and dispersion, point and area source pollutants, pollutant dispersal; Gaussian plume model, hydraulic potential, Darcy’s equation, types of flow, turbulence. Concept of heat transfer, conduction, convection; concept of temperature, lapse rate (dry and moist adiabatic); mixing heights, laws of thermodynamics; concept of heat and work, Carnot engine, transmission of electrical power, efficiency of turbines, wind mills and hydroelectric power plants.

UNIT III	**ECOLOGICAL RESTORATION**	**9**

Wastewater treatment: anaerobic, aerobic process, methanogenesis, treatment schemes for waste water: dairy, distillery, tannery, sugar, antibiotic industries; solid waste

treatment: sources and management (composting, vermiculture and methane production, landfill. hazardous waste treatment).		
UNIT IV	**ECOLOGICALLY SAFE PRODUCTS AND PROCESSES**	**9**
Biofertilizers, microbial insecticides and pesticides, bio-control of plant pathogen, Integrated pest management; development of stress tolerant plants, biofuel; mining and metal biotechnology: microbial transformation		
UNIT V	**CLIMATE CHANGE MODELS**	**9**
Constructing a climate model – climate system modeling – climate simulation and drift – Evaluation of climate model simulation – regional (RCM) – global (GCM) – Global average response to warming –climate change observed to date		
		TOTAL: 60 PERIODS

LIST OF EXPERIMENTS

1. Determination of Bio fuel parameters such as flash point and fire point.
2. Determination of density of biofuels.
3. Determination of BOD/COD in water.
4. Simulating the RCM and GCM model for different geographic conditions.
5. Measurement of Pollutant in environment by Gaussian Plume model.

COURSE OUTCOMES:

After completion of the course, the students will be able to:

CO1:	Explain the importance of the process of Environmental impact assessment and its types.
CO2:	Illustrate the chemical processes and pollutant chemistry
CO3:	Identify the methods to solve environmental problems
CO4:	Apply the knowledge to develop ecofriendly products.
CO5:	Construct the various simple climate models for simulation

CO6:	Apply the climate model simulation to monitor climate change
TEXT BOOKS:	
1	David .E Neelin "Climate Change and Modelling", Cambridge University Press, California 2012.
2	Evans, G.G. & Furlong, J. 2010. Environmental Biotechnology: Theory and Application (2nd edition). Wiley-Blackwell Publications.
3	Pani, B. 2007. Textbook of Environmental Chemistry. IK international Publishing House
4	N.S. Raman , A.R. Gajbhiye & S.R. Khandeshwar, Environmental Impact Assessment, 2014,IK International Pvt Ltd.
REFERENCES:	
1	Carson (1907-1964). Environment Conservation-book
2	Encyclopaedia of Environmental Issues by Craig W. Allin &Probe.
3	Encyclopaedia of Environmental studies by William Ashworth.
4	Climate Change and Climate Modeling- Kindle Edition.
5	Environmentally- Friendly Product development - Eberhand Abile ,Reiner Anderl,2005

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	-	-	-	2	1	-	-	-	-	-	2	-	-
2	3	2	1	1	-	3	2	-	-	-	-	1	3	-	-
3	3	2	1	1	-	3	2	-	-	-	-	1	3	-	-
4	3	2	1	1	-	3	2	-	-	-	-	1	3	-	-
5	3	2	1	1	-	3	2	-	-	-	-	1	3	-	-
6	3	2	1	1	-	3	2	-	-	-	-	1	3	-	-
Overall Correlation	**3**	**2**	**1**	**1**	**-**	**3**	**2**	**-**	**-**	**-**	**-**	**1**	**3**	**-**	**-**

Recommended by Board of Studies	**07-11-2024**		
Approved	**3rd ACM**	**Date**	**30-11-2024**

23MT611	INDUSTRIAL AUTOMATION	L	T	P	C
		3	0	2	4

COURSE OBJECTIVES:

- To understand the construction, operation and installation of PLCs.
- To understand the applications of PLC
- To provide the knowledge on interfacing the PLCs and field devices with communication protocols.
- To understand the concepts of DCS and SCADA systems.
- To study the Industrial process control

UNIT I	PROGRAMMABLE LOGIC CONTROLLER	9

Introduction –– Principles of operation – PLC Architecture and specifications – PLC hardware components Analog & digital I/O modules, CPU & memory module – Programming devices – PLC ladder diagram, Converting simple relay ladder diagram into ladder diagram. PLC programming- Simple instructions – Manually operated switches – Mechanically operated switches – Latching relays.

UNIT II	APPLICATIONS OF PLC	9

Timer instructions - On delay, Off delay, Cyclic and Retentive timers, Up /Down Counters, control instructions – Data manipulating instructions, math instructions; Applications of PLC – Motor start and stop, Simple materials handling applications, Automatic water level controller, Automatic lubrication of supplier Conveyor belt, Automatic car washing machine, Bottle label detection and process control application.

UNIT III	SCADA SYSTEM & ARCHITECTURE	9

Data acquisition systems, Evolution of SCADA, Communication technologies, Monitoring and supervisory functions, SCADA applications in Utility Automation, Industries - SCADA System Components: Schemes- Remote Terminal Unit (RTU), Intelligent Electronic Devices (IED), Communication Network, SCADA

Server, SCADA/HMI Systems Various SCADA architectures, advantages and disadvantages of each system.		
UNIT IV	**DISTRIBUTED CONTROL SYSTEM**	**9**
Introduction to DCS – Various Architectures – Comparison – Local control unit – Process interfacing issues – Communication facilities Operator interfaces - Low level and high level operator interfaces – Displays - Engineering interfaces – Low level and high level engineering interfaces – Factors to be considered in selecting DCS – Case studies – Sugar industry and Power plant.		
UNIT V	**INDUSTRIAL PROCESS CONTROL**	**9**
Study of Advanced Process control blocks: Statistical Process Control, Model Predictive Control, Fuzzy Logic Based Control, Neural-Network Based Control, PID Control.		
		TOTAL: 45 PERIODS
PRACTICAL EXERCISES:		
1. Design a Ladder Logic Program for various Logic Gates AND, OR, NOT, NOR, NAND, EX-OR and EX-NOR. 2. Develop Ladder Diagram Programming to set Timer and Counter in PLC. 3. Develop PLC Program to Control Traffic Light. 4. Develop PLC Program to Maintain the Pressure and Level in a Bottle Filling System. 5. Develop Ladder Diagram Program n PLC For Material Filling, Object Shorting, Orientation Check and Material Property Check. 6. Develop the Ladder Diagram Program in PLC for Material Handling, Delaying Conveyor, Feeding, Pick and Place Operation. 7. Sensor and Actuator Interfacing in PLC and PLC to PLC Communication.		
		TOTAL : 30 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Explain the architecture, installation procedures and troubleshooting of PLC.
CO2:	Develop PLC programs using various functions of PLCs for a given application.
CO3:	Explain the applications of PLC
CO4:	Explain the application development procedures in SCADA and manage data, alarm and storage.
CO5:	Explain DCS, SCADA and PLC
CO6:	Explain the controller elements and programming methods.
TEXT BOOKS:	
1	Gary Dunning, "Introduction to Programmable Logic Controllers",3rd India edition, Cengage Learning, 2007
2	John Webb, "Programmable Logic Controllers: Principles and Applications",5th edition Prentice Hall of India, 2012.
REFERENCES:	
1	Krishna Kant "Computer Based Process Control", Prentice Hall of India, 2004.
2	Michael P. Lukas, Distributed Control Systems: Their Evaluation and Design, Van Nostrand Reinhold Co., 1986
3	B. G. Liptak "Instrument Engineer's Handbook – Process Software and Digital Network", 3rd edition, CRC Press,2002.
4	Jose A. Romagnoli, Ahmet Palazoglu, "Introduction to Process control", CRC Taylor and Francis group, 2005.
5	Richard Cox, "Programmable Controllers", Delmer Thomson learning, 2001.
6	Richard Zurawski, "Industrial Communication Technology Handbook" 2nd edition, CRC Press,2015.
7	William T. Shaw, Cybersecurity for SCADA systems, Penn Well Books, 2006

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	2	1	1	-	-	-	2	-	-	-	2	2	2	2
2	3	2	1	1	-	-	-	3	-	-	-	3	3	3	3
3	2	2	1	1	-	-	-	2	-	-	-	2	2	2	2
4	2	2	1	1	-	-	-	2	-	-	-	2	2	2	2
5	2	2	1	1	-	-	-	2	-	-	-	2	2	2	2
6	2	2	1	1	-	-	-	2	-	-	-	2	2	2	2
Overall Correlation	2	2	1	1	-	-	-	2	-	-	-	2	2	2	2
Recommended by Board of Studies							07-11-2024								
Approved							3rd ACM			Date			30-11-2024		

23MT612	FLUID POWER SYSTEMS	L	T	P	C
		3	0	2	4

COURSE OBJECTIVES:

- To recognize the standard symbols and to understand the functions of basic fluid power generation and actuation elements.
- To realize the functions of hydraulic regulation and control elements and its typical uses in fluid power circuit and to acquire the practice on assembling the various types of hydraulic circuits.
- To familiarize and exercise the design procedure of various types of hydraulic fluid power circuits and to provide a training to create the various types of hydraulic circuits.
- .To recognize the functions of pneumatic elements and design pneumatic circuits and understand logic functions and circuits
- To realize problems in installation and selection of hydraulic and pneumatic components and applications of hydraulics and pneumatics

UNIT I	FLUID POWER PRINCIPLES AND HYDRAULIC PUMPS	9

Introduction to Fluid power- Advantages and Applications- Fluid power systems – Types of fluids- Properties of fluids – Basics of Hydraulics – Pascal's Law- Principles of flow – Friction loss- Work, Power and Torque. Problems Sources of Hydraulic power: Pumping Theory – Pump Classification- Construction, Working, Design, Advantages, Disadvantages, Performance, Selection criterion of Linear, Rotary- Fixed and Variable displacement pumps-Problems.

UNIT II	HYDRAULIC ACTUATORS AND VALVES	9

Hydraulic Actuators: Cylinders– Types and construction, Application, Hydraulic cushioning – Hydraulic motors Control

Components: Direction control, Flow control and Pressure control valves-Types, Construction and Operation- Servo and Proportional valves - Applications – Types of actuators. Accessories: Reservoirs, Pressure Switches- Applications- Fluid Power ANSI Symbols – Problems		
UNIT III	**HYDRAULIC SYSTEMS**	**9**
Accumulators, Intensifiers, Industrial hydraulic circuits- Regenerative, Pump Unloading, Double-pump, Pressure Intensifier, Air-over oil, Sequence, Reciprocation, Synchronization, Fail-safe, Speed control, Hydrostatic transmission, Electro hydraulic circuits, Mechanical Hydraulic servo systems		
UNIT IV	**PNEUMATIC SYSTEMS**	**9**
Properties of air– Perfect Gas Laws - Compressors- Filter, Regulator, Lubricator, Muffler, Air control Valves, Quick Exhaust valves, Pneumatic actuators, Design of pneumatic circuit cascade method- Electro pneumatic circuits, Introduction to Fluidics, Pneumatic logic circuits.		
UNIT V	**TROUBLE SHOOTING AND APPLICATIONS**	**9**
Installation, Selection, Maintenance, Trouble Shooting and Remedies in Hydraulic and Pneumatic systems. Design of hydraulic circuits for Drilling, Planning, Shaping, Surface grinding, Press and Forklift applications. Design of Pneumatic circuits for a Pick and Place application and tool handling in a CNC machine. - Low cost Automation – Hydraulic and Pneumatic power packs- case studies.		
		TOTAL: 45 PERIODS
PRACTICAL EXERCISES:		
1. Design and testing of hydraulic circuits such as Pressure control Flow control Direction control		

Design of circuit with programmed logic sequence, using an optional PLC in hydraulic Electrohydraulic Trainer. 2. Design and testing of pneumatic circuits such as Pressure control Flow control Direction control Circuits with logic controls Circuits with timers Circuits with multiple cylinder sequences in Pneumatic Electro pneumatic Trainer. Modeling and analysis of basic electrical, hydraulic, and pneumatic systems using MATLAB/LABVIEW software. 3. Simulation of basic hydraulic, pneumatic and electrical circuits using Automation studio software.	
	TOTAL:30 PERIODS
COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Explain the various concepts of hydraulic and pneumatic systems
CO2:	Explain the concepts of various actuators and valve for Hydraulic systems.
CO3:	Construct the various basic hydraulic circuit systems.
CO4:	Construct the fluid power circuits-based automation system
CO5:	Explain the trouble shooting and applications of PLC
CO6:	Demonstrate the standard fluid power circuits using trainer kit and simulation software
TEXT BOOKS:	
1	Anthony Esposito, “Fluid Power with Applications”, Prentice Hall, 2009.
2	Shanmuga Sundaram. K, “Hydraulic and Pneumatic Controls”, Chand & Co, 2006

REFERENCES:	
1	Majumdar, S.R., "Oil Hydraulics Systems- Principles and Maintenance", Tata Mc Graw Hill, 2001
2	Majumdar, S.R., "Pneumatic Systems – Principles and Maintenance", Tata Mc Graw Hill, 2007.
3	Dudelyt, A Pease and John J Pippenger, "Basic Fluid Power", Prentice Hall, 1987.
4	Srinivasan.R, "Hydraulic and Pneumatic Controls", Vijay Nicole Imprints, 2008.
5	Joji.P, "Pneumatic Controls", John Wiley & Sons India, 2008

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	-	-	-	-	-	2	-	-	-	2	3	2	3
2	2	1	-	-	-	-	-	2	-	-	-	2	3	2	3
3	3	2	2	2	2	-	-	2	-	-	-	2	3	2	3
4	3	2	2	2	2	-	-	2	-	-	-	2	3	2	3
5	2	1	-	-	-	-	-	2	-	-	-	2	3	2	3
6	3	3	3	3	3	-	-	2	-	-	-	2	3	2	3
Overall Correlation	3	2	2	2	2	-	-	2	-	-	-	2	3	2	3

Recommended by Board of Studies	**07-11-2024**		
Approved	**3rd ACM**	**Date**	**30-11-2024**

23MT621	PROJECT WORK PHASE-1	L	T	P	C
		0	0	4	2

COURSE DESCRIPTION:

This course provides an opportunity for students to apply their engineering knowledge to solve real-world problems through project-based learning. Students, working in groups with maximum of 4 under faculty supervision, undertake a comprehensive project addressing an approved topic. The course focuses on fostering collaboration, research, and practical skills, culminating in a detailed Phase 1 project report and oral presentations. Regular reviews ensure consistent progress and adherence to academic standards.

COURSE OBJECTIVES:

- Encourage students to apply theoretical knowledge to practical engineering problems.
- Develop collaborative and project management skills through teamwork.
- Train students in research methodology, technical documentation, and presentation skills.
- Enhance students' ability to design, analyze, and evaluate solutions systematically.
- Prepare students for real-world engineering challenges and multidisciplinary teamwork

PROJECT OUTLINE:

Week 1	Orientation and course overview. Formation of project teams and approval of topics by HoD.
Week 2	Initial meeting with supervisors. Define problem statement and objectives
Week 3	Literature review: Research methodologies and topic-specific studies.
Week 4	Zeroth Review.

Week 5	Refinement of literature review and identification of research gaps.
Week 6	Identification of Base Paper.
Week 7	First Review.
Week 8	Conceptual design discussions and brainstorming solutions.
Week 9	Narrowing done on the exact work.
Week 10	Completion of first stage of the Project.
Week 11	Development of detailed conceptual design and methodology.
Week 12	Incorporation of feedback and refinement of design and methodology.
Week 13	Second Review.
Week 14	Compilation of Phase 1 results, report writing, and presentation preparation.
Week 15	Final Viva Voce Presentations.
Individual meetings will be set up on a need's basis in conjunction with developing work	

EVALUATION:

- The progress of the project is evaluated based on a minimum of two reviews. The review committee may be constituted by the Head of the Department. A phase 1 project report is required to be submitted at the end of the semester. Evaluation is based on oral presentation and the phase 1 project report jointly by internal examiners constituted by the Head of the Department.
- Evaluate how effectively the project is structured and communicated in both oral presentations and written texts, emphasizing logical flow and coherence.
- Evaluate the relevance and innovation of practical resources or prototypes developed, focusing on their potential to support sustainability, innovation, and SDG-aligned goals.

- Review the accuracy of English usage, including grammar, clarity, and coherence in oral and written communication, ensuring effective delivery of technical content.

COURSE OUTCOMES:

After completion of the course, the students will be able to:

CO1:	Develop feasible solutions by analyzing complex engineering problems using foundational knowledge, mathematics, and science.
CO2:	Survey literatures to identify gaps, define research questions, and propose designs and methods for solving engineering problems.
CO3:	Make use of modern tools to check the feasibility of the solutions effectively.
CO4:	Evaluate societal and environmental impacts of solutions while incorporating sustainability and ethical practices.
CO5:	Combine in teams to plan, manage, and lead projects within professional and economic constraints.
CO6:	Formulate technical reports, deliver presentations, and engage in lifelong learning to adapt to new technologies.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	2	2	1	2	2	3	3	3	3	3	3	1	3
2	3	2	2	2	1	2	2	3	3	3	3	3	3	1	3
3	3	2	2	2	1	2	2	3	3	3	3	3	3	1	3
4	3	2	2	2	1	1	2	3	3	3	3	3	3	1	3
5	3	2	2	2	1	2	2	3	3	3	3	3	3	1	3
6	3	2	2	2	1	2	2	3	3	3	3	3	3	1	3
Overall Correlation	**3**	**2**	**2**	**2**	**1**	**2**	**2**	**3**	**3**	**3**	**3**	**3**	**3**	**1**	**3**

Recommended by Board of Studies	**07-11-2024**		
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23MT622	TECHNICAL TRAINING	L	T	P	C
		0	0	2	1

PREAMBLE:

The course 'Technical Training' is intended to enable a B.E./B.Tech. graduate to practice, learn, apply and prepare report about the training undergone. The learner shall be trained in the latest technology in relevant Industry preferably in computer-oriented platform. This course can help the learner to experience training and learn practical skills for the relevant domain. Learner should also be able to present his learning through PPT and report articulating his level of learning about the specific training.

COURSE OBJECTIVES:

- To equip students with practical skills and real-world experience in technical domains, enabling them to effectively apply theoretical knowledge to hands-on applications.
- To develop competencies in working with industry-relevant tools and software technologies.
- To foster teamwork, problem-solving, and technical skills through innovative technologies

COURSE OUTCOMES:

After completion of the course, the students will be able to:

CO1:	Identify specific domain from the enrolled branch and to get training preferable in computer-oriented platform.
CO2:	Survey and apprehend the learning modules in the training program and to become expert in the specific domain.

CO3:	Apply theoretical learning in the practical environment and enhance the skillset of learner.
CO4:	Estimate the learning using available data.
CO5:	Defend a presentation about the learning done in the specified skillset.
CO6:	Construct a technical report about the training.

GUIDELINES:

- More than one training program may be given depending on availability and interest of the students. One training coordinator may be appointed for the same.
- Training coordinator shall provide required input to their students regarding the selection of training topic.
- Choosing a Training topic: The topic for a Technical Training should be current and broad based rather than very specific area of interest. It should also be outside the present syllabus. It's advisable to choose a training topic to be computer oriented as the resources for the same may be readily available. Every student of the program should be involved and assessed.
- Head of Department shall approve the selected training topic by the second week of the semester. Training may be assessed based on the ability to apply the skillset in a practical domain.

EVALUATION PATTERN:

Training Coordinator:

50 marks (Training Manual – 40 (Each student shall maintain a Training Manual and the Coordinator shall monitor the progress of the training work on a weekly basis and shall

approve the entries in the Training Manual during the weekly meeting with the student), Attendance – 10,).

Presentation of Application:

Candidate should apply the skillset attained in training. 20 marks to be awarded by the Examiners (Clarity of presentation – 5, Interactions – 10, Quality of the slides – 5).

Report about Application:

30 marks to be awarded by the Examiners (check for technical content, overall quality, templates followed, adequacy of application of the skillset etc.).

Training duration – 30 Hours

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	-	2	1	-	-	-	-	3	3	-	-
2	3	3	2	1	-	2	1	-	-	-	-	3	3	-	-
3	3	3	3	3	3	-	-	1	-	2	-	3	3	3	1
4	3	3	3	2	2	-	-	1	-	3	-	3	3	2	1
5	3	3	3	2	1	2	-	2	-	2	-	2	3	1	2
6	3	3	3	3	2	2	-	2	-	3	-	3	3	2	2
Overall Correlation	**3**	**3**	**3**	**3**	**2**	**2**	**1**	**2**	**-**	**3**	**-**	**3**	**3**	**2**	**2**

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SEMESTER – VII

23MT711	MACHINE VISION SYSTEMS	L	T	P	C
		3	0	2	4

COURSE OBJECTIVES:

- To introduce the various concepts in machine vision
- To understand the concepts in image acquisition
- To learn about a various basics in image processing
- To knowledge about the feature extraction and vision techniques
- To understand the various applications in machine vision

UNIT I	INTRODUCTION	9

Human vision – Machine vision and Computer vision – Benefits of machine vision – Block diagram and function of machine vision system implementation of industrial machine vision system – Physics of Light – Interactions of light – Refraction at a spherical surface – Thin Lens Equation.

UNIT II	IMAGE ACQUISITION	9

Scene constraints – Lighting parameters – Lighting sources, Selection – Lighting Techniques – Types and Selection – Machine Vision Lenses and Optical Filters, Specifications and Selection– Imaging Sensors – CCD and CMOS, Specifications – Interface Architectures – Analog and Digital Cameras – Digital Camera Interfaces – Camera Computer Interfaces, Specifications and Selection – Geometrical Image formation models – Camera Calibration.

UNIT III	IMAGE PROCESSING	9

Machine Vision Software – Fundamentals of Digital Image – Image Acquisition Modes – Image Processing in Spatial and Frequency Domain – Point Operation, Thresholding, Grayscale Stretching – Neighborhood Operations, Image Smoothing and Sharpening – Edge Detection – Binary Morphology – Colour image processing.

UNIT IV	**FEATURE EXTRACTION**	**9**
Feature extraction – Region Features, Shape and size features – Texture Analysis – Template Matching and Classification – 3D Machine Vision Techniques – Decision Making.		
UNIT V	**MACHINE VISION APPLICATIONS**	**9**
Machine vision applications in manufacturing, electronics, printing, pharmaceutical, textile, applications in non-visible spectrum, metrology and gauging, OCR and OCV, vision guided robotics – Field and Service Applications – Agricultural, and Bio medical field, augmented reality, surveillance, biometrics.		
		TOTAL: 45 PERIODS

PRACTICAL EXERCISES:

1. Study of lighting techniques for machine vision
2. Study of design of machine vision system
3. Image processing reading, video playback Display
4. Image Processing, Dilation and Erosion
5. Counting similarly - shaped objects from an image.
6. Classifying similar objects
7. Detecting cells, angles and lines Colour and line segmentation

TOTAL:30 PERIODS

COURSE OUTCOMES:

After completion of the course, the students will be able to:

CO1:	Explain the various types of sensors, lightings, hardware and concept of machine vision
CO2:	Acquire the image by the appropriate use of sensors, lightings and hardware
CO3:	Apply the various techniques of image processing in real time applications
CO4:	Select the suitable sensors, lightings and hardware for machine vision system

CO5:	Apply the machine vision techniques in machine vision system
CO6:	Create a machine vision setup for various industrial tasks and write the programs for robot and machine vision applications
TEXT BOOKS:	
1	Eugene Hecht, A. R. Ganesan "Optics", Fourth Edition, 2008
2	Alexander Hornberg, "Handbook of Machine Vision", First Edition, 2006
REFERENCES:	
1	Emanuele Trucco, Alessandro Verri, "Introductory Techniques For 3D Computer Vision", First Edition, 1998
2	Rafael C. Gonzales, Richard. E. Woods, "Digital Image Processing Publishers", Fourth Edition, 2007

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	-	-	-	-	-	3	-	-	-	3	2	1	2
2	2	1	-	-	-	-	-	3	-	-	-	3	2	1	2
3	3	2	1	1	-	-	-	2	-	-	-	2	2	1	2
4	3	2	1	1	-	-	-	2	-	-	-	2	2	1	2
5	2	1	-	-	-	-	-	3	-	-	-	3	2	1	2
6	3	3	3	3	-	2	-	2	-	-	-	2	2	1	2
Overall Correlation	3	2	1	1	-	2	-	2	-	-	-	2	2	1	2

Recommended by Board of Studies	**07-11-2024**		
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23MT712	EMBEDDED SYSTEMS AND PROGRAMMING	L	T	P	C
		3	0	2	4

COURSE OBJECTIVES:

- To familiarize the architecture and fundamental units of microcontroller.
- To know the microcontroller programming methodology and to acquire the interfacing skillsand data exchange methods using various communication protocols.
- To design the interface circuit and programming of I/O devices, sensors and actuators.
- To understand ARM processor architecture and its functions to meet out the computational and interface needs of growing mechatronic systems.
- To acquaint the knowledge of real time embedded operating system for advanced systemdevelopments.

UNIT I	INTRODUCTION TO MICROCONTROLLER	9

Fundamentals Functions of ALU - Microprocessor - Microcontrollers – CISC and RISC – Types Microcontroller - 8051 Family - Architecture - Features and Specifications - Memory Organization – Addressing Modes.

UNIT II	PROGRAMMING AND COMMUNICATION	9

Instruction to Assembler – Compiler and IDE - C Programming for 8051 Microcontroller-Timer and Counter - Interrupts – Interfacing and Programming of Serial Communication, I2C, SPI and CAN of 8051 Microcontroller – Bluetooth and WI-FI interfacing of 8051 Microcontroller.

UNIT III	PERIPHERAL INTERFACING	9

I/O Programming – Interfacing of Memory, Keyboard and Displays – Alphanumeric and Graphic, RTC, interfacing of ADC and DAC, Sensors - Stepper Motors, DC Motors - PWM Programming – Closed Loop Control Programming of Servomotor – Traffic Light

UNIT IV	**ARM PROCESSOR**	**9**
Introduction ARM 7 Processor - Internal Architecture – Modes of Operations – Register Set – Instruction Sets – ARM Thumb - Thumb State Registers – Pipelining – basic programming of ARM 7 - Applications.		
UNIT V	**SINGLE BOARD COMPUTERS AND PROGRAMMING**	**9**
System on Chip - Broadcom BCM2711 SoC – SBC architecture - Models and Languages – Embedded Design – Python for Embedded Systems- GPIO Programming – Interfacing		
		TOTAL: 45 PERIODS
PRACTICAL EXERCISES:		

1. Assembly Language Programming and Simulation of 8051.
2. Alphanumeric and Graphic LCD Interfacing using 8051 Microcontroller.
3. Input switches and keyboard interfacing of 8051.
4. Sensor Interfacing with ADC to 8051 and DAC & RTC Interfacing with 8051.
5. Timer, Counter and Interrupt Program Application for 8051.
6. Step Motor (Unipolar & Bipolar Motor) and PWM Servo Motor Control to Interfacing with8051.
7. UART Serial and Parallel Port Programming of 8051.
8. I^2C, SPI and CAN Programming of 8051.
9. Interfacing and Programming of Bluetooth and Wi-Fi with 8051
10. Programming of ARM Processor for Sensor Interface.
11. Stepper Motor and Servo Motor Control Using ARM Processor.
12. Serial Communication of ARM Processor with Computation Platform.
13. Wireless Communication of ARM Processor with Computation Platform.

14. GPIO Programming of Real Time Embedded Operating Systems. 15. IOT application using SBC. **(Any 7 Experiments)**	
TOTAL:30 PERIODS	
COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Explain the various functional units of microcontrollers, processors, and system-on-chip based on their features and specifications.
CO2:	Analyse the role of each functional unit in microcontrollers, processors, and system-on-chip based on their features and specifications.
CO3:	Explain the Integrate sensors, actuators, and other I/O devices with microcontrollers, processors, and system-on-chip-based systems.
CO4:	Construct circuits using microcontrollers, processors, and system-on-chip for specific applications.
CO5:	Develop programs for microcontrollers, processors, and system-on-chip to meet desired functionalities.
CO6:	Create embedded system applications to solve real-world problems.
TEXT BOOKS:	
1	Frank Vahid and Tony Givagis, "Embedded System Design", 2011, Wiley.
2	Kenneth J. Aylala, "The 8051 Microcontroller, the Architecture andProgramming Applications", 2003.
REFERENCES:	
1	Muhammad Ali Mazidi and Janice GillispicMazdi, "The 8051 Microcontroller and Embedded Systems", Pearson Education, 2006.
2	Simon Monk, Programming the Raspberry Pi, Second Edition: Getting Started with Python McGraw Hill TAB; 2nd edition,2015

3	James W. Stewart, "The 8051 Microcontroller Hardware, Software and Interfacing", Regents Prentice Hall, 2003.
4	John B. Peatman, "Design with Microcontrollers", McGraw Hill International, USA, 2005.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	-	-	-	-	-	3	-	-	-	3	2	1	2
2	3	3	2	2	-	-	-	3	-	-	-	3	2	1	2
3	2	1	-	-	-	-	-	2	-	-	-	2	2	1	2
4	3	2	1	1	-	-	-	2	-	-	-	2	2	1	2
5	3	2	1	1	-	-	-	3	-	-	-	3	2	1	2
6	3	3	3	3	-	2	-	2	-	-	-	2	2	1	2
Overall Correlation	3	2	1	1	-	2	-	2	-	-	-	2	2	1	2

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23MT721	PROJECT WORK PHASE-2	L	T	P	C
		0	0	6	3

COURSE DESCRIPTION:

Project Phase 2 is a continuation of Project Phase 1, focusing on implementing the proposed methodology through fabrication, simulation, or experimental validation. Students will refine their designs, validate test problems, and commission setups for final testing. This phase emphasizes hands-on application, calibration, and demonstration of results, culminating in a final presentation and report submission.

COURSE OBJECTIVES:

- Implement the proposed methodology to address engineering problems identified in Phase 1.
- Develop and fabricate prototypes or simulate solutions for the selected project integrating theoretical knowledge with practical application across hardware and software systems.
- Validate solutions through testing ensuring reliability and performance in both physical and virtual environments.
- Enhance problem-solving and critical thinking skills by troubleshooting and optimizing either experiment setups or software code to improve results.
- Prepare a research manuscript or applying for patent grant either for design or research.

PROJECT OUTLINE:

Week 1	Review of Phase 1 outcomes and refinement of proposed methodology.
Week 2	Material procurement/ software setup for simulation, and initiation of fabrication/simulation work.
Week 3	Intermediate fabrication/simulation work and initial testing or calibration, troubleshooting challenges.

Week 4	Second Review.
Week 5	Validation of test problem or refinement of prototype/simulation
Week 6	Optimisation of the test setup or solution trials, Data curation / uncertainty analysis
Week 7	Final testing of setup or simulation outcomes, Validation of Data .
Week 8	Third Review
Week 9	Demonstration of the solution with high level of data accuracy and precision.
Week 10	Compilation of Phase 2 results, report writing, and presentation preparation.
Week 11	Preparing or publishing of research article/ Filing or Grant of Patent
Week 12	Final Viva Voce Presentations.
Individual meetings will be set up on a need's basis in conjunction with developing work	

EVALUATION:

- The progress of the project is evaluated based on a minimum of two reviews. The review committee may be constituted by the Head of the Department. A project report is required at the end of the semester. The project work is evaluated based on oral presentation and the project report jointly by external and internal examiners constituted by the Head of the Department.
- Assess the depth of understanding demonstrated in the project's conceptualization and the ability to answer questions during public presentations.

• Publication of Research article in indexed journal or Patent award is necessary at the end of completion of the project.	
COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Apply appropriate methodologies to implement solutions for complex engineering problems identified in phase -1 using hardware / software or both systems.
CO2:	Develop existing functional prototypes or simulations models by integrating theoretical and practical knowledge.
CO3:	Evaluate solutions ensuring compliance with design specifications.
CO4:	Appraise the performance of solutions by refining designs or improving algorithms for enhanced outcomes.
CO5:	Collaborate effectively with team members to plan, manage, and execute engineering projects adhering to ethical principles and professional standards.
CO6:	Prepare technical reports, impactful presentations that communicate solutions effectively.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	2	2	1	2	2	3	3	3	3	3	3	1	3
2	3	2	2	2	1	2	2	3	3	3	3	3	3	1	3
3	3	2	2	2	1	2	2	3	3	3	3	3	3	1	3
4	3	2	2	2	1	1	2	3	3	3	3	3	3	1	3
5	3	2	2	2	1	2	2	3	3	3	3	3	3	1	3
6	3	2	2	2	1	2	2	3	3	3	3	3	3	1	3
Overall Correlation	**3**	**2**	**2**	**2**	**1**	**2**	**2**	**3**	**3**	**3**	**3**	**3**	**3**	**1**	**3**

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23MT722	TECHNICAL SEMINAR	L	T	P	C
		0	0	4	1

PREAMBLE:

The course 'Technical Seminar' is intended to enable a B.E./B. Tech graduate to read, understand,present and prepare report about an academic document. The learner shall search in the literature including peer reviewed journals, conference, books, project reports etc., and identify an appropriate paper/thesis/report in her/his area of interest, in consultation with her/his seminar coordinator. This course can help the learner to experience how a presentation can be made about a selected academic document and empower her/him to prepare a technical report.

COURSE OBJECTIVES:

- To do Literature surveys in a selected area of study
- To understand an academic document from the literature and to give a presentation about it
- To prepare a technical report.

GUIDELINES:

- The Department shall form an Internal Assessment Committee (IAC) for the seminar with academic coordinator for that program as the Chairperson and seminar coordinator as member. During the seminar presentation of a student, all members of IAC shall be present.
- Formation of IAC shall be completed within a week after the End Semester Examination (or last working day) of the previous semester.
- Seminar Coordinator shall provide required input to their students regarding the selection of topic/ paper.
- Choosing a seminar topic: The topic for a UG seminar should be current and broad based rather than very specific research work, beyond the syllabus. Every member of the project team could choose or be assigned

	Seminar topics that covers various aspects linked to the Project area. • A topic/paper relevant to the discipline shall be selected by the student during the semester break. • Topic/Paper shall be finalized in the first week of the semester and shall be submitted to the IAC. The IAC shall approve the selected topic/paper by the second week of the semester. • Accurate references from genuine peer reviewed published material to be given in the report and to be verified.
EVALUATION PATTERN	
Seminar Coordinator: 40 marks (Background Knowledge – 10 (The coordinator shall give deserving marks for a candidate based on the candidate's background knowledge about the topic selected), Relevance of the paper/topic selected – 10). (Seminar Diary – 10 (Each student shall maintain a seminar diary and the coordinator shall monitor the progress of the seminar work on a weekly basis and shall approve the entries in the seminar diary during the weekly meeting with the student), Attendance – 10). **Presentation:** 40 marks to be awarded by the IAC (Clarity of presentation – 10, Interactions – 10 (to be based on the candidate's ability to answer questions during the interactive session of her/his presentation), Overall participation – 10 (to be given based on her/his involvement during interactive sessions of presentations by other students), Quality of the slides – 10). **Report:** 20 marks to be awarded by the IAC (check for technical content, overall quality, templates followed, adequacy of references etc.).	
COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Identify academic documents from the literature which are related to her/his areas of interest.

CO2:	Survey and apprehend an academic document from the literature which is related to her/ his areas of interest.
CO3:	Compile a presentation about an academic document.
CO4:	Estimate the Contents using available literature.
CO5:	Defend a presentation about an academic document.
CO6:	Construct a technical report.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	3	3	2	2	1	1	2	3	3	2	2	3	2	2
2	3	3	3	1	2	1	1	2	3	3	2	2	3	2	2
3	3	3	2	2	2	1	1	1	3	3	1	1	3	2	2
4	3	3	2	1	1	1	2	2	3	3	2	1	3	2	2
5	3	3	2	1	1	1	1	2	2	2	2	2	3	1	2
6	3	3	2	1	1	1	1	2	2	2	2	2	3	1	2
Overall Correlation	**3**	**3**	**2**	**1**	**1**	**1**	**1**	**2**	**3**	**3**	**2**	**2**	**3**	**2**	**2**

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SEMESTER -VIII

2MT821	CAPSTONE PROJECT	L	T	P	C
		0	0	20	10

COURSE DESCRIPTION:

Prerequisites:

i) Team segregation.
ii) Identification of Project Guide.
iii) Identification of Area of Interest.
iv) Literature Review on the chosen area of interest.

Zeroth Review needs to be completed in the previous semester by the project coordinator

The *Capstone Project* ***(CP)*** provides an opportunity for students to engage in high-level inquiry focusing on an area of specialization within the engineering field. Capstone projects will be investigative, practice-centered. All capstones aim to bridge theory and practice and are aimed to have an impact on the professional life of students

The aim of the course is to facilitate the development of your *Capstone Projects.* Students are encouraged to apply and expend knowledge gained on teaching and learning throughout the Bachelor of Engineering Education program as part of this process

COURSE OBJECTIVES:

The Capstone Project should demonstrate the depth and extent of knowledge of students

During this course, students will

- Investigate and evaluate prominent literature connected to your CP.
- Present a clearly articulated investigative framework, while situating projects within established academic

practices and/ or ideas. • Develop and create practical resources (either computational or experimental) for the concerned area of interest in engineering field. • Offer inquiry-based argumentation for development in the concerned area within engineering field. • Summarize the findings in the form of report, documentation and presentation	
PROJECT OUTLINE:	
Week 1	Identification problem.
Week 2	Literature review.
Week 3	Preliminary work.
Week 4	First review.
Week 5	Completion of first stage of the Project methodology.
Week 6	Development.
Week 7	Testing & Validation.
Week 8	Second review.
Week 9	Repeatability.
Week 10	Report correction and Documentation
Week 11	Third review-Submission of paper for conference/journal
Week 12	Thesis Correction and Submission
Individual meetings will be set up on a need's basis in conjunction with developing work	
COURSE OUTCOMES:	
After completion of the course, the students will be able to:	

CO1:	Take part in challenging practical problems and find solutions by formulating proper methodology.
CO2:	Plan research methodology to tackle a specific problem.
CO3:	Construct extensive study on particular research projects.
CO4:	Develop experimental and computational studies on innovative research projects.
CO5:	Estimate incremental study on existing research projects.
CO6:	Take part in real life engineering challenges and propose appropriate solutions.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
2	3	2	3	3	2	3	2	3	2	3	2	3	3	2	3
3	2	3	3	3	3	3	3	3	3	3	3	3	2	3	3
4	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
5	2	3	3	3	3	3	3	3	3	3	3	3	2	3	3
6	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Overall Correlation	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

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VERTICALS – 1 – APPLIED ROBOTICS

23MT031	ROBOTS AND SYSTEMS IN SMART MANUFACTURING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To get a knowledge of working on Industrial robots and their load handling capacity
- To enlist with an application of robots in various operation
- To familiar with a material handling system
- To impart the knowledge on robotic welding
- To obtain the knowledge on various type of robot welding operation

UNIT I	INTRODUCTION	7

Types of industrial robots - Load handling capacity - general considerations in Robotic material handling-material transfer - machine loading and unloading - CNC machine tool loading - Robot centered cell.

UNIT II	SELECTION OF ROBOTS AND OTHER APPLICATIONS	9

Factors influencing the choice of a robot - robot performance testing - economics of robotization - Impact of robot on industry and society. Application of Robots in continuous arc welding - Spot welding - Spray painting -assembly operation - cleaning - robot for underwater applications.

UNIT III	MATERIAL HANDLING	13

Concepts of material handling - principles and considerations in material handling systems design - conventional material handling systems - industrial trucks - monorails - rail guided vehicles - conveyor systems -cranes and hoists - advanced material handling systems - automated guided vehicle systems - automated storage and retrieval systems (ASRS) - bar code technology - radio frequency identification technology -Introduction to Automation Plant design software.

UNIT IV	**ROBOTIC WELDING**	**8**
Robotic welding system, Programmable and flexible control facility –Introduction-Types- Flex Pendant-Lead through programming, Operating mode of robot, Jogging-Types, programming for robotic welding, Welding simulation, Welding sequences, Profile welding.		
UNIT V	**APPLICATIONS OF ROBOTS IN WELDING AND ALLIED PROCESSES**	**8**
Application of robot in manufacturing- Exploration of practical application of robots in welding - Robots for car body's welding, robots for box fabrication, robots for microelectronic welding and soldering – Applications in nuclear, aerospace and ship building, case studies for simple and complex applications		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Explain the various concepts of Industrial Robot.
CO2:	Apply the appropriate manufacturing procedure for Robots
CO3:	Explain the various industrial applications of robots
CO4:	Explain the applications of robots in material handling.
CO5:	Explain the concepts of robots for the Welding operation.
CO6:	Construct the procedure of a manufacturing plan for developing a robot

TEXT BOOKS:	
1	Richard D Klafter, Thomas Achmielewski, MickaelNegin , "Robotic Engineering – An integrated Approach", Prentice Hall India, New Delhi, 2006.
2	Mikell P Groover , "Automation, Production Systems, and Computer-Integrated Manufacturing", Pearson Education, New York, 2019.

REFERENCES:	
1	Pires J N, Loureiro A, Bolson G, "Welding Robots: Technology, System Issues and Application", Springer, London, 2010.
2	Parmar R S , "Welding Processes and Technology", Khanna Publishers, New Delhi, 2nd Edition, 2013.
3	John A. Piotrowski, William T. Randolph , "Robotic welding: A Guide to Selection and Application, Welding Division, Robotics International of SME", Publications Development Dept., Marketing Division, 1987.
4	Mikell P Groover, Mitchel Weiss, Roger N Nagel, N.G.Odrey, Ashish Dutta "Industrial Robotics (SIE): Technology, Programming and Applications", 2nd Edition, McGraw Hill Education India Pvt Ltd, 2012.
5	Yoram Koren , "Robotics for Engineers", McGraw-Hill, 1987.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	-	-	-	-	-	2	-	-	-	2	2	2	2
2	3	2	1	1	-	-	-	3	-	-	-	3	3	2	3
3	2	1	-	-	-	-	-	2	-	-	-	2	2	2	2
4	2	1	-	-	-	-	-	2	-	-	-	2	2	2	2
5	2	1	-	-	-	-	-	2	-	-	-	2	2	2	2
6	3	2	1	1	-	-	-	3	-	-	-	3	3	2	3
Overall Correlation	2	1	1	1	-	-	-	2	-	-	-	2	2	2	2

23AE069	DRONE TECHNOLOGIES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the fundamental concepts, history, and business opportunities associated with drone technology.
- To acquire knowledge of drone design, fabrication, and programming, including assembling and configuring components.
- To learn drone flight operations, control mechanisms, and the integration of sensors and storage devices.
- To explore commercial applications of drones in various industries such as agriculture, logistics, and inspection services.
- To understand safety practices, aviation regulations, licensing, and advancements in drone autonomy and swarm technology.

UNIT I	INTRODUCTION TO DRONE TECHNOLOGY	9

Drone Concept - Vocabulary Terminology - History of drone - Types of current generation of drones based on their method of propulsion - Drone technology impact on the businesses - Drone business through entrepreneurship - Opportunities/applications for entrepreneurship and employability.

UNIT II	DRONE DESIGN, FABRICATION AND PROGRAMMING	9

Classifications of the UAV - Overview of the main drone parts - Technical characteristics of the parts - Function of the component parts - Assembling a drone - The energy sources - Level of autonomy- Drones configurations -The methods of programming drone - Download program - Install program on computer- Running Programs - Multi rotor stabilization - Flight modes - Wi-Fi connection.

UNIT III	**DRONE FLYING AND OPERATION**	**9**
Concept of operation for drone - Flight modes - Operate a small drone in a controlled environment - Drone controls Flight operations – management tool – Sensors - Onboard storage capacity - Removable storage devices - Linked mobile devices and applications.		
UNIT IV	**DRONE COMMERCIAL APPLICATIONS**	**9**
Choosing a drone based on the application - Drones in the insurance sector - Drones in delivering mail, Parcels and other cargo - Drones in agriculture - Drones in inspection of transmission lines and power distribution - Drones in filming and panoramic picturing.		
UNIT V	**FUTURE DRONES AND SAFETY**	**9**
The safety risks - Guidelines to fly safely - Specific aviation regulation and standardization - Drone license - Miniaturization of drones - Increasing autonomy of drones - The use of drones in swarms.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Explain various types of drone technology and drone fabrication.
CO2:	Construct the programming for various types of drones.
CO3:	Apply the concepts of flying drone in a controlled environment.
CO4:	Explain the concepts of drone control flight tools operations and its function.
CO5:	Develop a drone mechanism for specific applications.
CO6:	Explain the safety and future development of drones.

TEXT BOOKS:	
1	Daniel Tal and John Altschuld, “Drone Technology in Architecture, Engineering and Construction: A Strategic Guide to Unmanned Aerial Vehicle Operation and Implementation”, John Wiley & Sons, Inc. 2021.
2	Garvit Pandya, “Basics of Unmanned Aerial Vehicles: Time to start working on Drone Technology”, Notion Press, 2021.
REFERENCES:	
1	John Baichtal, “Building Your Own Drones: A Beginners' Guide to Drones, UAVs, and ROVs”, Que Publishing, 2016.
2	Jha, A. R. “Theory, design, and applications of unmanned aerial vehicles”. CRC Press, 2016.
3	Sachi Nandan Mohanty, J.V.R. Ravindra, “Drone Technology: Future Trends and Practical Applications”, Wiley, 2023.
4	Terry Kilby and Belinda Kilby, “Make: Getting Started with Drones “, Maker Media, Inc., 2016.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	-	-	-	-	-	2	-	-	-	2	2	1	2
2	3	2	1	1	-	-	-	3	-	-	-	3	3	1	3
3	3	2	1	1	-	-	-	3	-	-	-	3	3	1	3
4	2	1	-	-	-	-	-	2	-	-	-	2	2	1	2
5	3	2	1	1	-	-	-	3	-	-	-	3	3	1	3
6	2	1	-	-	-	-	-	2	-	-	-	2	2	1	2
Overall Correlation	2	2	1	1		-	-	2	-	-	-	3	3	1	3

23MT032	MICROROBOTICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To expose students to the fundamental aspects of the emerging field of micro robotics.
- To expose students to micro scale, technologies for fabricating small devices, bio- inspired design, and applications of the field.
- To expose students to various Mathematical formalism for flexures, Electrostatic actuators, Piezo-electric actuators, Magneto-strictive actuators and other sensors.
- To apply micro robotics to various applications
- To engage students in implementation of microrobotics

UNIT I	INTRODUCTION TO MICROROBOTICS	9

Introduction - MST (Micro System Technology) - Micromachining - Working principles of Microsystems Applications of Microsystems - Micro-fabrication principles-Design selection criteria for micromachining - Packaging and Integration aspects - Micro-assembly platforms and manipulators.

UNIT II	SCALING LAWS AND MATERIALS FOR MEMS	9

Introduction - Scaling laws - Scaling effect on physical properties scaling effects on Electrical properties - scaling effect on physical forces - Physics of Adhesion - Silicon - compatible material system - Shape memory alloys - Material properties - Piezo resistivity, Piezoelectricity and Thermoelectricity.

UNIT III	FLEXURES, ACTUATORS AND SENSORS	9

Elemental flexures - Flexure systems - Mathematical formalism for flexures - Electrostatic actuators - Piezo-electric actuators - Magneto-strictive actuators - Electromagnetic sensors - Optical-based displacement sensors - Motion tracking with microscopes.

UNIT IV	MICROROBOTICS	9

Introduction - Task specific definition of micro robots - Size and

Fabrication Technology based definition of micro- robots - Mobility and Functional-based definition of micro-robots - Applications for MEMS based micro-robots.		
UNIT V	**IMPLEMENTATION OF MICROROBOTS**	**9**
Arrayed actuator principles for micro-robotic applications - Micro-robotic actuators- Design of locomotive micro-robot devices based on arrayed actuators - Micro-robotics devices - Micro grippers and other micro-tools - Micro-conveyors - Walking MEMS Micro-robots - multi-robot system: Micro-robot powering, Micro-robot communication.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Explain the fundamental concepts of micro robotics.
CO2:	Explain the concepts of scaling laws and physical properties.
CO3:	Explain the various materials and its properties for MEMS
CO4:	Explain the various sensors and actuators used in micro robots
CO5:	Illustrate the fabrication technology and mobility functions for micro-robotics.
CO6:	Apply the concepts of micro-robotics in real time applications
TEXT BOOKS:	
1	Mohamed Gad-el-Hak , "The MEMS Handbook", 2nd Edition, CRC Press, New York, 2019.
2	Yves Bellouard, "Microrobotics Methods and Applications", CRC Press, Massachusetts, 2019.
REFERENCES:	
1	Nadim Maluf and Kirt Williams, "An Introduction to Microelectromechanical systems Engineering", 2nd edition, Artech House, 2004.
2	Julian W Gardner, "Microsensors: Principles and Applications", 2nd edition, Wiley, 2007.
3	Metin Sitti, "Mobile Microrobotics", MIT Press, 2017.
4	Nicolas Chaillet, Stephane Rangier, “Microrobotics for Micromanipulation”, John Wiley & Sons, 2013.

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	1	-	-	-	-	-	2	-	-	-	-	2	2	2
2	2	1	-	-	-	-	-	3	-	-	-	-	2	2	3
3	2	1	-	-	-	-	-	2	-	-	-	-	2	2	3
4	2	1	-	-	-	-	-	2	-	-	-	-	2	2	2
5	2	1	-	-	-	-	-	2	-	-	-	-	2	2	3
6	3	2	1	1	-	-	-	3	-	-	-	-	2	2	2
Overall Correlation	3	1	1	1	-	-	-	2	-	-	-	-	2	2	3

23MT033	AGRICULTURAL ROBOTICS AND AUTOMATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To learn about Farming-related Machines.
- To understand the global position and information system in machines.
- To know about traction and testing
- To familiarize the concept on weed management
- To learn about machinery selection.

UNIT I	**INTRODUCTION**	**9**

History of Mechanized Agriculture - Farming Operations and Related Machines - Tillage, Planting Cultivation, and Harvesting, Agricultural Automation - Agricultural Vehicle Robot.

UNIT II	**PRECISION AGRICULTURE**	**9**

Sensors – types and agricultural applications, Global Positioning System (GPS) - GPS for civilian use, Differential GPS, Carrier-phase GPS, Real-time kinematic GPS, Military GPS, Geographic Information System, Variable Rate Applications and Controller Area Networks.

UNIT III	**TRACTION**	**9**

Hitching- Principles of hitching, Types of hitches, Hitching and weight transfer, Control of hitches, Tires and Traction models, Traction predictor spread sheet, Soil Compaction, Traction Aids, Tractor Testing.

UNIT IV	**SOIL TILLAGE AND WEED MANAGEMENT**	**9**

Tillage Methods and Equipment, Mechanics of Tillage Tools, Performance of Tillage Implements, Hitching of Tillage Implements, Weed Management - Conventional Cropping Systems, Tools, Crop Rotation, Mechanical Cultivation.

UNIT V	**MACHINERY SELECTION**	**9**

Screw Conveyors, Pneumatic Conveyors, Bucket Elevators, Forage Blowers and Miscellaneous Conveyors, Machinery Selection - Field Capacity and Efficiency, Draft and Power Requirements, Machinery Costs.

TOTAL: 45 PERIODS

COURSE OUTCOMES:	
	After completion of the course, the students will be able to:
CO1:	Explain the fundamental concepts of mechanizing robots in agricultural automation.
CO2:	Illustrate sensor and system for a required specific process in agricultural applications.
CO3:	Explain traction system for agricultural robots.
CO4:	Explain the methods, performance and equipment mechanics of soil tillage.
CO5:	Explain the concepts of weed management cropping and cultivation system.
CO6:	Develop suitable robotic system for specific agricultural tasks.

TEXT BOOKS:

1	Ajit K. Srivastava, Carroll E. Goering, Roger P. Rohrbach, Dennis R. Buckmaster, "Engineering Principles of Agricultural Machines", ASABE Publication, 2012.
2	Myer Kutz , "Handbook of Farm, Dairy and Food Machinery Engineering", Academic Press, 2019.

REFERENCES:

1	Qin Zhang, Francis J. Pierce, "Agricultural Automation Fundamentals and Practices", CRC Press, 2016.
2	Stephen L Young, Francis J. Pierce, "Automation: The Future of Weed Control in Cropping Systems", Springer, Dordrecht Heidelberg New York London, 2014.
3	R.A. Kepner, Roy Bainer, E.L. Barger, "Principles of Farm Machinery", 3rd Edition, CBS Publishers, New Delhi, 2005.
4	Guangnan Chen, "Advances in Agricultural Machinery and Technologies", 1st Edition, CRC Press, 2021.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	-	-	-	-	-	2	-	-	-	2	2	2	2
2	2	1	-	-	-	-	-	3	-	-	-	2	2	2	3
3	2	1	-	-	-	-	-	2	-	-	-	2	2	2	3
4	2	1	-	-	-	-	-	2	-	-	-	2	2	2	2
5	2	1	-	-	-	-	-	2	-	-	-	2	2	2	3
6	3	2	1	1	-	-	-	3	-	-	-	2	2	2	2
Overall Correlation	3	2	1	1	-	-	-	2	-	-	-	2	2	2	3

23MT034	COLLABORATIVE ROBOTICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To know the fundamentals of Collaborative Robotics
- To introduce Swarm robot and trajectory planning for Swarm
- To introduce Modular Robotics and its Mechanics
- To learn about various Natural models of robot collaboration
- To introduce the concept of Reconfigurable robot

UNIT I	INTRODUCTION TO COBOTICS	9

Collaborative Robotics- Properties - Introduction to Modern Mobile Robots: Swarm Robots, Cooperative and Collaborative Robots, Mobile Robot Manipulators-Current Challenges.

UNIT II	SWARM ROBOTICS	9

Introduction, mapping, kinematics and trajectory error compensation, state transitions, collective decision making and methodologies, swarm robot scenarios-aggregation, clustering dispersion, pattern formation, sorting, flocking and collective motion, shepherding, heterogeneous swarms, Error Detection and Security.

UNIT III	MODULAR ROBOTICS	9

Module Designs - Modular Robot Representation -Modular Serial Robot Kinematics - Kinematic Calibration for Modular Serial Robots- Modular Serial Robot Dynamics - Modular Parallel Robot Kinematics.

UNIT IV	NATURALLY INSPIRED COLLABORATION	9

Collective Decision-Making. Group Decision Making in Animals, Collective Motion as Decision Process, Models for Collective Decision-Making Processes, Urn Models, Voter Model ,Majority Rule , Hegselmann and Krause , Kuramoto Model , Axelrod Model, Ising Model, Fiber Bundle Model, Sznajd Model, Bass Diffusion Model, Socio physics and Contrarians.

UNIT V	RECONFIGURABLE ROBOTS	9

V-Shaped Formation Control for Robotic Swarms Constrained by Field of View – formation of reconfigurable virtual linkage -

Reconfigurable Formation Control of Multi-Agents – Self assembly Modular Robot Platform Based on Sambot - Swarm Dynamics Emerging from Asymmetry.	
	TOTAL: 45 PERIODS
COURSE OUTCOMES:	
	After completion of the course, the students will be able to:
CO1:	Explain the fundamentals of Collaborative Robotics.
CO2:	Apply Swarm robots technology in real time applications.
CO3:	Analyze and select the suitable concept of Modular Robotics
CO4:	Analyze the concept of Robot Mechanics for modelling a collaborative robot
CO5:	Construct the various Natural models for robot collaboration.
CO6:	Develop collaborative robots for various requirements in industrial tasks.
TEXT BOOKS:	
1	Guilin Yang, I-Ming Chen, "Modular Robots: Theory and Practice", Springer, 2022.
2	Giandomenico Spezzano, "Swarm Robotics", Applied Sciences, MDPI, 2019.
REFERENCES:	
1	Heiko Hamann, "Collective Decision-Making in Swarm Robotics: A Formal Approach", Springer, 2019.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	-	-	-	-	-	2	-	-	2	2	1	1	1
2	3	2	1	1	-	-	-	3	-	-	2	2	1	1	1
3	3	3	2	2	-	-	-	2	-	-	2	2	1	1	1
4	3	3	2	2	-	-	-	2	-	-	2	2	1	1	2
5	3	2	1	1	-	-	-	2	-	-	2	2	1	1	1
6	3	2	1	1	-	-	-	3	-	-	2	2	1	1	1
Overall Correlation	3	2	1	1	-	-	-	2	-	-	2	2	1	1	1

<table>
<tr><td rowspan="2">23MT035</td><td rowspan="2" colspan="2">ROBOT OPERATING SYSTEMS</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="7">COURSE OBJECTIVES:</td></tr>
<tr><td colspan="7">• To introduce ROS and programming
• To develop the Robot environment
• To obtain the simulation robots in ROS with GAZEBO
• To simulate robots with V-Rep
• To understand mapping, navigation and motion planning ROS with Move-it</td></tr>
<tr><td>UNIT I</td><td colspan="5">ROS ESSENTIALS</td><td>9</td></tr>
<tr><td colspan="7">Introduction to ROS- Advantages and Disadvantages of ROS - ROS Framework- ROS package C++, Python – ROS computation Graph – nodes, Messages, topics, services, bags, ROS Master- ROS Community- Basic programming and Syntax overview in C++ and Python – start with ROS programming - Creating Environment - Services-Actions and Nodes- Simple Interaction with the Simulation environment.</td></tr>
<tr><td>UNIT II</td><td colspan="5">BUILD YOUR OWN ROBOT ENVIRONMENT</td><td>9</td></tr>
<tr><td colspan="7">CAD Tools for Robot Modelling – ROS Packages for robot modelling – Unified Robot Description Format and Tags-Kinematics and Dynamics Library – Create URDF Model - Robot Modelling using Unified Robot Description Format (URDF),-ROS parameter server and adding real-world object representations to the simulation environment _ Create Robot description using 7 DOF: joint number, name, type and angle limits – Xacro – Rviz – viewing of 7 DOF arm – creation of wheeled robot.</td></tr>
<tr><td>UNIT III</td><td colspan="5">SIMULATION ROBOTS IN ROS WITH GAZEBO</td><td>9</td></tr>
<tr><td colspan="7">Robot simulation - Gazebo –create simulation model at Gazebo- Adding colors, textures, transmission tags, 3D vision sensor to Gazebo- Moving robot joints using ROS controllers- ROS controller interacts with Gazebo, interfacing state controller,</td></tr>
</table>

simulation of moving the robot joints – simulation of differential wheeled robot in Gazebo.		
UNIT IV	**ROS WITH V-REP**	**9**
V-REP is a multi-platform robotic simulator - Simulating the robotic arm using V-REP - Adding the ROS interface to V-REP joint - Simulating a differential wheeled robot, Adding a laser sensor , 3D vision sensor.		
UNIT V	**ROS WITH MOVEIT**	**9**
Moveit Installation - Generating the Self-Collision matrix .virtual joints, planning groups, robot poses, robot end effector - Moveit Architecture Diagram - Trajectory from RViz GUI executing in Gazebo - Planning scene overview diagram-Collision Checking **-** Motion Planning, Pick and Place Behaviors using Industrial Robots with ROS Moveit – ROS with MATLAB - ROS with Industrial applications.		
		TOTAL: 45 PERIODS
COURSE OUTCOMES:		
After completion of the course, the students will be able to:		
CO1:	Explain the concept of ROS and programming.	
CO2:	Evaluate various robot algorithms in ROS programming.	
CO3:	Explain the mapping, navigation and motion planning ROS with Move-it.	
CO4:	Identify the suitable robots in ROS with GAZEBO	
CO5:	Identify the suitable Robots in ROS with V-REP	
CO6:	Develop the program a Robot using ROS and its toolboxes	
TEXT BOOKS:		
1	Lentin Joseph, Jonathan Cacace, “Mastering ROS for Robotics Programming”, Second Edition, Packt Publishing, 2018.	

REFERENCES:	
1	Lentin Joseph, Aleena Johny, "Robot Operating System (ROS) for Absolute Beginners Robotics Programming Made Easy", Second Edition, Apress, 2022.
2	Lentin Joseph, "ROS Robotics Projects", Packt publishing, 2017

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	1	-	-	-	-	-	2	-	-	1	1	2	1	2
2	3	2	1	1	-	-	-	3	-	-	1	1	2	1	2
3	2	1	-	-	-	-	-	2	-	-	1	1	2	1	2
4	3	2	1	1	-	-	-	2	-	-	1	1	2	1	2
5	3	2	1	1	-	-	-	2	-	-	1	1	2	1	2
6	3	2	1	1	-	-	-	3	-	-	1	1	2	1	2
Overall Correlation	2	1	1	2	-	-	-	2	-	-	1	1	2	1	2

23MT036	MEDICAL ROBOTICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- Identify and describe different types of medical robots and their potential applications.
- Know basic concepts in kinematics, Dynamics, and control relevant to Medical Robotics.
- Develop the Analytical and Experimental skills necessary to Design and Implement robotic assistance for both minimally invasive surgery and Image guided interventions.
- Be familiar with the state of the art in applied medical robotics and medical robotics research.
- Understand the various roles that robotics can play in healthcare.

UNIT I	INTRODUCTION	9

Types of medical robots - Navigation - Motion Replication - Imaging - Rehabilitation and Prosthetics – State of art of robotics in the field of healthcare-DICOM

UNIT II	LOCALIZATION AND TRACKING	9

Position sensors requirements - Tracking - Mechanical linkages - Optical – Sound based - Electromagnetic - Impedance-based - In-bore MRI tracking-Video matching - Fiber optic tracking systems - Hybrid systems.

UNIT III	DESIGN OF MEDICAL ROBOTS	9

Characterization of gestures to the design of robots - Design methodologies - Technological choices - Security.

UNIT IV	SURGICAL ROBOTICS	9

Minimally invasive surgery and robotic integration - surgical robotic sub systems - synergistic control - Control Modes - Radiosurgery - Orthopedic Surgery - Urologic Surgery and Robotic Imaging -Cardiac Surgery – Neurosurgery - case studies.

UNIT V	**ROBOTS IN REHABILITATION AND MEDICAL CARE**	**9**
Rehabilitation for Limbs - Brain-Machine Interfaces - Steerable Needles - Assistive robots - Robots in Physiotherapy - case studies.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Identify various medical robots and their potential applications.
CO2:	Explain the position tracking and hybrid systems.
CO3:	Apply Robotics and its concepts in medical field.
CO4:	Apply the Simulate a MIS procedure and be aware of the state of art in surgical robots
CO5:	Explain the Oncology surgical robotics.
CO6:	Develop the medical robotic system for Rehabilitation and Medical care.
TEXT BOOKS:	
1	Achim Ernst Floris Schweikard, "Medical Robotics", Springer, 2016.
2	Paula Gomes, "Medical robotics minimally invasive surgery", Wood head, 2013.
REFERENCES:	
1	Jaydev P Desai, Rajni V Patel, Antoine Ferreira; Sunil Kumar Agrawal, "The Encyclopedia of Medical Robotics", World Scientific Publishing Co. Pvt. Ltd, 2019.
2	Jocelyne Troccaz , "Medical Robotics", John Wiley & Sons Incorporated, 2013.
3	Vanja Bonzovic , "Medical Robotics", I-tech Education publishing, Austria, 2008.

COs	POs												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	-	-	-	2	-	-	-	1	3	2	3
2	2	1	-	-	-	-	-	3	-	-	-	1	3	2	3
3	3	2	1	1	-	-	-	2	-	-	-	1	3	2	3
4	3	2	1	1	-	-	-	2	-	-	-	1	3	2	3
5	2	1	-	-	-	-	-	2	-	-	-	1	3	2	3
6	3	2	1	1	-	-	-	3	-	-	-	1	3	2	3
Overall Correlation	3	2	1	1	-	-	-	2	-	-	-	1	3	2	3

23MT037	HUMANOID ROBOTICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To learn the basic knowledge about Humanoid robots.
- To impart knowledge in kinematics of humanoids.
- To learn about the dynamics in humanoid robots.
- To understand the basics of biped walking.
- To know about the different walking patterns.

UNIT I	INTRODUCTION	9

Historical development of Humanoids, Human Likeness of a Humanoid Robot, Trade-Offs in Humanoid Robot Design, Human-Friendly Humanoid Robot Design, characteristics of humanoid robots.

UNIT II	KINEMATICS	9

Kinematic structure, forward and inverse kinematic problems, differential kinematics, Twist, Spatial Velocity, and Spatial Transform, Inverse Differential Kinematic Relations. Differential kinematics at singular configurations- Gait Analysis.

UNIT III	ZMP AND DYNAMICS	9

ZMP Overview,2D Analysis,3D Analysis, Measurement of ZMP, General Discussion- ZMP of Each Foot, ZMP for Both Feet Contact, Dynamics of Humanoid Robots, Humanoid Robot Motion and Ground Reaction Force, Momentum, Angular Momentum, Angular Momentum and Inertia Tensor of Rigid Body, Calculation of Robot's Center of Mass, Link Speed and Angular Velocity, Calculation of Robot's Momentum and Angular Momentum

UNIT IV	BIPED WALKING	9

Two-Dimensional Walking Pattern Generation, Two Dimensional Inverted Pendulum, Behavior of Linear Inverted Pendulum, Orbital Ener y Sup rt Le Exchange, Planning a Simple

Biped Gait, Extension to a Walk on Uneven Terrain.		
UNIT V	**WALKING PATTERN GENERATION**	**9**
ZMP Based Walking Pattern Generation, Cart-Table Model, Off-Line Walking Pattern Generation, Stabilizer, Principles of Stabilizing Control, Stabilizing Control of Honda Humanoid Robot, Advanced Stabilizers.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Explain the evolution of Humanoid robots.
CO2:	Explain the basic knowledge in kinematics of humanoids.
CO3:	Explain the dynamics of humanoid robots.
CO4:	Explain the Humanoid Robot Motion and Ground Reaction Force.
CO5:	Identify Two-Dimensional Walking pattern on different terrain.
CO6:	Develop the Walking Pattern models and Stabilizing the Control.
TEXT BOOKS:	
1	Dragomir N. Nenchev, Atsushi Konno, "Humanoid Robots Modeling and Control", Butterworth Heinemann, 2019
2	Shuuji K, Hirohisa H, Kensuke H, Kazuhito, Springer-Verlag GmbH "Introduction to Humanoid Robotics", Springer, London, 2014.
3	Goswami Ambarish, Vadakkepat Prahlad, "Humanoid Robotics: A Reference", Springer, 2019.
4	J. Craig, "Introduction to Robotics: Mechanics and Control", Fourth Edition, Pearson, 2022.
REFERENCES:	
1	A. Goswami, P. Vadakkepat (Eds.), "Humanoid Robotics: A Reference", Springer, Netherlands, Dordrecht, 2018

2	J K. Harada, E. Yoshida, K. Yokoi (Eds.), "Motion Planning for Humanoid Robots", Springer, London, 2010.
3	Lorenzo Jean-Claude Latombe, "Robot Motion Planning", Kluwer.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	2	-	-	-	-	-	2	-	-	-	1	1	2	3
2	2	2	-	-	-	-	-	3	-	-	-	1	1	2	3
3	2	2	-	-	-	-	-	2	-	-	-	1	1	2	3
4	2	2	-	-	-	-	-	2	-	-	-	1	1	2	3
5	3	2	1	1	-	-	-	2	-	-	-	1	1	2	3
6	3	2	1	1	-	-	-	3	-	-	-	1	1	2	3
Overall Correlation	2	2	1	1	-	-	-	2	-	-	-	1	1	2	3

VERTICALS – 2 –DESIGN AND MANUFACTURING

23MT038	DESIGN OF MACHINE ELEMENTS AND ROBOT GRIPPERS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- Designing machine members are subjected to static and variable loads.
- Designing flexible elements like belts, ropes, and chain drives for engineering applications.
- Designing shafts and threaded fasteners for various applications.
- Designing and selecting bearings and robot grippers.
- Designing gears and gearbox for machine tools and applications.

UNIT I	FUNDAMENTAL CONCEPTS IN DESIGN	9

Introduction to design - factors influencing design, selection of materials based on mechanical properties - Modes of failure - Factor of safety – stresses due to bending and torsion moment - Eccentric loading, Design against fluctuating loads - theories of failures.

UNIT II	DESIGN OF FLEXIBLE ELEMENTS AND BEARINGS	9

Introduction to flexible elements, Design of belt drives – Flat, and Vee Belts, Design of chain drives - Sliding contact and rolling contact bearings - Hydrodynamic journal bearings- Selection of Rolling Contact bearings.

UNIT III	DESIGN OF SHAFTS AND THREADED FASTENERS	9

Shafts and Axles - Design of solid and hollow shafts based on strength, rigidity, and critical speed- Keys and splines.

UNIT IV	DESIGN OF GEARS	9

Gear Terminology - classification of gears- Design of Spur,

Helical, and Bevel gears drive using conventional gear life method		
UNIT V	**DESIGN OF ROBOT GRIPPERS AND END EFFECTORS**	**9**
Robot – End effectors, Types of End Effectors and Gripper Mechanisms, Force analysis, Miniature Grippers and Micro Grippers, Compliance, Selected case studies - Sheet metal handling, pretension of cuboid / cylindrical / objects, coils, irregular surfaces and flexible objects, handling castings, and medical applications.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Apply the fundamental concepts in the design of machine elements.
CO2:	Analyze the various parameters in flexible elements and bearings.
CO3:	Analyze the various parameters in sliding and rolling contact bearing bearings.
CO4:	Analyze the design of shafts and fasteners.
CO5:	Analyze the design of spur gear, helical gear and bevel gear.
CO6:	Explain the design concept of robot gripper and end effectors in various case studies
TEXT BOOKS:	
1	Bhandari. V.B, “Design of Machine Elements”, Tata McGraw-Hill Education, 5th edition, 2020.
2	Joseph Edward Shigley, Charles R. Mischke, “Mechanical Engineering Design”, McGraw Hill, 11th edition, 2020.
3	Gareth J.Monkman, Stefan Hesse, Ralf Steinmann, HenrikSchunk, “Robot Grippers”, Wiley, 2007.

REFERENCES:	
1	Sundararajamoorthy T. V, Shanmugam N., "Machine Design", Anuradha Publications, 2015.
2	Robert L.Norton, “Machine Design – An Integrated Approach”, Prentice HallInternational Edition, 5th edition, 2018.
3	Sharma. C.S, Purohit. K. ”Design of Machine Elements”, Prentice-Hall of India, 2003.
4	Adam Morecki, JozeKnapczyk, “Basics of Robo ics: Theory and Components of Manipulators and Robots”, Springer, 1999.
5	Shimon Y. Nof, “Handbook of Industrial Robotics”, John Wiley & Sons, 1999.
6	“P.S.G.Design Data Hand Book”, PSG College of Tech Coimbatore.
7	Mikell P. Groover, "Industrial Robotics", McGraw Hill, 2nd edition, 2017.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	1	-	-	2	-	-	-	2	2	2	2
2	3	3	3	3	3	-	-	3	-	-	-	3	2	2	3
3	3	3	3	3	3	-	-	3	-	-	-	3	2	2	3
4	3	3	3	3	3	-	-	3	-	-	-	3	2	2	3
5	3	3	3	3	3	-	-	3	-	-	-	3	2	2	3
6	2	1	-	-	-	-	-	2	-	-	-	2	2	2	2
Overall Correlation	3	3	3	3	3	-	-	3	-	-	-	3	2	2	3

23MT039	DESIGN FOR X	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To introduce the economic process selection principles and general design principles for manufacturability in the development and design of products for various engineering applications. Also, apply design consideration principles of casting in the design of cast products.
- To learn the design consideration principles of forming in the design of extruded, stamped, and forged products T
- To learn design consideration principles of machining in the design of turned, drilled, milled, planed, shaped, slotted, and ground products.
- To learn design consideration principles of welding in the design of welded products.
- To learn design consideration principles in additive manufacturing

UNIT I	INTRODUCTION	9

General design principles for manufacturability - strength and mechanical factors, mechanisms selection, evaluation method, Process capability - Feature tolerances Geometric Tolerances - Assembly limits -Datum features - Tolerance stacks. Design to minimize material usage – Design for disassembly – Design for recyclability – Design for manufacture – Design for energy efficiency – Design to regulations and standards.

UNIT II	FACTORS INFLUENCING FORM DESIGN	9

Working principle, Material, Manufacture, Design - Possible solutions - Materials choice - Influence of materials on form design - form design of welded members, forgings and castings.

UNIT III	**COMPONENT DESIGN - MACHINING CONSIDERATION**	**9**
Design features to facilitate machining - drills - milling cutters - keyways - Doweling procedures, counter sunk screws – Reduction of machined area - simplification by separation - simplification by amalgamation - Design for machinability - Design for economy - Design for clampability - Design for accessibility - Design for assembly - Product design for manual assembly - Product design for automatic assembly - Robotic assembly.		
UNIT IV	**COMPONENT DESIGN – CASTING**	**9**
Redesign of castings based on Parting line considerations - Minimizing core requirements, machined. holes, redesign of cast members to obviate cores. Identification of uneconomical design - Modifying the design - group technology - Computer Applications for DFMA.		
UNIT V	**DESIGN FOR ADDITIVE MANUFACTURING**	**9**
Introduction to AM, DFMA concepts and objectives, AM unique capabilities, exploring design freedoms, Design tools for AM, Part Orientation, Removal of Supports, Hollowing out parts, Inclusion of Undercuts and Other Manufacturing Constraining Features, Interlocking Features, Reduction of Part Count in an Assembly, Identification of markings/ numbers.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Explain the various design principles for manufacturability.
CO2:	Explain the various factors influencing form design.
CO3:	Apply the component design features of various machines.
CO4:	Apply the component design factor consideration for casting.

CO5:	Explain the design consideration principles of welding in the design of welded products.
CO6:	Explain the design consideration principles of additive manufacturing.
TEXT BOOKS:	
1	James G. Bralla, “Design for Manufacturability Handbook”, McGraw Hill Professional, 1998.
2	O. Molloy, E.A. Warman, S. Tilley, Design for Manufacturing and Assembly: Concepts, Architectures and Implementation, Springer, 1998.
REFERENCES:	
1	CorradoPoli, Design for Manufacturing: A Structured Approach, Elsevier, 2001.
2	David M. Anderson, Design for Manufacturability & Concurrent Engineering: How to Design for Low Cost, Design in High Quality, Design for Lean Manufacture, and Design Quickly for Fast Production, CIM Press, 2004.
3	Erik Tempelman, Hugh Shercliff, Bruno Ninaber van Eyben, Manufacturing and Design: Understanding the Principles of How Things Are Made, Elsevier, 2014.
4	Graedel T. Allen By. B, Design for the Environment Angle Wood Cliff, Prentice Hall. Reason Pub., 1996.
5	Boothroyd, G, Heartz and Nike, Product Design for Manufacture, Marcel Dekker, 1994

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	-	-	-	-	-	2	-	-	-	2	2	3	2
2	2	1	-	-	-	-	-	2	-	-	-	2	2	3	2
3	3	2	1	1	-	-	-	3	-	-	-	3	2	3	3
4	3	2	1	1	-	-	-	3	-	-	-	3	2	3	3
5	2	1	-	-	-	-	-	2	-	-	-	2	2	3	2
6	2	1	-	-	-	-	-	2	-	-	-	2	2	3	2
Overall Correlation	2	1	1	1	-	-	-	2	-	-	-	2	2	3	2

23MT040	CNC MACHINE TOOLS AND PROGRAMMING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand evolution and principle of CNC machine tools.
- To understand constructional features of CNC machine tools.
- To explain drives and positional transducers used in CNC machine tools.
- To write simple programs for CNC turning and machining centres.
- To generate CNC programs for popular CNC controllers.
- To explain tooling and work holding devices for CNC machine tools.

UNIT I	INTRODUCTION TO CNC MACHINE TOOLS	9

Evolution of CNC Technology, principles, features, advantages, applications, CNC and DNC concept, classification of CNC Machines – turning centre, machining centre, grinding machine, EDM, types of control systems, CNC controllers, characteristics, interpolators– Computer Aided Inspection.

UNIT II	STRUCTURE OF CNC MACHINE TOOL	9

CNC Machine building, structural details, configuration and design, guide ways – Friction, Anti friction and other types of guide ways, elements used to convert the rotary motion to a linear motion – Screw and nut, recirculating ball screw, planetary roller screw, recirculating roller screw, rack and pinion, spindle assembly, torque transmission elements – gears, timing belts, flexible couplings, Bearings.

UNIT III	DRIVES AND CONTROLS	9

Spindle drives – DC shunt motor, 3 phase AC induction motor, feed drives –stepper motor, servo principle, DC and AC servomotors, Open loop and closed loop control, Axis measuring system – synchro, synchro-resolver, encoders, inductosysn, laser interferometer.

UNIT IV	CNC PROGRAMMING	9
Coordinate system, structure of a part program, G & M Codes, tool length compensation, cutter radius and tool nose radius compensation, do loops, subroutines, canned cycles, mirror image, parametric programming, machining cycles, programming for machining centre and turning centre for well-known controllers using Fanuc.		
UNIT V	**TOOLING AND WORK HOLDING DEVICES**	**9**
Introduction to cutting tool materials – Carbides, Ceramics, CBN, PCD–inserts classification- PMK, NSH, qualified, semi qualified and preset tooling, tooling system for Machining centre and Turning centre, work holding devices for rotating and fixed work parts, economics of CNC, maintenance of CNC machines.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:

After completion of the course, the students will be able to:

CO1:	Explain the evolution and principle of CNC machine tools.
CO2:	Explain the constructional features of CNC machine tools.
CO3:	Explain drives and positional transducers used in CNC machine tools
CO4:	Construct CNC manual part program for turning center.
CO5:	Construct CNC manual part program for machining center.
CO6:	Explain the tooling and work holding devices for CNC machine tools

TEXT BOOKS:

1	Kalpakjian. S, "Manufacturing Engineering and Technology", Pearson Education 8th Edition, 2022.
2	Michael Fitzpatrick, "Machining and CNC Technology", McGraw-Hill Education;4thedition, 2019.

REFERENCES:

1	Roy. A. Lindberg, "Processes and materials of manufacture", Pearson India Education Services Pvt. Ltd, 4th edition, 2015.

2	Geofrey Boothroyd, "Fundamentals of Metal Machining and Machine Tools", McGraw Hill, 1985
3	Rao. P.N, "Manufacturing Technology Volume 2, Metal Cutting and Machine Tools", McGraw- Hill, New Delhi, 3rd edition, 2013.
4	Peter Smid, "CNC Programming Handbook", Industrial Press Inc., 3rd edition, 2007.
5	A. B. Chattopadhyay, "Machining and Machine Tools", Wiley, 2nd edition, 2017.
6	Roy. A. Lindberg, "Processes and materials of manufacture", Pearson India Education Services Pvt. Ltd, 4th edition, 2015.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	-	-	-	-	-	2	-	-	-	2	-	3	2
2	2	1	-	-	-	-	-	2	-	-	-	2	-	3	2
3	2	1	-	-	-	-	-	2	-	-	-	2	-	3	2
4	3	2	1	1	-	-	-	2	-	-	-	2	-	3	2
5	3	2	1	1	-	-	-	3	-	-	-	3	-	3	3
6	2	1	-	-	-	-	-	3	-	-	-	3	-	3	3
Overall Correlation	2	2	1	1	-	-	-	2	-	-	-	2	-	3	2

23MT041	COMPUTER INTEGRATED MANUFACTURING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To provide the overview of evolution of automation, CIM and its principles.
- To learn various automation tools, including material handling systems.
- To train students to apply group technology and FMS.
- To familiarize the computer aided process planning in manufacturing.
- To introduce to basics of data transaction, information integration and control of CIM.

UNIT I	INTRODUCTION	9

Introduction to CAD, CAM, and CIM - Evolution of CIM – CIM wheel and cycle – Production concepts and mathematical models – Simple problems in production models – CIM hardware and software – Major elements of CIM system – Three step process for implementation of CIM – Computers in CIM – Computer networks for manufacturing – The future automated factory – Management of CIM – safety aspects of CIM– advances in CIM

UNIT II	AUTOMATED MANUFACTURING SYSTEMS	9

Automated production line – system configurations, work part transfer mechanisms – Fundamentals of Automated assembly system – System configuration, Part delivery at workstations – Design for automated assembly – Overview of material handling equipment – Consideration in material handling system design – The 10 principles of Material handling. Conveyor systems – Types of conveyors – Operations and features. Automated Guided Vehicle system – Types &applications – Vehicle guidance technology – Vehicle management and safety. Storage system performance – storage location strategies – Conventional storage methods and equipment – Automated storage/Retrieval system

and Carousel storage system Deadlocks in Automated manufacturing systems – Petrinet models – Applications in Dead lock avoidance – smart manufacturing – Industry 4.0 - Digital manufacturing – Virtual manufacturing		
UNIT III	**GROUP TECHNOLOGY AND FMS**	**9**
Part families – Visual – Parts classification and coding – Production flow analysis – Grouping of parts and Machines by rank order clustering method – Benefits of GT – Case studies. FMS – Components – workstations – FMS layout configurations – Computer control systems – FMS planning and implementation issues – Architecture of FMS – flow chart showing various operations in FMS – Machine cell design – Composite part concept, Holier method, Key machine concept – Quantitative analysis of FMS – Bottleneck model – Simple and complicated problems – Extended Bottleneck model - sizing the FMS ─ FMS applications, Benefits.		
UNIT IV	**PROCESS PLANNING**	**9**
Process planning – Activities in process planning, Information required. From design to process planning – classification of manufacturing processes – Selection of primary manufacturing processes – Sequencing of operations according to Anteriority's – various examples – forming of Matrix of Anteriority – case study. Typical process sheet – case studies in Manual process planning. Computer Aided Process Planning – Process planning module and data base – Variant process planning – Two stages in VPP – Generative process planning – Flow chart showing various activities in generative PP – Semi generative process planning-Comparison of CAPP and Manual PP.		
UNIT V	**PROCESS CONTROL AND DATA ANALYSIS**	**9**
Introduction to process model formulation – linear feedback control systems – Optimal control – Adaptive control –Sequence control and PLC& SCADA. Computer process control –		

Computer process interface – Interface hardware – Computer process monitoring – Direct digital control and Supervisory computer control - Overview of Automatic identification methods – Bar code technology –Automatic data capture technologies. - Quality management (SPC) and automated inspection	
TOTAL: 45 PERIODS	
COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Explain the concepts and fundamentals for computer integrated manufacturing.
CO2:	Apply the principle and concepts of advanced manufacturing systems.
CO3:	Explain fundamentals of group technology.
CO4:	Explain concepts of flexible manufacturing systems
CO5:	Explain the functions and operations of process planning.
CO6:	Illustrate the concepts of process control and data analysis.
TEXT BOOKS:	
1	Shivanand H K, Benal M M and Koti V, Flexible Manufacturing System, New Age, 2016.
2	CIM: Computer Integrated Manufacturing: Computer Steered Industry Book by August- Wilhelm Scheer.
REFERENCES:	
1	Alavudeen and Venkateshwaran, Computer Integrated Manufacturing, PHI Learning Pvt. Ltd., New Delhi, 2013.
2	Gideon Halevi and Ronald D. Weill, Principles of Process Planning, Chapman Hall, 1995.
3	James A. Retrg, Herry W. Kraebber, Computer Integrated Manufacturing, Pearson Education, Asia, 3rd Edition,2004.
4	Mikell P. Groover, Automation, Production system and Computer integrated Manufacturing, Prentice Hall of India Pvt. Ltd., 4th Edition, 2014.

5	Radhakrishnan P, Subramanian S and Raju V, CAD/CAM/CIM, New Age International Publishers, 3rd Edition, 2008.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	-	-	-	-	-	1	-	-	-	1	-	2	2
2	3	2	1	-	-	-	-	2	-	-	-	2	-	3	3
3	2	1	-	-	-	-	-	1	-	-	-	1	-	2	2
4	2	1	-	-	-	-	-	1	-	-	-	1	-	2	2
5	2	1	-	-	-	-	-	1	-	-	-	1	-	2	2
6	2	1	-	-	-	-	-	1	-	-	-	1	-	2	2
Overall Correlation	2	2	1	-	-	-	-	1	-	-	-	1	-	2	2

23MT042	ADVANCED MANUFACTURING SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- Teach the lean tools to attain optimum level in quality.
- Enhance the ability to make decisions for new product development.
- Develop the students to conserve energy and natural resources, and to ensure that they have minimal impact on the environment and society.
- Give students an introduction to an advanced information process technique.
- Learn about the various smart manufacturing techniques and applications.

UNIT I	INTRODUCTION TO LEAN MANUFACTURING	9

Objectives of lean manufacturing-key principles and implications of lean manufacturing - traditional Vs lean manufacturing- flow-continuous improvement/Kaizen –worker involvement- 5S principles elements of JIT - uniform production rate - Kanban system - Lean implementation, Reconciling lean with other systems - lean six sigma- lean and ERP - lean with ISO 9001:2000.

UNIT II	AGILE MANUFACTURING	9

Agile Manufacturing Vs Mass Manufacturing - Agile practice for product development - Manufacturing agile practices - Implementing new technology - A checklist, technology applications that enhance agility - agile technology make or buy decisions. - Costing for Agile Manufacturing practices.

UNIT III	SUSTAINABLE MANUFACTURING	9

Concepts of competitive strategy and manufacturing strategies and development of a strategic improvement Programme - Manufacturing strategy in business success strategy formation and formulation - Structured strategy formulation - Sustainable

manufacturing system design options - Approaches to strategy formulation - Realization of new strategies/system designs.		
UNIT IV	**INTELLIGENT MANUFACTURING**	**9**
Concepts of competitive strategy and manufacturing strategies and development of a strategic improvement Programme - Manufacturing strategy in business success strategy formation and formulation - Structured strategy formulation - Sustainable manufacturing system design options - Approaches to strategy formulation - Realization of new strategies/system designs.		
UNIT V	**SMART MANUFACTURING**	**9**
Introduction to various Smart Manufacturing Techniques-Supply chain management-Block chain of inventory management-Plant digitization-Predictive maintenance-Supply chain visibility-Warehouse-Cost reduction-Waste management-Automated systems-Applications.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Explain basic concept of lean manufacturing.
CO2:	Explain various developments and technology involved in agile manufacturing.
CO3:	Explain concepts of sustainable manufacturing.
CO4:	Apply concept of modern intelligent manufacturing.
CO5:	Explain smart manufacturing and its various techniques.
CO6:	Explain the basic concepts of predictive and waste management.
TEXT BOOKS:	
1	Lonnie Wilson, "How to Implement Lean manufacturing", McGraw-Hill Professional; 2nd edition, 2015.
2	Ibrahim Garbie, "Sustainability in Manufacturing Enterprises Concepts, Analyses and Assessments for Industry 4.0", Springer International Publishing., United States, 2016, ISBN-13: 978-3319293042.

REFERENCES:

1	Kusiak, Andrew, “Intelligent Manufacturing Systems”, Prentice Hall, 1st edition, 1990.
2	Black .J.T. and Kohser R.A, “DeGarmo’s Materials and Processes in Manufacturing”, Published by Wiley, 11th edition, 2011.
3	Christian N. Madu, “Handbook of environmentally conscious manufacturing”, Springer, US Publishers, 1st edition, 2001.
4	John Schey, “Introduction to Manufacturing Processes”, Tata McGraw-Hill Education,3rd edition,1999
5	Seliger G., “Sustainable Manufacturing: Shaping Global Value Creation”, Springer, United States, 2012, ISBN 978-3-642-27289-9.
6	Rao R. V, “Advanced Modeling and Optimization of Manufacturing Processes”, 2nd edition, 2006.
7	Ronald G. Askin and Jeffrey B. Goldberg, “Design and Analysis of Lean Production Systems”, John Wiley and Sons, 2003.
8	Kutz M., “Environmentally Conscious Mechanical Design”, John Wiley & Sons., United States, 2007, ISBN: 978-0-471-72636-4.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	-	-	-	-	-	1	-	-	-	1	-	2	2
2	2	1	-	-	-	-	-	1	-	-	-	1	-	2	2
3	2	1	-	-	-	-	-	1	-	-	-	1	-	2	2
4	3	2	1	-	-	-	-	2	-	-	-	2	-	3	3
5	2	1	-	-	-	-	-	1	-	-	-	1	-	2	2
6	2	1	-	-	-	-	-	1	-	-	-	1	-	2	2
Overall Correlation	2	2	1	-	-	-	-	1	-	-	-	1	-	2	2

23ME031	ADDITIVE MANUFACTURING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To introduce the development of Additive Manufacturing (AM), various business opportunities and applications
- To familiarize various software tools, processes and techniques to create physical objects that satisfy product development / prototyping requirements, using AM.
- To be acquainted with vat polymerization and direct energy deposition processes

UNIT I	INTRODUCTION	9

Overview - Need - Development of Additive Manufacturing (AM) Technology: Rapid Prototyping - Rapid Tooling - Rapid Manufacturing - Additive Manufacturing. AM Process Chain- ASTM/ISO 52900 Classification - Benefits. Applications: Building Printing - Bio Printing - Food Printing - Electronics Printing. Case studies: Automobile, Aerospace, Healthcare.

UNIT II	DESIGN FOR ADDITIVE MANUFACTURING (DFAM)	9

Concepts and Objectives - AM Unique Capabilities - Part Consolidation – Topology Optimization - Generative design - Lattice Structures - Multi-Material Parts and Graded Materials - Data Processing: CAD Model Preparation - AM File formats: STL -Problems with STL - AMF Design for Part Quality Improvement: Part Orientation - Support Structure - Slicing - Tool Path Generation– Design rules for Extrusion based AM.

UNIT III	VAT POLYMERIZATION AND DIRECTED ENERGY DEPOSITION	9

Photo polymerization: Stereo lithography Apparatus (SLA) - Materials - Process – top down and bottom up approach - Advantages - Limitations - Applications. Digital Light Processing (DLP) - Process - Advantages - Applications. Continuous Liquid

Interface Production (CLIP) Technology. Directed Energy Deposition: Laser Engineered Net Shaping (LENS) - Process - Material Delivery - Materials -Benefits - Applications.		
UNIT IV	**POWDER BED FUSION AND MATERIAL EXTRUSION**	**9**
Powder Bed Fusion: Selective Laser Sintering (SLS): Process - Powder Fusion Mechanism - Materials and Application. Selective Laser Melting (SLM): Materials - Process - Advantages and Applications. Material Extrusion: Fused Deposition Modeling (FDM) - Process-Materials - Applications and Limitations.		
UNIT V	**OTHER ADDITIVE MANUFACTURING PROCESSES**	**9**
Binder Jetting: Three-Dimensional Printing - Materials - Process - Benefits- Limitations - Applications. Material Jetting: Multi-jet Modeling - Materials - Process - Benefits - Applications. Sheet Lamination: Laminated Object Manufacturing (LOM) - Basic Principle - Mechanism: Gluing or Adhesive Bonding – Materials - Application and Limitation.		
		TOTAL: 45 PERIODS
COURSE OUTCOMES:		
After completion of the course, the students will be able to:		
CO1:	Identify the development of AM technology into various businesses.	
CO2:	Explain about process of transforming a concept into the final product in AM technology.	
CO3:	Explain the VAT polymerization and direct energy deposition processes and its applications.	
CO4:	Summarize about the process and applications of powder bed fusion and material extrusion.	
CO5:	Compare the advantages, limitations, applications of binder jetting, material jetting and sheet lamination processes.	
CO6:	Evaluate the mechanism of gluing or other adhesive bonding and other techniques used in rapid prototype.	

TEXT BOOKS:

1	Ian Gibson, David Rosen, Brent Stucker, Mahyar Khorasani "Additive manufacturing technologies". 3rd edition Springer Cham, Switzerland, 2021.
2	Andreas Gebhardt and Jan-Steffen Hötter, "Additive Manufacturing: 3D Printing for Prototyping and Manufacturing", Hanser publications, United States, 2015.

REFERENCES:

1	Andreas Gebhardt, "Understanding Additive Manufacturing: Rapid Prototyping, Rapid Manufacturing", Hanser Gardner Publication, Cincinnati., Ohio, 2011.
2	Milan Brandt, "Laser Additive Manufacturing: Materials, Design, Technologies and Applications", Woodhead Publishing, United Kingdom, 2016.
3	Amit Bandyopadhyay and Susmita Bose, "Additive Manufacturing", 1st Edition, CRC Press, United States, 2015.
4	Kamrani A.K. and Nasr E.A., "Rapid Prototyping: Theory and practice", Springer., United States, 2006.

COs	POs												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	-	-	-	-	-	-	-	-	3	-	-
2	2	1	-	-	-	-	-	-	-	-	-	-	2	-	-
3	2	1	-	-	-	-	-	-	-	-	-	-	2	-	-
4	2	1	-	-	-	-	-	-	-	-	-	-	2	-	-
5	3	3	2	2	-	-	-	-	-	-	-	-	3	-	-
6	3	3	3	3	-	-	-	-	-	-	-	-	3	-	-
Overall Correlation	3	2	1	1	-	-	-	-	-	-	-	-	3	-	-

23MT043	ELECTRONICS MANUFACTURING TECHNOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To impart knowledge on wafer preparation and PCB fabrication
- To introduce Through Hole Technology (THT) and Surface Mount Technology (SMT) with various types of electronic components
- To elaborate various steps in Surface Mount Technology (SMT)
- To be acquainted with various testing and inspection methods of populated PCBS
- To outline repair, rework and quality aspects of Electronic assemblies.

UNIT I	INTRODUCTION TO ELECTRONICS MANUFACTURING	9

History, definition, wafer preparation by growing, machining, and polishing, diffusion, microlithography, etching and cleaning, Printed circuit board –fabrication, types, single sided, double sided, multi-layer and flexible printed circuit board

UNIT II	COMPONENTS AND PACKAGING	9

Introduction to packaging, types-Through hole technology(THT) and Surface mount technology (SMT), Through hole components – axial, radial, multi leaded, odd form Surface-mount components-active, passive. Interconnections - chip to lead interconnection, die bonding, wire bonding, TAB, flip chip, chip on board, multi chip module, direct chip array module, leaded, leadless, area array and embedded packaging, miniaturization and trends.

UNIT III	SURFACE MOUNT TECHNOLOGY	9

SMT Process, SMT equipment and material handling systems, handling of components and assemblies - moisture sensitivity and ESD, safety and precautions needed, IPC and other standards, stencil printing process - solder paste material, storage and

handling, stencils and squeegees, process parameters, quality control Component placement- equipment type, flexibility, accuracy of placement, throughput, packaging of components for automated assembly, soldering- wave soldering, reflow process, process parameters, profile generation and control, adhesive, underfill and encapsulation process.		
UNIT IV	**INSPECTION AND TESTING**	**9**
Inspection techniques, equipment and principle- AOI, X-ray. Defects and Corrective action - stencil printing process, component placement process, reflow soldering process, electrical testing of PCB assemblies- In circuit test, functional testing, fixtures and jigs.		
UNIT V	**REPAIR, REWORK, QUALITY AND RELIABILITY OF ELECTRONICS ASSEMBLIES**	**9**
Repair and rework of PCB- Coating removal, base board repair, conductor repair, thermo- mechanical effects and thermal management, Reliability fundamentals, reliability testing, failure analysis, design for manufacturability, assembly, rework ability, testing, reliability, and environment.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:

After completion of the course, the students will be able to:

CO1:	Explain the Perceive wafer preparation and PCB fabrication.
CO2:	Explain the importance of Through Hole Technology (THT) and Surface Mount Technology (SMT)
CO3:	Explain the concepts and process of Surface Mount Technology (SMT)
CO4:	Identify various testing and inspection methods of populated PCBS
CO5:	Explain various techniques in repair, rework, quality and reliability of electronic Assemblies.
CO6:	Identify the suitable electronics manufacturing technology for modern industry.

TEXT BOOKS:	
1	Prasad R., "Surface Mount Technology – Principles and practice",2nd Edition, Chapman and Hall., New York, 1997, ISBN 0-41-12921-3.
2	Tummala R.R., "Fundamentals of microsystem packaging", Tata McGraw Hill Co. Ltd., New Delhi, 2001, ISBN 00-71-37169-9.
REFERENCES:	
1	Harper C.A., "Electronic Packaging and Interconnection Handbook" 2nd Edition, McGraw Hill Inc., New York, N.Y., 1997, ISBN 0-07-026694-8.
2	Lee N.C., "Reflow Soldering Process and Trouble Shooting SMT, BGA, CSP and Flip Chip Technologies", Elsevier Science. United Kingdom, 2001.
3	Puligandla Viswanadham and Pratap Singh., "Failure Modes and Mechanisms in Electronic Packages", Chapman and Hall., New York, 1997, N.Y. ISBN 0-412-105591-8. Science and Technology, United Kingdom, 1997, ISBN 0750698756.
4	Totta P., Puttlitz K. and Stalter K., "Area Array Interconnection Handbook", Kluwer Academic
5	Publishers, Norwell, MA, United States, 2001, ISBN 0-7923-7919-5.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	-	-	-	-	-	2	-	-	-	2	2	2	2
2	2	1	-	-	-	-	-	2	-	-	-	2	2	2	2
3	2	1	-	-	-	-	-	2	-	-	-	1	2	2	2
4	3	2	1	-	-	-	-	3	-	-	-	2	3	3	3
5	2	1	-	-	-	-	-	2	-	-	-	1	2	2	2
6	3	2	1	-	-	-	-	3	-	-	-	1	3	3	3
Overall Correlation	2	1	1	-	-	-	-	2	-	-	-	2	2	2	2

<table>
<tr><td rowspan="2">23MT044</td><td rowspan="2">COMPUTER AIDED INSPECTION AND TESTING</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="6">COURSE OBJECTIVES:</td></tr>
<tr><td colspan="6">

To familiar the measurement standards and to know the instruments used and various errors in measurements
To recognize the use of basic and advanced instruments for measurements.
To learn the applications of opto-electronics device for measurements.
To describe the various measurement techniques using laser metrology.
To gain knowledge on computer aided inspection and advances in metrology.

</td></tr>
<tr><td>UNIT I</td><td colspan="4">FUNDAMENTALS AND CONCEPTS IN METROLOGY</td><td>9</td></tr>
<tr><td colspan="6">Standards of Measurement – Analog and Digital Measuring Instruments - Comparators – Limits, Fits and Tolerances – Gauge Design –Surface Roughness – Form Errors and Measurements.</td></tr>
<tr><td>UNIT II</td><td colspan="4">INSPECTION AND GENERAL MEASUREMENTS</td><td>9</td></tr>
<tr><td colspan="6">Linear Measuring Instruments – Evolution – Types – Classification – Limit Gauges – Gauge Design – Terminology – Procedure – Concepts of Interchange Ability and Selective Assembly – Angular Measuring Instruments – Types – Bevel Protractor Clinometers Angle Gauges, Spirit Levels Sine Bar – Angle Alignment Telescope – Autocollimator – Applications - Inspection of Gears And Threads – Tool Makers' Microscope – Universal Measuring Machine.</td></tr>
<tr><td>UNIT III</td><td colspan="4">OPTO ELECTRONICS IN ENGINEERING INSPECTION</td><td>9</td></tr>
<tr><td colspan="6">Use of Optoelectronics in Tool Wear Measurements – Microhole Measurement and Surface Roughness – Applications in In-Process Measurement and On-Line Inspection.</td></tr>
</table>

UNIT IV	**LASER METROLOGY**	**9**

Precision instrument based on Laser - Use of Lasers - Principle – Interferometers, Interference microscope -Optical flats - Laser Interferomter - Application in Linear and Angular measurements - Testing of machine tools using Laser Interferometer. Use of Laser Interferometer in Machine Tool Inspection – Uses of Laser in On-Line Inspection – Laser Micrometer – Laser Alignment Telescope.

UNIT V	**COMPUTER AIDED INSPECTION AND ADVANCES IN METROLOGY**	**9**

Co-ordinate Measuring Machines - Constructional features - Types - Applications of CMM - CNC CMM applications - Measurement arms, Laser tracker - Fundamentals of Computer Aided Inspection - Introduction to Nano metrology.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

	After completion of the course, the students will be able to:
CO1:	Explain fundamental concepts of metrology.
CO2:	Illustrate the various inspection measurements.
CO3:	Explain the fundamental concepts and principle of various general measurements.
CO4:	Apply the concepts of opto electronics in inspection
CO5:	Explain the various measurements using laser interferometry
CO6:	Explain the fundamentals of computer aided inspection and advances in metrology.

TEXT BOOKS:

1	Anil. K. Jain, “Fundamentals of Digital Image Processing”, Prentice Hall of India Pvt. Ltd.,2006
2	Alan S. Morris, “The Essence of Measurement”, Prentice Hall of India, 2002.
3	Beckwith, Marangoni, Lienhard, “Mechanical Measurements”, Pearson Education, 2014.

REFERENCES:	
1	Charles Reginald Shotbolt, "Metrology for Engineers", Cengage Learning EMEA,5th edition, 1996.
2	Jain R.K., "Engineering Metrology", Khanna Publishers, 2012.
3	Robert G. Seippel, "Opto-Electronics for Technology and Engineering", Prentice Hall, 1989.
4	Robert J. Hocken, Paulo H. "Coordinate Measuring Machines and Systems", CRC Press, 2nd edition, 2016.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	-	-	-	-	-	1	-	-	-	1	-	2	2
2	2	1	-	-	-	-	-	1	-	-	-	1	-	2	2
3	2	1	-	-	-	-	-	1	-	-	-	1	-	2	2
4	3	2	1	-	-	-	-	2	-	-	-	2	-	3	3
5	2	1	-	-	-	-	-	1	-	-	-	1	-	2	2
6	2	1	-	-	-	-	-	1	-	-	-	1	-	2	2
Overall Correlation	2	2	1	-	-	-	-	1	-	-	-	1	-	2	2

VERTICAL – 3 – SMART MOBILITY SYSTEMS

23MT045	AUTOMOTIVE MECHATRONICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To study the basics of electronics, emission controls and its Importance in automobiles.
- To study the Ignition and Injection system in Automobiles
- To study the various sensors and actuators used in automobiles for improving fuel economy and emission control.
- To study the various blocks of mechatronic control units used for control of fuel, ignition and exhaust systems.
- To learn about different types of chassis and mechatronics safety systems in automobile

UNIT I	INTRODUCTION	8

Evolution of electronics in automobiles – emission laws – introduction to Euro I, Euro II, Euro III, Euro IV, Euro V standards – Equivalent Bharat Standards. Charging systems: Working and design of charging circuit diagram – Alternators – Requirements of starting system - Starter motors and starter circuits.

UNIT II	IGNITION AND INJECTION SYSTEMS	10

Ignition systems: Ignition fundamentals - Electronic ignition systems - Programmed Ignition – Distribution less ignition - Direct ignition – Spark Plugs. Electronic fuel Control: Basics of combustion – Engine fueling and exhaust emissions – Electronic control of carburetion – Petrol fuel injection – Diesel fuel injection.

UNIT III	SENSOR AND ACTUATORS IN AUTOMOTIVES	7

Working principle and characteristics of Airflow rate, Engine crankshaft angular position, Hall effect, Throttle angle, temperature, exhaust gas oxygen sensors – study of fuel injector, exhaust gas recirculation actuators, stepper motor actuator, and vacuum operated actuator.

UNIT IV	**ENGINE CONTROL SYSTEMS**	**10**
Control modes for fuel control-engine control subsystems – ignition control methodologies – different ECUs used in the engine management – block diagram of the engine management system. In vehicle networks: CAN standard, format of CAN standard – diagnostics systems in modern automobiles.		
UNIT V	**CHASSIS AND SAFETY SYSTEMS**	**10**
Traction control system – Cruise control system – electronic control of automatic transmission – antilock braking system – electronic suspension system – working of airbag and role of MEMS in airbag systems – centralized door locking system – climate control of cars.		
		TOTAL: 45 PERIODS
COURSE OUTCOMES:		
After completion of the course, the students will be able to:		
CO1:	Explain the importance of emission standards in automobiles.	
CO2:	Apply the concepts of electronic fuel injection and ignition components.	
CO3:	Explain the use of sensors in automotive vehicle system	
CO4:	Explain the different actuator system in automotives.	
CO5:	Explain issues in electronic engine control systems	
CO6:	Explain the chassis control and safety system	
TEXT BOOKS:		
1	Ribbens, "Understanding Automotive Electronics", 8th Edition, Elsevier, Indian Reprint, 2017.	
2	Barry Hollembeak, "Automotive Electricity, Electronics & Computer Controls", Delmar Publishers, 7th edition, 2019	
REFERENCES:		
1	Richard K. Dupuy "Fuel System and Emission controls", Check Chart Publication,4th edition, 2000.	
2	Ronald. K. Jurgon, "Automotive Electronics Handbook", McGraw-Hill, 1999.	
3	Tom Denton, "Automobile Electrical and Electronics Systems", Edward Arnold Publishers,2000.	

Cos	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	1	-	-	-	-	-	1	-	-	-	1	1	2	1
2	3	2	1	1	-	-	-	1	-	-	-	1	1	2	1
3	2	1	-	-	-	-	-	1	-	-	-	1	1	2	1
4	2	1	-	-	-	-	-	1	-	-	-	1	1	2	1
5	2	1	-	-	-	-	-	1	-	-	-	1	1	2	1
6	2	1	-	-	-	-	-	1	-	-	-	1	1	2	1
Overall Correlation	2	1	1	1	-	-	-	1	-	-	-	1	1	2	1

23MT046	ELECTRIC AND HYBRID VEHICLES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To know about the general aspects of Electric and hybrid vehicles
- To learn about the architecture of electric and hybrid vehicles.
- To learn to model the electric and hybrid vehicles
- To study the sizing, sub system design and hybrid vehicle control of electric and hybrid vehicles.

UNIT I	DESIGN OF ELECTRIC VEHICLES	9

Need - Comparative study of diesel, petrol, hybrid and electric Vehicles. Advantages and Limitations of hybrid and electric Vehicles. - Design requirement for electric vehicles- Range, maximum velocity, acceleration, power requirement, mass of the vehicle. Various Resistance- Transmission efficiency- Electric vehicle chassis and Body Design, Electric Vehicle Recharging and Refueling Systems.

UNIT II	ENERGY SOURCES	9

Battery Parameters- - Different types of batteries – Lead Acid- Nickel Metal Hydride - Lithium ion- Sodium based- Metal Air. Battery Modelling - Equivalent circuits, Battery charging- Quick Charging devices. Fuel Cell- Fuel cell Characteristics- Fuel cell types-Half reactions of fuel cell. Ultra capacitors. Battery Management System.

UNIT III	MOTORS AND DRIVES	9

Types of Motors- DC motors- AC motors, PMSM motors, BLDC motors, Switched reluctance motors working principle, construction and characteristics.

UNIT IV	POWER CONVERTERS AND CONTROLLERS	9

Solid state Switching elements and characteristics – BJT, MOSFET,

IGBT, SCR and TRIAC - Power Converters – Introduction to Motor Drives - DC, AC, PMSM, BLDC, SRM Motor.		
UNIT V	**HYBRID AND ELECTRIC VEHICLES**	**9**
Main components and working principles of hybrid and electric vehicles, Different configurations of hybrid and electric vehicles. Power Split devices for Hybrid Vehicles - Operation Modes - Control Strategies for Hybrid Vehicles - Economy of hybrid Vehicles - Case study on specification of electric and hybrid vehicles.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
	After completion of the course, the students will be able to:
CO1:	Explain the operation and architecture of electric and hybrid vehicle
CO2:	Explain the various energy source options like battery and fuel cell.
CO3:	Identify the suitable electric motor for applications in hybrid and electric vehicles.
CO4:	Explain the Switching Characteristics of Power Converters and motor drives.
CO5:	Explain the working principle of Electric and Hybrid vehicles
CO6:	Explain the operating modes, control strategies of Hybrid vehicles and study the specifications of electric and hybrid vehicles.
TEXT BOOKS:	
1	Iqbal Husain, "Electric and Hybrid Vehicles-Design Fundamentals", CRC Press,2003
2	Mehrdad Ehsani, "Modern Electric, Hybrid Electric and Fuel Cell Vehicles", CRCPress,2005.
REFERENCES:	
1	James Larminie and John Lowry, "Electric Vehicle Technology Explained " John Wiley & Sons,2003

2	Lino Guzzella, “ Vehicle Propulsion System” Springer Publications,2005
3	Ron HodKinson, “Light Weight Electric/ Hybrid Vehicle Design”, Butterworth Heinemann Publication,2005.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	-	-	-	3	2	2	-	-	-	2	1	1	3
2	2	1	-	-	-	3	2	2	-	-	-	2	1	1	3
3	3	2	1	-	-	3	2	2	-	-	-	2	1	1	3
4	2	1	-	-	-	3	2	2	-	-	-	2	1	1	3
5	2	1	-	-	-	3	2	2	-	-	-	2	1	1	3
6	2	1	-	-	-	3	2	2	-	-	-	2	1	1	3
Overall Correlation	2	2	1	-	-	3	2	2	-	-	-	2	1	1	3

23MT047	AUTOMOBILE ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To study the construction and working principle of various parts of an automobile.
- To study the practice for assembling and dismantling of engine parts and transmission system
- To study various transmission systems of automobile.
- To study about steering, brakes and suspension systems
- To study alternative energy sources

UNIT I	VEHICLE STRUCTURE AND ENGINES	9

Types of automobiles vehicle construction and different layouts, chassis, frame and body, Vehicle aerodynamics (various resistances and moments involved), IC engines – components-functions and materials, variable valve timing (VVT).

UNIT II	ENGINE AUXILIARY SYSTEMS	9

Electronically controlled gasoline injection system for SI engines, Electronically controlled diesel injection system (Unit injector system, Rotary distributor type and common rail direct injection system), Electronic ignition system (Transistorized coil ignition system, capacitive discharge ignition system), Turbo chargers (WGT, VGT), Engine emission control by three-way catalytic converter system, Emission norms (Euro and BS).

UNIT III	TRANSMISSION SYSTEMS	9

Clutch-types and construction, gear boxes- manual and automatic, gear shift mechanisms, Overdrive, transfer box, fluid flywheel, torque converter, propeller shaft, slip joints, universal joints, Differential and rear axle, Hotchkiss Drive and Torque Tube Drive.

UNIT IV	STEERING, BRAKES AND SUSPENSION SYSTEMS	9

Steering geometry and types of steering gear box-Power Steering,

Types of Front Axle, Types of Suspension Systems, Pneumatic and Hydraulic Braking Systems, Antilock Braking System (ABS), electronic brake force distribution (EBD) and Traction Control.		
UNIT V	**ALTERNATIVE ENERGY SOURCES**	**9**
Use of Natural Gas, Liquefied Petroleum Gas, Bio-diesel, Bio-ethanol, Gasohol and Hydrogen in Automobiles- Engine modifications required –Electric and Hybrid Vehicles, Fuel Cell		
		TOTAL: 45 PERIODS
COURSE OUTCOMES:		
After completion of the course, the students will be able to:		
CO1:	Identify the various parts of automobile, their functions, materials and analyze aerodynamics forces.	
CO2:	Explain the working principle of engine auxiliary system and engine emission control system.	
CO3:	Explain the different types of transmission systems and its working.	
CO4:	Explain the working mechanism of steering and steering gear boxes.	
CO5:	Explain the working principle of braking and suspension systems.	
CO6:	Explain the various alternate sources of energy and drives for automobiles.	
TEXT BOOKS:		
1	Jain K.K. and Asthana .R.B, “Automobile Engineering” Tata McGraw Hill Publishers, New Delhi, 2002.	
2	Kirpal Singh, “Automobile Engineering”, Vol 1 & 2, Seventh Edition, Standard Publishers, New Delhi, 13th Edition 2014.	
REFERENCES:		
1	Ganesan V. “Internal Combustion Engines”, Third Edition, Tata McGraw-Hill, 2012.	
2	Heinz Heisler, “Advanced Engine Technology,” SAE International Publications USA, 1998.	

3	Joseph Heitner, "Automotive Mechanics," Second Edition, East-West Press, 1999.
4	Martin W, Stockel and Martin T Stockle , "Automotive Mechanics Fundamentals," The Good heart - Will Cox Company Inc, USA ,1978.
5	Newton, Steeds and Garet, "Motor Vehicles", Butterworth Publishers,1989.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	-	-	2	2	3	-	-	-	3	3	-	1
2	2	1	-	-	-	3	3	2	-	-	-	3	2	-	1
3	2	1	-	-	-	2	2	2	-	-	-	3	2	-	1
4	2	1	-	-	-	2	2	2	-	-	-	3	2	-	1
5	2	1	-	-	-	2	2	2	-	-	-	3	2	-	1
6	2	1	-	-	-	3	3	2	-	-	-	3	2	-	1
Overall Correlation	3	2	1	-	-	2	3	2	-	-	-	3	2		1

23MT048	AUTOMOTIVE SYSTEM MODELING AND SIMULATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the various steps involved in the design of automotive components
- To show their knowledge in designing engine components.
- To complete design exercise and arrive at important dimensions of chassis components.
- To learn the use of standard practices in design.
- To determine the dimensions of front and rear axles

UNIT I	DESIGN OF CYLINDER, PISTON AND CONNECTING ROD	9

Choice of material for cylinder and piston, design of cylinder, design of piston, piston pin, piston rings and piston assembly. Material for connecting rod, design of connecting rod assembly. Case study on piston for car with Modelling and simulation.

UNIT II	DESIGN OF CRANK SHAFT AND VALVES	9

Material for crankshaft, design of crankshaft under bending and twisting. Design aspects of intake & exhaust manifolds, inlet & exhaust valves, valve springs, tappets and valve train. Design of cam& camshaft. Design of rocker arm. Cam profile generation. 3D Engine simulation: Introduction to thermal and flow analysis in engine cylinder, modeling of cylinder and piston for combustion analysis.

UNIT III	DESIGN OF CLUTCHES AND GEARS	9

Design of single plate clutch, multiplate clutch and cone clutch assembly. Torque capacity of clutch. Design of clutch components. Gear train calculations, layout of gearboxes. Calculation of bearing loads and selection of bearings. Design of three speed and four speed gearboxes. Modelling and simulation: braking system.

UNIT IV	**DESIGN OF VEHICLE FRAME AND SUSPENSION**	**9**
Study of loads-moments and stresses on frame members. Design Of frame for passenger and commercial vehicle - Design of leaf Springs-Coil springs and torsion bar springs. Case study on development of frame for ATV. Modelling and simulation of suspension system.		
UNIT V	**DESIGN OF FRONT AND REAR AXLE**	**9**
Design of propeller shaft. Design details of final drive gearing. Design details of full floating, semi-floating and three quarter floating rear shafts and rear axle housings. Analysis of loads-moments and stresses at different sections of front axle. Determination of optimum dimensions and proportions for steering linkages, Design of front axle beam. Modelling and simulation of steering system, transmission system.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
	After completion of the course, the students will be able to:
CO1:	Analyze the design of cylinder, piston and connecting rod.
CO2:	Analyze the design of crank shaft and valves.
CO3:	Apply the concepts to design the single and muti plate clutches
CO4:	Construct the design of gear boxes and simulate the braking systems
CO5:	Analyze the design of vehicle frame and suspension system.
CO6:	Construct the design and analysis the various types of load in front and rear axle.
TEXT BOOKS:	
1	Giancarlo Genta, Lorenzo Morello, “The Automotive Chassis Volume 1, Components Design”, Springer International Edition, 2nd edition,2020

2	Khurmi. R.S. & Gupta. J.K., "A textbook of Machine Design", Eurasia Publishing House (Pvt) Ltd, 25th edition, 2022.
3	Alec Stokes, “Manual gearbox design”, Butterworth-Heinemann 1992.
REFERENCES:	
1	“Design Data Hand Book”, PSG College of Technology, 2013- Coimbatore.
2	Dean Averns, "Automobile Chassis Design", Il life Book Co., 2001.
3	Kolchin-Demidov , “Design of Automotive Engines”-Mir Publishers (1984)
4	Lukin P G G and Rodionov V, “Automobile Chassis Design and Calculations”, MirPu blishers, Moscow, 1989.
5	Robert C. Juvinall and Kurt M. Marshek, “Fundamentals of Machine component Design”,6th Edition, Wiley, 2017.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	3	3	3	3	-	-	1	-	-	-	1	2	2	3
2	3	3	3	3	3	-	-	1	-	-	-	1	2	2	3
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4	3	3	2	2	2	-	-	1	-	-	-	1	2	2	3
5	3	3	3	3	3	-	-	1	-	-	-	1	2	2	3
6	3	3	3	3	3	-	-	1	-	-	-	1	2	2	3
Overall Correlation	3	3	3	3	3	-	-	1	-	-	-	1	2	2	3

<table>
<tr><td rowspan="2">23MT049</td><td colspan="2" rowspan="2">VEHICLE DYNAMICS AND CONTROLS</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="7">COURSE OBJECTIVES:</td></tr>
<tr><td colspan="7">
• To Develop physical and mathematical models to predict the dynamic response of vehicles
• To Apply vehicle design performance criteria and how to use the criteria to evaluate vehicle dynamic response
• To Use dynamic analyses in the design of vehicles.
• To understand the principle behind the lateral dynamics.
• To Evaluate the longitudinal dynamics and control in an automobile
</td></tr>
<tr><td>UNIT I</td><td colspan="5">INTRODUCTION</td><td>9</td></tr>
<tr><td colspan="7">History of road and off-road vehicle system dynamics - dynamics of the motor vehicle, coordinate systems- vehicle fixed coordinates system, , details of vehicle systems, wheel angles, typical data of vehicles. Fundamental approaches to vehicle dynamics modeling lumped mass, vehicle fixed coordinate system, motion variables, earth fixed coordinate system, Definitions- modeling and simulation of dynamic behavior of vehicle., motion analysis, force analysis, and energy analysis.</td></tr>
<tr><td>UNIT II</td><td colspan="5">LONGITUDINAL DYNAMICS</td><td>9</td></tr>
<tr><td colspan="7">Introduction to longitudinal dynamics - Performance of road vehicles: forces and moments on vehicle, equation of motion, tire forces, rolling resistance, weight distribution, tractive effort/tractive resistance and power available from the engine/ power required for propulsion, road performance curves-acceleration, grade ability, drawbar pull, and the problems related to these terms. Calculation of maximum acceleration braking torque, braking force, brake proportioning, braking efficiency, stopping distance, load distribution (three wheeled and four wheeled vehicles), calculation of acceleration, tractive effort and reactions for different drives, Stability of a vehicle on slope, (Problems related to these). Steer-By-Wire Systems.</td></tr>
</table>

UNIT III	LATERAL DYNAMICS	9
Introduction to lateral dynamics Steering geometry, types of steering systems, fundamental condition for true rolling, development of lateral forces. slip angle, cornering force, cornering stiffness, pneumatic trail, self-aligning torque, power consumed by tire, tire stiffness, hysteresis effect in tires, steady state handling characteristics. yaw velocity, lateral acceleration, curvature response & directional stability. Stability of a vehicle on a curved track and a banked road. Gyroscopic effects, weight transfer during acceleration, cornering and braking, stability of a rigid vehicle and equations of motion of a rigid vehicle, cross wind handling, the problems related to these terms		
UNIT IV	**VERTICAL DYNAMICS**	**9**
Introduction to vertical dynamics - Human response to vibrations, classification of vibration, specification and vibration , sources of vibration, suspension systems, Modal Analysis, One DOF, two DOF, free and forced vibration, damped vibration, magnification and transmissibility, vibration absorber, functions of suspension system. body vibrations: bouncing and pitching. Doubly conjugate points (only basic idea). body rolling. roll center and roll axis, roll axis and the vehicle under the action of side forces, stability against body rolling. Vehicle dynamics and suspension design for stability, choice of suspension spring rate, chassis springs and theory of chassis springs, gas & hydraulic dampers and choice of damper, damper characteristics, mechanics of an independent suspension system. Design and analysis of passive, semi-active and active suspension using quarter car, half car and full car mode-Hydraulic Actuators for Active Suspensions.		
UNIT V	**VEHICLE AERODYNAMIC AND DYNAMIC CONTROL SYSTEM**	**9**
Road Loads: Air resistance-Mechanics of air flow around a vehicle, pressure distribution on a vehicle, factors affecting rolling resistance, aerodynamic forces – aerodynamic drag, drag		

components, dynamic Control, modelling of actuators, sensors for automobile control, sensors for detecting vehicle environment, central tire inflation system. Prediction of vehicle performance. ABS, stability control, traction control. Dynamic Model for Simulation of a Parallel Gas-Electric Hybrid Vehicle Dynamic Model for Simulation of a Power-Split Hybrid Vehicle. Background on Control Design Techniques for Energy Management – steer by wire controller Design.		
TOTAL: 45 PERIODS		
COURSE OUTCOMES:		
	After completion of the course, the students will be able to:	
CO1:	Explain the concepts of vehicle system dynamics.	
CO2:	Evaluate the driving/ braking resistances and their influences on vehicle dynamics	
CO3:	Analyze the dynamics systems such as suspension systems, body vibrations, steering mechanisms.	
CO4:	Analyze and solve engineering problems related to vehicle dynamics.	
CO5:	Identify the different types of control systems in automobiles.	
CO6:	Explain the dynamic model for simulation of hybrid vehicle	
TEXT BOOKS:		
1	Rajesh Rajamani, "Vehicle Dynamics and Control", 2nd edition, Springer, 2021.	
2	Singiresu S. Rao, "Mechanical Vibrations", 8th Edition, Prentice Hall, 2018.	
3	Thomas D. Gillespie, "Fundamentals of Vehicle Dynamics", Society of Automotive Engineers	
4	Inc., 2021.	
5	Wong. J. Y., "Theory of Ground Vehicles", 5th Edition, Wiley-Interscience, 2022 .	
REFERENCES:		
1	J. Y. Woung - John Willey & Sons "Theory of Ground Vehicles ", NY ,5th Edition,2022	
2	J. G. Giles," Steering, Suspension &Tyres", Ilete Books Ltd., London,1968	
3	W. Steed "Mechanics of Road Vehicles ", Ilete Books Ltd. London,1960	

4	P. M. Heldt, "Automotive Chassis", Chilton Co. NK
5	Gillespie.T.D., "Fundamental of vehicle dynamic society of Automotive Engineers ", USA, 2021 Revised Edition.
6	Rajesh Rajamani, "Vehicle dynamics and control", Springer publication,2014
7	Reza N Jazar, "Vehicle Dynamics: Theory and Application", Springer publication,3rd Edition,2018

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	-	-	-	-	-	2	-	-	-	2	2	2	2
2	3	3	3	3	2	-	-	3	-	-	-	3	2	2	3
3	3	3	2	2	1	-	-	3	-	-	-	3	2	2	3
4	3	3	2	2	1	-	-	3	-	-	-	3	2	2	3
5	3	2	1	1	-	-	-	3	-	-	-	3	2	2	3
6	2	1	-	-	-	-	-	2	-	-	-	2	2	2	2
Overall Correlation	3	2	2	2	1	-	-	3	-	-	-	3	2	2	3

23MT050	AIRCRAFT MECHATRONICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To introduce the basic of avionics and its need for civil and military aircrafts
- To impart knowledge about the avionic architecture and various avionics data bases
- To gain more knowledge on various avionics subsystems
- To impart knowledge on aircraft materials.
- To analyze the application of Mechatronics in aircraft.

UNIT I	AIRCRAFT AERODYNAMICS	9

Nomenclature used in Aerodynamics, different parts of airplane-Wing as lifting surface, Types of wing plan forms, Aerodynamic features like Aerofoil pressure distribution- Aerodynamic forces and moments Lift and Drag- Drag polar, L/D ratio, high lift devices, Airplane performance like Thrust/Power available, climb and glide - maximum range and endurance, take off and landings.

UNIT II	AIRCRAFT PROPULSION	9

Requirement of power- various means of producing power - Brief description of thermodynamics of engines - Piston engines, Jet engines - Airplane Structure, Materials and Production - Structural arrangement of earlier airplane- developments leading to all metal aircraft - Strength to weight ratio choice of aircraft materials for different parts.

UNIT III	AIRCRAFT MATERIALS	9

Detailed description of wing - tail and fuselage joints - Stress-Strain diagrams, Plane and Space, Mechanical properties of materials - Materials for different components - use of composites - Aircraft production methods and equipment.

UNIT IV	PRIMARY FLIGHT CONTROLS	9

Ailerons - Aileron Control System of a Commercial Aircraft - Elevators - Elevator control system of a commercial aircraft – Rudders- Rudder Control System.

UNIT V	APPLICATIONS OF MECHATRONICS IN AVIATION	9

Aileron-Flaps and Actuator drive unit-Pilot Static system-Fly by wire control system-Yaw damper-Primary flight control system-

Internal navigation system-Under carriage-Measurement of motor rpm-Measurement of air flow velocity-Altitude measurement sensor-Air speed.	
TOTAL: 45 PERIODS	
COURSE OUTCOMES:	
	After completion of the course, the students will be able to:
CO1:	Explain the Basics in aerodynamics, aircraft propulsion, materials and controls
CO2:	Explain about the various concepts used in aerodynamics.
CO3:	Apply the techniques to develop the aero system.
CO4:	Apply the aircraft concepts used in aerodynamics
CO5:	Develop the aircraft design with concepts in aircraft propulsion, materials and controls.
CO6:	Apply this aircraft system in various applications.
TEXT BOOKS:	
1	Fundamentals of Flight; By Dr. O. P. Sharma and Lalit Gupta.2006.
2	Albert Helfrick.D., "Principles of Avionics", Avionics Communications Inc., 2004.
REFERENCES:	
1	Middleton, D.H., Ed., "Avionics systems, Longman Scientific and Technical", Longman Group UK Ltd., England, 1989.
2	Pallet. E.H.J., "Aircraft Instruments and Integrated Systems", Pearsons, Indian edition 2011.
3	Spitzer, C.R. "Digital Avionics Systems", Prentice-Hall, Englewood Cliffs, N.J.,U.S.A. 1993.
4	Spitzer. C.R. "The Avionics Hand Book", CRC Press, 2000.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	-	-	-	-	-	-	-	-	-	-	3	2	-
2	2	1	-	-	-	-	-	-	-	-	-	-	3	2	-
3	3	2	1	1	-	-	-	-	-	-	-	-	3	2	-
4	3	2	1	1	-	-	-	-	-	-	-	-	3	2	-
5	3	2	1	1	-	-	-	-	-	-	-	-	3	2	-
6	3	2	1	1	-	-	-	-	-	-	-	-	3	2	-
Overall Correlation	3	2	1	1	-	-	-	-	-	-	-	-	3	2	-

23MT051	SMART MOBILITY AND INTELLIGENT VEHICLES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To introduce students to the various technologies and systems used to implement smart mobility and intelligent vehicles.
- To learn Basics of Radar Technology and Systems, Ultrasonic Sonar Systems, LIDAR Sensor Technology and Systems and other sensors for automobile vision system.
- To learn Basic Control System Theory applied to Autonomous Automobiles.
- To produce overall impact of automating like various driving functions, connecting the automobile to sources of information that assist with a task
- To allow the automobile to make autonomous intelligent decisions concerning future actions of the vehicle that potentially impact the safety of the occupants through connected car & autonomous vehicle technology.

UNIT I	INTRODUCTION TO AUTOMATED, CONNECTED, AND INTELLIGENT VEHICLES	9

Concept of Automotive Electronics, Electronics Overview, History & Evolution, Infotainment, Body, Chassis, and Powertrain Electronics, Introduction to Automated, Connected, and Intelligent Vehicles. Case studies: Automated, Connected, and Intelligent Vehicles.

UNIT II	SENSOR TECHNOLOGY FOR SMART MOBILITY	9

Basics of Radar Technology and Systems, Ultrasonic Sonar Systems, Lidar Sensor Technology and Systems, Camera Technology, Night Vision Technology, Other Sensors, Use of Sensor Data Fusion, Integration of Sensor Data to On-Board Control Systems

UNIT III	**CONNECTED AUTONOMOUS VEHICLE**	**9**
Basic Control System Theory applied to Automobiles, Overview of the Operation of ECUs, Basic Cyber-Physical System Theory and Autonomous Vehicles, Role of Surroundings Sensing Systems and Autonomy, Role of Wireless Data Networks d Autonomy.		
UNIT IV	**VEHICLE WIRELESS TECHNOLOGY AND NETWORKING**	**9**
Wireless System Block Diagram and Overview of Components, Transmission Systems – Modulation/Encoding, Receiver System Concepts– Demodulation/Decoding, Wireless Networking and Applications to Vehicle Autonomy, Basics of Computer Networking – the Internet of Things, Wireless Networking Fundamentals, Integration of Wireless Networking and On-Board Vehicle Networks		
UNIT V	**CONNECTED CAR & AUTONOMOUS VEHICLE TECHNOLOGY**	**9**
Connectivity Fundamentals, Navigation and Other Applications, Vehicle-to-Vehicle Technology and Applications, Vehicle-to-Roadside and Vehicle-to-Infrastructure Applications, Autonomous Vehicles - Driverless Car Technology, Moral, Legal, Roadblock Issues, Technical Issues, Security Issues.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
	After completion of the course, the students will be able to:
CO1:	Explain the operation and architecture of electric and hybrid vehicles.
CO2:	Explain the types of sensor technology needed to implement remote sensing
CO3:	Explain the basic control system theory applied for Automobiles & operation of ECU’s.
CO4:	Explain the concept of cyber-physical control systems and their application to collision avoidance and autonomous vehicles
CO5:	Explain the basic concepts of wireless communications and wireless data networks

CO6:	Apply the concept of the connected vehicle and its role in automated vehicles
TEXT BOOKS:	
1	"Intelligent Transportation Systems and Connected and Automated Vehicles", 2016, Transportation Research Board
2	Radovan Miucic, "Connected Vehicles: Intelligent Transportation Systems", 2019,Springer
REFERENCE:	
1	Tom Denton, "Automobile Electrical and Electronic systems", Roultedge Taylor & Francis Group, 5th Edition, 2018.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	-	-	-	-	-	-	-	-	-	-	3	2	-
2	2	1	-	-	-	-	-	-	-	-	-	-	3	2	-
3	2	1	-	-	-	-	-	-	-	-	-	-	3	2	-
4	2	1	-	-	-	-	-	-	-	-	-	-	3	2	-
5	2	1	-	-	-	-	-	-	-	-	-	-	3	2	-
6	3	2	1	1	-	-	-	-	-	-	-	-	3	2	-
Overall Correlation	2	1	1	1	-	-	-	-	-	-	-	-	3	2	-

23MT052	ADVANCED DRIVER ASSISTANCE SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To introduce students with various fundamentals related to advanced driver assistance technologies.
- To impart knowledge on sensors, control and actuation methodologies and create impact of automating vehicles.
- To acquire skills on vehicle prognostics and impaired driver technology
- To learn about various commonly available Advanced Driver Assistance Systems.
- To study about Center Console Technology and other display technology

UNIT I	AUTOMOTIVE FUNDAMENTALS	9

Power System-Running System-Comfort System– Engine Components – Drive train – suspension system, ABS, Steering System.

UNIT II	AUTOMOTIVE SENSORS	9

Knock sensors, oxygen sensors, crankshaft angular position sensor, temperature sensor, speed sensor, Pressure sensor, Mass air flow sensor, Manifold Absolute Pressure Sensors, crash sensor, Coolant level sensors, Brake fluid level sensors – operation, types, characteristics, advantage and their applications. Radar, Ultrasonic Sonar Systems, Lidar Sensor Technology and Systems, Camera.

UNIT III	OVERVIEW OF DRIVER ASSISTIVE TECHNOLOGY	9

Basics of Theory of Operation, Applications, Integration of ADAS Technology into Vehicle Electronics, System Examples, Role of Sensor Data Fusion. Vehicle Prognostics Technology.

UNIT IV	ADVANCED DRIVER ASSISTANCE SYSTEMS	9

Advanced Driver Assistance Systems - Lane Departure (LDW), Active Cruise Control (ACC), Blind Spot Detection, Parking Assist, Autonomous Emergency Braking (AEB), Night Vision, Traffic Sign

Recognition (TSR), Intelligent High beam Assistant (IHC), Tire Pressure Monitoring (TPMS), Front Collision Warning System (FCWS), Front Vehicle Departure Warning (FVDW), Adaptive Lighting, Driver Drowsiness Detection, Hill Decent Control, Rear Cross Traffic.		
UNIT V	**ADAS DISPLAY AND IMPAIRED DRIVER TECHNOLOGY**	**9**
Center Console Technology, Gauge Cluster Technology, Heads-Up Display Technology, and Warning Technology – Driver Notification. Impaired Driver Technology -Driver Impairment Sensor Technology, Sensor Technology for Driver Impairment Detection, Transfer of Control Technology.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
	After completion of the course, the students will be able to:
CO1:	Explain the fundamentals of automotive system
CO2:	Explain the various automotive functions, sensors Technology
CO3:	Explain the concept of driver assistance systems.
CO4:	Explain the proposed autonomous vehicle systems
CO5:	Explain the concept of sensor data fusion as it relates to ADAS.
CO6:	Apply possible evolution of vehicle prognostics and impaired driver technology.
TEXT BOOKS:	
1	Tom Denton, "Automobile Electrical and Electronic systems," Roultedge Taylor & Francis Group, 5th Edition, 2018.
2	William B Ribbens, "Understanding Automotive Electronic: An Engineering Perspective", Elsevier Science, 8th Edition, 2017.
REFERENCES:	
1	"Intelligent Transportation Systems and Connected and Automated Vehicles", Transportation Research Board, 2016.
2	Radovan Miucic, "Connected Vehicles: Intelligent Transportation Systems", Springer, 2019.

COs	POs												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	-	-	-	-	-	2	-	-	-	2	3	2	3
2	2	1	-	-	-	-	-	2	-	-	-	2	3	2	3
3	2	1	-	-	-	-	-	2	-	-	-	2	3	2	3
4	2	1	-	-	-	-	-	2	-	-	-	2	3	2	3
5	2	1	-	-	-	-	-	2	-	-	-	2	3	2	3
6	3	2	1	1	-	-	-	2	-	-	-	2	3	2	3
Overall Correlation	2	1	1	1	-	-	-	2	-	-	-	2	3	2	3

VERTICAL – 4 – INTELLIGENCE SYSTEMS

23MT053	APPLIED SIGNAL PROCESSING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the characteristics of various types of signals.
- To carry out the preprocessing of continuous time signals and systems
- To learn DTFT, FFT and Z-Transform methods in signals processing.
- To design digital IIR, FIR filters for signal processing
- To learn about various signal processors and its applications of signals.

UNIT I	INTRODUCTION TO SIGNALS AND SYSTEMS	9

Elementary signals in continuous and discrete time - graphical and mathematical representation - Elementary operations and classification of continuous and discrete time signals – CT systems and DT systems - Properties of CT systems and DT systems Classification of systems.

UNIT II	ANALYSIS OF CONTINUOUS TIME SIGNALS AND SYSTEMS	9

The continuous time Fourier series - Fourier Transform properties - Laplace transform and properties - Impulse response - convolution integrals - Fourier and Laplace transforms in Analysis of CT systems - Frequency response of systems characterized by differential Equations.

UNIT III	ANALYSIS OF DISCRETE TIME SIGNALS AND SYSTEMS	9

Fourier Transform of discrete time signals (DTFT) Properties of DTFT - Discrete Fourier Transform - Fast Fourier Transform (FFT) - Z Transform and Properties – Impulse response -Convolution sum - System analysis from difference equation model - Stability of systems.

UNIT IV	**DESIGN OF DIGITAL FILTERS**	**9**
Review of design techniques for analog low pass filters - Frequency transformation – IIR filters Properties - Design of IIR digital filters using bilinear transformation - FIR filters - Characteristics of FIR filters with linear phase - Design of FIR filters using Window functions.		
UNIT V	**DIGITAL SIGNAL PROCESSORS AND APPLCATIONS**	**9**
Architecture of TMS320C54xx DSP - Addressing Modes - Instructions and Programming - Applications: Signal Compression - Sine wave generators - Noise generators – DTMF Tone Detection - Echo cancellation - Speech enhancement and recognition		
		TOTAL: 45 PERIODS
COURSE OUTCOMES:		
	After completion of the course, the students will be able to:	
CO1:	Explain the characteristics of various types of signals.	
CO2:	Analyze continuous time signals and systems	
CO3:	Explain the DTFT, FFT and Z-Transform methods in signals processing.	
CO4:	Analyze the digital IIR, FIR filters for signal processing	
CO5:	Analyze the various signal processors.	
CO6:	Apply signal processing techniques to practical applications.	
TEXT BOOKS:		
1	Alan V Oppenheim, Alan S Willsky, Hamid Nawab S , "Signals and Systems", 2nd edition, Learning, New Delhi, 2015.	
2	John G. Proakis, Dimitris K Manolakis , "Digital Signal Processing, 5th edition, Hoboken,NJ : Pearson Education, New Delhi, 2021	
REFERENCES:		
1	Lonnie C Ludeman, "Fundamentals of Digital Signal Processing", Wiley & Sons, New Delhi, 2014.	
2	Emmanuel C Ifeachor,	
3	Haykin S, Barry Van Veen, "Signals and Systems", John Wiley and sons, New Delhi, 2016.	

4	Vinay K Ingle, John G Proakis , "Digital Signal Processing using MATLAB", Cengage Learning, New Delhi, 2012.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	-	-	-	-	-	2	-	-	-	2	1	1	3
2	3	3	2	2	-	-	-	2	-	-	-	2	1	1	3
3	2	1	-	-	-	-	-	2	-	-	-	2	1	1	3
4	3	3	2	2	-	-	-	2	-	-	-	2	1	1	3
5	3	3	2	2	-	-	-	2	-	-	-	2	1	1	3
6	3	2	1	1	-	-	-	2	-	-	-	2	1	1	3
Overall Correlation	3	2	2	2	-	-	-	2	-	-	-	2	1	1	3

<table>
<tr><td rowspan="2">23MT054</td><td rowspan="2">APPLIED IMAGE PROCESSING</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="6">COURSE OBJECTIVES:</td></tr>
<tr><td colspan="6">• To introduce various image processing and preprocessing techniques.
• To learn about feature detection and matching using Image processing
• To learn about segmentation using Image processing techniques.
• To learn about computational photography.
• To learn about image recognition using Image processing techniques.</td></tr>
<tr><td>UNIT I</td><td colspan="4">IMAGE FORMATION AND PROCESSING</td><td>9</td></tr>
<tr><td colspan="6">Introduction - Geometric primitives and Transformations - Photometric Image formation - The digital camera. Introduction to image processing - point - spatial - Fourier Transform - Pyramids and wavelets - Geometric transformations - global optimization</td></tr>
<tr><td>UNIT II</td><td colspan="4">FEATURE DETECTION AND MATCHING</td><td>9</td></tr>
<tr><td colspan="6">Introduction - Points and patches - Feature detectors - Feature Descriptors - SIFT - PCA SIFT - Gradient location orientation histogram</td></tr>
<tr><td>UNIT III</td><td colspan="4">SEGMENTATION</td><td>9</td></tr>
<tr><td colspan="6">Introduction - Active contours - Snakes - Scissors - Level sets - Split and merge - Watershed – Region splitting - region merging - and graph based segmentation - mean shift and mode finding - Normalized cuts – graph cuts and energy based methods – application</td></tr>
<tr><td>UNIT IV</td><td colspan="4">COMPUTATIONAL PHOTOGRAPHY</td><td>9</td></tr>
<tr><td colspan="6">Photometric calibration - Radiometric response function - Noise level estimation - Vignetting - Optical blur - High dynamic range imaging - Super resolution and blur removal - Color image demos icing – application</td></tr>
<tr><td>UNIT V</td><td colspan="4">IMAGE RECOGNITION</td><td>9</td></tr>
<tr><td colspan="6">Object detection - Face recognition - Instance recognition - category</td></tr>
</table>

recognition - Bag of words- Part based models - context and scene understanding- Application: Image search.	
	TOTAL: 45 PERIODS

COURSE OUTCOMES:

After completion of the course, the students will be able to:

CO1:	Illustrate various image formation techniques.
CO2:	Explain the various image processing techniques.
CO3:	Illustrate various preprocessing techniques.
CO4:	Construct the feature detection algorithm for the given application.
CO5:	Explain the various computational photography techniques.
CO6:	Explain the concept of an image recognition techniques for a given application.

TEXT BOOKS:

1	Richard Szeliski, "Computer Vision: Algorithms and Applications", Springer, 2010.
2	Hartley R, Zisserman A, "Multiple View Geometry in Computer Vision", Cambridge University Press, 2004.

REFERENCES:

1	Forsyth D A, Ponce J, "Computer Vision: A Modern Approach", 2nd Edition Bostan Pearson, 2015
2	Duda R O, Hart P E, Stork D G, "Pattern Classification", Wiley, 2001.
3	Richard Sc "Computer Vision: Algorithms and Applications", Springer, 2010.
4	Simon J.D.Prince "Computer Vision: Models, Learning and Inference", Cambridge University Press, New York, 2014.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	-	-	-	-	2	2	-	-	-	2	1	3	2
2	2	1	-	-	-	-	2	2	-	-	-	2	1	3	2
3	2	1	-	-	-	-	2	2	-	-	-	2	1	3	2
4	3	2	1	1	-	-	2	2	-	-	-	2	1	3	2
5	2	1	-	-	-	-	2	2	-	-	-	2	1	3	2
6	2	1	-	-	-	-	2	2	-	-	-	2	1	3	2
Overall Correlation	2	2	1	1	-	-	2	2	-	-	-	2	1	3	2

<table>
<tr><td rowspan="2">23MT055</td><td rowspan="2">MACHINE LEARNING FOR INTELLIGENT SYSTEMS</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="6">COURSE OBJECTIVES:</td></tr>
<tr><td colspan="6">

To introduce basic machine learning techniques such as regression, classification
To learn about introduction of clustering, types and segmentation methods
To learn about fuzzy logic, fuzzification and defuzzification
To learn about basics of neural networks and neuro fuzzy networks.
To learn about Recurrent neural networks and Reinforcement learning.

</td></tr>
<tr><td>UNIT I</td><td colspan="4">INTRODUCTION TO MACHINE LEARNING</td><td>9</td></tr>
<tr><td colspan="6">Philosophy of learning in computers- Overview of different forms of learning- Classifications vs. Regression- Evaluation metrics and loss functions in Classification- Evaluation metrics and loss functions in Regression- Applications of AI in Robotics.</td></tr>
<tr><td>UNIT II</td><td colspan="4">CLUSTERING AND SEGMENTATION METHODS</td><td>9</td></tr>
<tr><td colspan="6">Introduction to clustering- Types of Clustering- Agglomerative clustering- K-means clustering- Mean Shift clustering- K-means clustering application study- Introduction to recognition- K-nearest neighbor algorithm- KNN Application case study- Principal component analysis (PCA)- PCA Application case study in Feature Selection for Robot Guidance.</td></tr>
<tr><td>UNIT III</td><td colspan="4">FUZZY LOGIC</td><td>9</td></tr>
<tr><td colspan="6">Introduction to Fuzzy Sets- Classical and Fuzzy Sets- Overview of Classical Sets- Membership Function- Fuzzy rule generation- Fuzzy rule generation- Operations on Fuzzy Sets- Numerical examples- Fuzzy Arithmetic- Numerical examples- Fuzzy Logic- Fuzzification- Fuzzy Sets- Defuzzification- Application Case Study of Fuzzy Logic for Robotics Application.</td></tr>
</table>

UNIT IV	**NEURAL NETWORKS**	**9**
Mathematical Models of Neurons- ANN architecture- Learning rules- Multi-layer Perceptron's- Back propagation- Introduction of Neuro-Fuzzy Systems- Architecture of Neuro Fuzzy Networks- Application Case Study of Neural Networks in Robotics.		
UNIT V	**RNN AND REINFORCEMENT LEARNING**	**9**
Unfolding Computational Graphs- Recurrent neural networks- Application Case Study of recurrent networks in Robotics- Reinforcement learning- Examples for reinforcement learning- Markov decision process- Major components of RL- Q-learning. Application Case Study of reinforcement learning in Robotics		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:

After completion of the course, the students will be able to:

CO1:	Explain basic concepts of machine learning techniques.
CO2:	Illustrate about the clustering and segmentation.
CO3:	Construct the Model for fuzzy logic system with fuzzification and defuzzification.
CO4:	Develop the concepts of neural networks.
CO5:	Develop the concepts of neuro fuzzy networks.
CO6:	Explain the concepts on Reinforcement learning.

TEXT BOOKS:

1	Micheal Negnevitsky, Artificial Intelligence: A Guide to Intelligent Systems, 3rd Edition, Addision Wesley, England, 2011.
2	TTimothy J Ross, "Fuzzy Logic with Engineering Applications", 4th Edition, Chichester, 2011, Sussex Wiley

REFERENCES:

1	Bruno Siciliano, Oussama Khatib, "Handbook of Robotics", 2016 2nd Edition, Springer
2	Simon Haykin, "Neural Networks and Learning Machines: A Comprehensive Foundation", Third Edition, Pearson, Delhi 2016.

COs	POs												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	-	-	-	-	2	2	-	-	-	2	1	3	2
2	2	1	-	-	-	-	2	2	-	-	-	2	1	3	2
3	3	2	1	1	-	-	2	2	-	-	-	2	1	3	2
4	3	2	1	1	-	-	2	2	-	-	-	2	1	3	2
5	3	2	1	1	-	-	2	2	-	-	-	2	1	3	2
6	2	1	-	-	-	-	2	2	-	-	-	2	1	3	2
Overall Correlation	2	2	1	1	-	-	2	2	-	-	-	2	1	3	2

23MT056	CONDITION MONITORING AND FAULT DIAGNOSTICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the basics of various condition monitoring methods.
- To identify the selection of condition monitoring sensors for various applications.
- To study various signal processing for condition monitoring applications.
- To know about various failure analysis, maintenance and machine learning.
- To provide a basic understanding with case studies on different fault diagnosis methods.

UNIT I	CONDITION MONITORING TECHNIQUES AND MACHINE CONDITION MONITORING	9

Condition Monitoring in manufacturing industries; Noise monitoring, Wear and debris Analysis, Thermography, Cracks monitoring, Ultrasonic techniques - Case studies. Vibration, Acoustic emission and vibro-acoustics signal analysis; intelligent fault detection system, Case studies.

UNIT II	SENSORS FOR FAULT DIAGNOSTICS	9

Introduction - Contaminant monitoring sensors- Corrosion monitoring sensors - Force monitoring sensors - Gas leakage monitoring - sensors Air pollution monitoring sensors - Liquid contamination monitoring sensors - Non-destructive testing techniques - Optical examination -Temperature sensing.

UNIT III	SIGNAL PROCESSING AND ANALYSIS	9

Study of periodic and random signals, probability distribution, statistical properties, auto and cross correlation and power spectral density functions. Time domain and Frequency domain and Time-frequency domain analysis.

UNIT IV	FAILURE ANALYSIS, MAINTENANCE AND MACHINE LEARNING	9
Maintenance Principles, Failure mode analysis - Equipment down time analysis – Breakdown analysis - condition based maintenance, Vibration, Acoustic emission and vibrio-acoustics signal analysis; intelligent fault detection system, Case studies.		
UNIT V	**MONITORING SYSTEMS CASE STUDEIS**	**9**
Introduction - Marine monitoring systems - Marine turbine monitoring systems - Shipboard vibration monitoring - Monitoring integrity verification - Aircraft condition monitoring - Condition monitoring - generating plant - Automotive diagnostic equipment - Systematic fault monitor selection		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
	After completion of the course, the students will be able to:
CO1:	Explain the basics of various condition monitoring methods.
CO2:	Apply the suitable condition monitoring sensors for various applications.
CO3:	Analyze various signals processing methods for condition monitoring.
CO4:	Identify various failure analysis methods and maintenance.
CO5:	Apply different fault diagnosis method for Marine monitoring.
CO6:	

TEXT BOOK:	
1	"Mechanical Fault Diagnosis and condition monitoring" by R. A. Collacott, Chapman and Hall London A Halstead Press Book John Wiley & Sons, New York.

REFERENCE:	
1	"Condition Monitoring and Assessment of Power Transformers Using Computational Intelligence", W.H. Tang, Q.H. Wu, Springer-Verlag London

COs	POs												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	-	-	-	-	-	1	-	-	1	3	3	2	3
2	3	2	1	1	1	-	-	1	-	-	1	3	3	2	3
3	3	3	2	2	1	-	-	1	-	-	1	3	3	2	3
4	3	2	1	1	1	-	-	1	-	-	1	3	3	2	3
5	3	2	1	1	1	-	-	1	-	-	1	3	3	2	3
6	3	2	1	1	1	-	-	1	-	-	1	3	3	2	3
Overall Correlation	3	2	1	1	1	-	-	1	-	-	1	3	3	2	3

23MT057	SYSTEMS MODELLING AND SIMULATION METHODS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To introduce the characteristics of system modelling and the importance of simulation.
- To study the various approaches of modelling.
- To model the solutions using queuing theory.
- To teach the generation of data for simulation.
- To study the various system models and familiarize the simulation tools

UNIT I	INTRODUCTION TO SIMULATION	9

System definition - Types and characteristics - Need for modelling and simulation -Types of Simulation - Introduction to discrete event simulation - Single server – Multi server Exercises – System modelling - Simple Petrinets.

UNIT II	MODELLING APPROACHES	9

Modelling concurrent systems - Analysis of Petrinets - Finite state Automata and Regular Expressions - Relationship - FSA with silent transitions - Pumping lemma for regular sets – Analysis using DFS and model checking.

UNIT III	QUEUING MODELS	9

Characteristics of queuing systems - Notations - Types of Queues - Markovian model – non- Markovian model - Queuing Networks - Applications of queuing systems.

UNIT IV	SIMULATION DATA	9

Methods for generating random numbers - Testing of random numbers - Methods of generating random variants - Problem formulation - input modelling -Verification and Validation - Output1ZX Analysis.

UNIT V	CASE STUDY	9

NS2 - Simulation of Computer Systems - Simulation of Computer Networks - Simulation of Mobile Networks -Simulation of

Manufacturing and Material Handling Systems.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After completion of the course, the students will be able to:

CO1:	Explain the characteristics of system modelling
CO2:	Analyze the importance of simulation.
CO3:	Develop system model using various approaches.
CO4:	Apply queuing theory to various systems.
CO5:	Develop appropriate data for simulation.
CO6:	Construct the Model and analyze a given system using simulation tools.

TEXT BOOKS:

1. Jerry Banks "Discrete-event system simulation", 5th edition Pearson Education, Harlow,2009.
2. Fitzgerald, John, Larsen, PeterGorm, "Modeling Systems; Practical Tools and Techniques in software development", Cambridge University Press, 2009.

REFERENCES:

1. Hopcroft, John E, Motwani, Rajeev, Ullman, Seffrey D, "Introduction to automata theory, languages and computation",3rd edition, Pearson/Dorling Kindersley, New Delhi, 2002.
2. Hamdy A Taha, "Operations Research an Introduction", 9th edition, Pearson/Prentice Hall, New jersey, 2007.
3. Donald Gross and Carl M. Harris, "Fundamentals of Queuing theory", 5th Edition, John Wiley and Sons, New York 2018

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	1	-	-	-	2	-	1	-	-	1	1	3	2	1
2	3	3	2	2	1	2	-	1	-	-	1	1	3	2	1
3	3	2	1	1	1	2	-	1	-	-	1	1	3	2	1
4	3	2	1	1	1	2	-	1	-	-	1	1	3	2	1
5	3	2	1	1	1	2	-	1	-	-	1	1	3	2	1
6	3	2	1	1	1	2	-	1	-	-	1	1	3	2	1
Overall Correlation	3	2	1	1	1	2	-	1	-	-	1	1	3	2	1

23MT058	FUNDAMENTALS OF UAV SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To expose students to concepts needed in modelling and analysing an unmanned system.
- To expose students to the design and development of UAV.
- To expose students to the type of payloads used in UAV.
- To study path planning
- To understand the avionics hardware used in the UAV.

UNIT I	INTRODUCTION TO UAV	9

History of UAV –classification – Introduction to Unmanned Aircraft Systems--models and prototypes – System Composition-applications.

UNIT II	THE DESIGN OF UAV SYSTEMS	9

Introduction to Design and Selection of the System- Aerodynamics and Airframe Configurations- Characteristics of Aircraft Types-Design Standards and Regulatory Aspects-UK,USA and Europe-Design for Stealth--control surfaces-specifications.

UNIT III	AVIONICS HARDWARE	9

Autopilot – AGL-pressure sensors-servos-accelerometer –gyros-actuators- power supply-processor, integration, installation, configuration, and testing.

UNIT IV	COMMUNICATION PAYLOADS AND CONTROLS	9

Payloads-Telemetry-tracking-Aerial photography-controls-PID feedback-radio control frequency range –modems-memory system-simulation-ground test-analysis-trouble shooting.

UNIT V	THE DEVELOPMENT OF UAV SYSTEMS	9

Waypoints navigation-ground control software- System Ground Testing- System In-flight Testing- Future Prospects and Challenges-Case Studies – Mini and Micro UAVs.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After completion of the course, the students will be able to:

CO1:	Explain the design concepts of UAV system
CO2:	Explain preliminary design requirements for an unmanned aerial vehicle.
CO3:	Identify different hardware for UAV.
CO4:	Apply system testing for unmanned aerial vehicles.
CO5:	Identify Communication Payloads and Controls.
CO6:	Explain the micro aerial vehicle systems by considering practical limitations.

TEXT BOOKS:

1	Paul G Fahlstrom, Thomas J Gleason, "Introduction to UAV Systems", UAV Systems, Inc, 1998
2	Reg Austin "Unmanned Aircraft Systems UAV design, development and deployment", Wiley, 2010.

REFERENCES:

1	Dr. Armand J. Chaput, "Design of Unmanned Air Vehicle Systems", Lockheed Martin Aeronautics Company, 2001
2	Kimon P. Valavanis, "Advances in Unmanned Aerial Vehicles: State of the Art and the Road to Autonomy", Springer, 2007
3	Robert C. Nelson, Flight Stability and Automatic Control, McGraw-Hill, Inc, 1998.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	-	-	-	2	-	1	-	-	1	1	3	2	1
2	2	1	-	-	-	2	-	1	-	-	1	1	3	2	1
3	3	2	1	1	-	2	-	1	-	-	1	1	3	2	1
4	3	2	1	1	-	2	-	1	-	-	1	1	3	2	1
5	3	2	1	1	-	2	-	1	-	-	1	1	3	2	1
6	2	1	-	-	-	2	-	1	-	-	1	1	3	2	1
Overall Correlation	1	2	1	1	-	2	-	1	-	-	1	1	3	2	1

23MT059	IMMERSIVE TECHNOLOGIES AND HAPTICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To identify the terminologies of haptic devices.
- To understand the structure of haptic system and to aware the tele-operation for various applications.
- To acquire the knowledge on modelling for haptic system development relevant to the human.
- To emphasize the significance of knowledge in virtual and augmented reality.

To know the concepts and hardware of mixed reality.

UNIT I	INTRODUCTION TO HAPTICS	8

Definition - Importance of Touch - Tactile Proprioception - Tactual Stereo Genesis - Kinesthetic Interfaces - Tactile Interfaces - Human Haptics - Overview of Existing applications - Basics of Force Feedback Devices - Kinesthetic Vs. Tactile Haptic Devices - Configurations of Kinesthetic Devices -Types of Kinesthetic Devices

UNIT II	KINESTHETIC HAPTIC DEVICES AND TELEOPERATION	10

Mechatronics in Haptics System - Haptic Kinematics - Haptic Dynamics - Existing Kinesthetic Devices - Haptic Device Static Rendering - Haptic Device Dynamic Rendering - Control of Haptic Devices - Stability Analysis of Haptic Devices - Stability Analysis of the Rendered Model

-Passivity of the Rendered Model. Types of Sensors - Measurement of Haptic Parameters - Types of Actuators - Types of Transmission - Admittance Type Kinesthetic Device - Admittance Control - Comparison of Impedance and Admittance Type Devices - Genesis of Tele-Operation

- Tele-Operation Controllers -Tele-Operator Transparency - Stability Analysis of Tele-operator - Tracking and Transparency - Surface Haptic - Exogenous Force Inputs.

UNIT III	HUMAN HAPTICS ITS PLATFORM	9
Introduction - Types of Haptic Sensing - Active vs. Passive Touch - Mechanoreception- Mechanoreceptive Afferents - Kinesthetic Sensing - Force Sensing and Proprioception- Introduction to Psychophysics - Measurement Thresholds - Laws of Psychophysics - Weber's Law - Fechner's Law - Fitt's Law - Psychophysical Methods of Limit, Constant Stimuli and Adjustment - Introduction to Virtual Reality Modelling Language (VRML) – Open Haptic Platform - OpenGL- Virtual Environment Manager - Modelling of Simple Haptic System.		
UNIT IV	**VIRTUAL AND AUGMENTED REALITY**	**9**
The Reality – Virtuality Continuum - Virtual Reality Definitions - Software, Hardware, Sensation and Perception - Multi-Modal Interaction Challenges - System Architecture of Virtual Reality. Aspects of Geometrical Modelling and Environmental Modelling General Solution for Calculating Geometric & Illumination Consistency in the Augmented Environment. Usability Guidelines - Design and Implementation of an Immersive User Experience - Case Study for VR and AR.		
UNIT V	**MIXED REALITY**	**9**
System Architecture of a Mixed Reality System - Common Interaction Techniques for Mixed Reality Environments - Common Navigation Techniques - Common Interface for MR - Menu Design Directions - Haptic Control Panel - Performance of an Interaction Techniques, Advanced Interaction Techniques, Design and Implementation of an Immersive User Experience - Case Study for MR.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
	After completion of the course, the students will be able to:
CO1:	Explain the haptic technology and its concepts in various haptic systems. Explain the fundamentals of haptics system elements and tele-operation in detail.
CO2:	Apply the concepts of human haptics in its platform.
CO3:	Explain the basic concepts of virtual reality models.
CO4:	Explain the basic concepts of augmented reality models
CO5:	Explain the mixed model hardware reality.
CO6:	Explain the haptic technology and its concepts in various haptic systems. Explain the fundamentals of haptics system elements and tele-operation in detail.
TEXT BOOKS:	
1	Burdea, G. C. and P. Coffet. "Virtual Reality Technology", 3rd edition, Wiley-Interscience, Hoboken New Jersey, 2012.
2	Eckehard Steinbach et al, "Haptic Communications", Vol. 100, 4:937-956, 2012
3	Hannaford B and Okamura A. M "Haptics: Handbook of Robotics", Springer, pp. 718735, 2008.
REFERENCES:	
1	Kenneth Salisbury, Francois Conti and Federico Barbagli, "Haptic Rendering: IEEE Computer Graphics and Applications, v24 n2 (200403): 24-32, 2004.
2	Jean-Pierre Bresciani, Knut Drewing and Marc O. Ernst. "Human Haptic Perception and the Design of Haptic-Enhanced Virtual Environments: The Sense of Touch and Its Rendering",STAR 45, pp. 61–106, 2008.
3	MacLean K. E, "Haptic Interaction Design for Everyday Interfaces: Reviews of Human Factors and Ergonomics", 4:149194, 2008.
4	Weir D. W and Colgate J. E "Stability of Haptic Display: Haptic Rendering: Foundations, Algorithms, and Applications". AK Peters, 2008.

5	Sherman, William R. and Alan B. Craig. "Understanding Virtual Reality – Interface, Application, and Design" 2nd edition, Morgan Kaufmann, Cambridge U.S 2019.
6	Yuichi Ohta, Hideyuki Tamura, "Mixed Reality: Merging Real and Virtual Worlds", Springer Verlag, Berlin, 2014.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	-	-	-	-	-	2	-	-	-	2	2	3	1
2	2	1	-	-	-	-	-	2	-	-	-	2	2	3	1
3	3	2	1	1	-	-	-	2	-	-	-	2	2	3	1
4	2	1	-	-	-	-	-	2	-	-	-	2	2	3	1
5	2	1	-	-	-	-	-	2	-	-	-	2	2	3	1
6	2	1	-	-	-	-	-	2	-	-	-	2	2	3	1
Overall Correlation	2	1	1	1	-	-	-	2	-	-	-	2	2	3	1

23MT060	COMPUTER VISION AND DEEP LEARNING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To familiar the fundamentals of image processing and functioning of camera.
- To appreciate 3 dimensional structure and motions.
- To learn the visual servicing for robotic applications
- To understand the fundamentals of Neural network
- To appreciate and develop the deep learning networks for image processing

UNIT I	IMAGE FORMATION AND CAMERA CALIBRATION	9

Basics: Sampling Theorem – Numerical Differentiation – Singular Value Decomposition Introduction to Vision, Terminologies of Fields, Comparison of Biological and Computer Vision, Projective Geometry Basics, Modelling of Geometric Image Formation, Modelling of Camera Distortion, Camera Calibration, Methods of Camera Calibration, Estimation of Projection Matrix, Experimental Performance Assessment in Computer Vision.

UNIT II	3-D STRUCTURE AND MOTION	9

Computational Stereopsis – Geometry, Parameters – Correspondence Problem, Epipolar Geometry, Essential Matrix And Fundamental Matrix, Eight Point Algorithm – Reconstruction by Triangulation, Visual Motion – Motion Field of Rigid Objects – Optical Flow – Estimation of Motion Field – 3D Structure and Motion from Sparse and Dense Motion Fields – Motion Based Segmentation – Image Processing.

UNIT III	ACTIVE AND ROBOT VISION	9

LIDAR - Construction, Working Principle, Specifications and Selection Criteria. Point Cloud Data Processing. Visual Tracking – Kalman Filtering – Visual SLAM, Solutions, Visual Servoing, Types and Architecture.

UNIT IV	INTRODUCTION TO NEURAL NETWORKS	9
Introduction to Neural Networks, Philosophy and Types of Networks, Back propagation, Numerical Problems for Back Propagation, Multi-Layer Perceptrons, Numerical Problems Based on Perceptron, Conventional Neural Networks vs. Deep Learning in the Context of Computer Vision, Loss Function, Optimization, Higher-Level Representations, Image Features, Stochastic Gradient Descent		
UNIT V	**DEEP LEARNING**	**9**
Convolutional Neural Networks - Convolution, Pooling, Activation Functions, Initialization, Dropout, Batch Normalization, Deep Learning Hardware - CPU, GPU and TPU - Tuning Neural Networks, Best Practices, Training Neural Networks, Update Rules, Ensembles, Data Augmentation, Transfer Learning, Popular CNN Architectures for Image Classification – Alexnet, VGG, Resnet, , Inception, CNN Architectures for Object Detection – RCNN and Types – Yolo - Semantic Segmentation - FCN, Instance Segmentation - Mask RCNN – Deep Learning frameworks.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
	After completion of the course, the students will be able to:
CO1:	Explain the Process of image's formation and camera calibration.
CO2:	Apply the concepts of 3-Dimensional structures in real time application.
CO3:	Explain the fundamentals of motion for image processing.
CO4:	Explain the concepts of active and robot vison.
CO5:	Explain the fundamental of neural networks.
CO6:	Develop and train the deep learning networks for image processing.

TEXT BOOKS:	
1	Boguslaw Cyganek, J. Paul Siebert, “An Introduction to 3D Computer Vision Techniques and Algorithms”, 2nd edition, John Willey, 2017.
2	Davies E.R, “Computer and Machine Vision: Theory, Algorithm, Practicalities”, 4th edition Academic Press, Elsevier, Waltham 2012.
3	Emanuele Trucco, Alessandro Verri, “Introductory Techniques for 3D Computer Vision”, Prentice Hall, South Asia, 2006.
REFERENCES:	
1	Rafael C. Gonzales, Richard. E. Woods, “Digital Image Processing”, 3rd edition, Gatesmark Publishing, Tenessee 2020.
2	Emanuele Trucco, Alessandro Verri, “Introductory Techniques for 3D Computer Vision”, Prentice Hall, 1998.
3	Ian Goodfellow and YoshuaBengio and Aaron Courville, “Deep Learning”, First Edition, MIT Press, 2018.
4	Forsyth and Ponce, “Computer Vision: A Modern Approach”, 2nd edition Pearson, Harlow Uk 2015.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	-	-	-	-	-	2	-	-	-	2	2	3	1
2	3	2	1	1	-	-	-	2	-	-	-	2	2	3	1
3	2	1	-	-	-	-	-	2	-	-	-	2	2	3	1
4	2	1	-	-	-	-	-	2	-	-	-	2	2	3	1
5	2	1	-	-	-	-	-	2	-	-	-	2	2	3	1
6	3	2	1	1	-	-	-	-	-	-	-	-	-	-	-
Overall Correlation	3	1	1	1	-	-	-	2	-	-	-	2	2	3	1

VERTICAL –5 – AUTOMATION

23MT061	MICRO ELECTROMECHANICAL SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To provide knowledge of semiconductors and solid mechanics to fabricate MEMS devices.
- To educate on the rudiments of Micro fabrication techniques.
- To introduce various sensors and actuators
- To introduce different materials used for MEMS.
- To educate on the applications of MEMS to disciplines beyond Electrical and Mechanical engineering

UNIT I	INTRODUCTION	9

Intrinsic Characteristics of MEMS – Energy Domains and Transducers- Sensors and Actuators – Introduction to Micro fabrication - Silicon based MEMS processes – New Materials – Review of Electrical and Mechanical concepts in MEMS – Semiconductor devices –Polymers in MEMS– Polyamide - SU-8 - Liquid Crystal Polymer (LCP) – PDMS – PMMA – Parylene – Fluorocarbon.

UNIT II	SENSORS	9

Characteristics of sensors - Electrostatic sensors – Parallel plate capacitors – Piezoresistive sensors – Piezoresistive sensor materials - Stress and strain analysis – Flexural beam bending- Torsional deflection– Applications to Inertia, Pressure, Tactile and Flow sensors Piezoelectric sensors and actuators – piezoelectric effects – piezoelectric materials.

UNIT III	ACTUATOR	9

Applications – Interdigitated Finger capacitor – Comb drive devices – Micro Grippers – Micro Motors - Thermal Sensing and Actuation – Thermal expansion – Thermal couples – Thermal resistors – Thermal Bimorph - Applications –Magnetic Actuators –

Micromagnetic components – Case studies of MEMS in magnetic actuators -Actuation using Shape Memory Alloys.		
UNIT IV	**MICROMACHINING**	**9**
Silicon Anisotropic Etching – Anisotropic Wet Etching – Dry Etching of Silicon – Plasma Etching– Deep Reaction Ion Etching (DRIE) – Isotropic Wet Etching – Gas Phase Etchants – Case studies - Basic surface micro machining processes – Structural and Sacrificial Materials – Acceleration of sacrificial Etch – Stiction and Ant restriction methods – LIGA Process - Assembly of 3D MEMS – Foundry process		
UNIT V	**APPLICATIONS OF MEMS INERTIAL SENSORS**	**9**
Application to Acceleration, Inertia, Acoustic, Tactile, Pressure, Flow and Tactile sensors- Optical MEMS –Lenses and Mirrors - Actuators for Active Optical MEMS.– RF MEMS and Microfluidics.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
	After completion of the course, the students will be able to:
CO1:	Explain MEMS Energy Domains and Transducers, Sensors and Actuators.
CO2:	Explain the various characteristics of sensors and application, Stress and strain analysis
CO3:	Explain the various types of MEMS actuators
CO4:	Identify the Real time system applications of magnetic actuators.
CO5:	Explain various Micro machining processes.
CO6:	Explain the various MEMS Internal sensors
TEXT BOOKS:	
1	Chang Liu, "Foundations of MEMS", Pearson Education Inc., 2014, 2ndedition
2	Stephen D Senturia, "Microsystem Design", Springer Publication, 2001.

REFERENCES:	
1	Tai Ran Hsu, "MEMS & Micro systems Design and Manufacture" Tata McGraw Hill, New Delhi, 2008.
2	James J.Allen, "Micro Electro Mechanical System Design", CRC Press Publisher, 2010
3	Julian w. Gardner, Vijay K. Varadan, Osama O. Awadelkarim, "Micro Sensors MEMS and Smart Devices", John Wiley & Son LTD,2002.
4	Mohamed Gad-el-Hak, editor, " The MEMS Handbook", CRC press Baco Raton, 2000
5	Nadim Maluf," An Introduction to Micro Electro Mechanical System Design", Artech House, 2000.
6	Thomas M.Adams and Richard A.Layton, "Introduction MEMS, Fabrication and Application," Springer 2010.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	-	-	-	-	-	1	-	-	1	1	2	1	1
2	2	1	-	-	-	-	-	1	-	-	1	1	2	1	1
3	2	1	-	-	-	-	-	1	-	-	1	1	2	1	1
4	3	2	1	1	-	-	-	1	-	-	1	1	2	1	1
5	2	1	-	-	-	-	-	1	-	-	1	1	2	1	1
6	2	1	-	-	-	-	-	1	-	-	1	1	2	1	1
Overall Correlation	2	1	1	1	1	-	-	1	-	-	1	1	2	1	1

23EE501	POWER ELECTRONICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the various applications of power electronic devices for conversion, control and conditioning of the electrical power and to get an overview of different types of power semiconductor devices and their dynamic characteristics.
- To understand the operation, characteristics and performance parameters of controlled rectifiers
- To study the operation, switching techniques and basic topologies of DC-DC switching regulators.
- To learn the different modulation techniques of pulse width modulated inverters and to understand harmonic reduction methods.
- To study the operation of AC voltage controller and various configurations of AC voltage controller.

UNIT I	POWER SEMI-CONDUCTOR DEVICES	9

Study of switching devices MOSFET, IGBT and SCR- Static characteristics: MOSFET, IGBT SiC, GaN and SCR - Introduction to Driver and snubber circuits of MOSFET and IGBT.

UNIT II	PHASE-CONTROLLED CONVERTERS	9

2-pulse, 3-pulse and 6-pulseconverters– performance parameters (Average output voltage, RMS output voltage, rectification efficiency) –Effect of source inductance, Applications-light dimmer, Excitation system, Solar PV systems.

UNIT III	DC TO DC CONVERTERS	9

Step-down and step-up chopper-control strategy-Switched mode regulators- Buck, Boost, Buck- Boost regulator, Introduction to Resonant Converters, Applications-Battery operated vehicles

UNIT IV	INVERTERS	9

Single phase and three phase voltage source inverters (both 1200 mode and 1800 mode)– Voltage& harmonic control--PWM

techniques: Multiple PWM, Sinusoidal PWM, modified sinusoidal PWM – Introduction to space vector modulation –Current source inverter, Applications-Type of UPS.		
UNIT V	**AC TO AC CONVERTERS**	**9**
Single phase AC voltage controllers-single phase step up and step down Cyclo- converters – Introduction to Matrix converters.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Summarize the operation of semiconductor devices and static characteristics
CO2:	Analyze the various uncontrolled rectifiers and its waveform.
CO3:	Make use of the operation of the DC-DC converters and evaluate the performance parameters.
CO4:	Explain various PWM techniques and apply voltage control and harmonic elimination methods to inverter circuits.
CO5:	Demonstrate the operation of AC voltage controllers.
CO6:	Illustrate the operation of Step up and Step Down Cyclo-converter.
TEXT BOOKS:	
1	Ned Mohan, T.M. Undeland, W.P. Robbins, “Power Electronics: Converters, applications and design”, John Wiley and Sons, 3rd Edition (reprint), 2009
2	Rashid M.H., Power Electronics Circuits, Devices and Applications, Prentice Hall India, 3rd Edition, New Delhi, 2004.
REFERENCES:	
1	Cyril. W.Lander, Power Electronics, McGraw Hill International, Third Edition, 1993.
2	P.S.Bimbhra, Power Electronics, Khanna Publishers, Third Edition 2003.

3	Philip T.Krein, Elements of Power Electronics, Oxford University Press, 2013.
4	P.C.Sen, Power Electronics, Tata McGraw-Hill, 30th reprint, 2008.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	-	-	-	-	-	-	-	1	-	1	2	-	-
2	3	3	2	2	-	1	-	-	-	1	-	1	3	2	-
3	3	2	1	1	-	1	-	1	-	1	-	1	2	2	1
4	2	1	-	-	-	1	-	-	-	1	-	1	3	2	-
5	2	1	-	-	-	-	-	-	-	1	-	1	2	-	-
6	2	1	-	-	-	1	-	1	-	1	-	1	2	2	1
Overall Correlation	**3**	**2**	**1**	**1**	**-**	**1**	**-**	**1**	**-**	**1**	**-**	**1**	**3**	**2**	**1**

23CS404	COMPUTER ARCHITECTURE	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To learn the basic structure and operations of a computer.
- To learn the arithmetic and logic unit and implementation of fixed-point and floating point arithmetic unit.
- To learn the basics of pipelined execution.
- To understand the memory hierarchies, cache memories and virtual memories.
- To introduce the parallel processing technique.

UNIT I	BASIC STRUCTURE OF A COMPUTER SYSTEM	9

Functional Units – Basic Operational Concepts – Performance – Instructions: Language of the Computer – Operations, Operands – Instruction representation – Logical operations decision making – MIPS Addressing.

UNIT II	ARITHMETIC FOR COMPUTERS	9

Addition and Subtraction – Multiplication – Division – Floating Point Representation – Floating Point Operations

UNIT III	PROCESSOR AND CONTROL UNIT	9

Basic MIPS implementation – Building a Datapath – Control Implementation Scheme – Pipelining – Pipelined datapath and control – Handling Data Hazards & Control Hazards Exceptions

UNIT IV	MEMORY AND I/O ORGANIZATION	9

Memory hierarchy, Memory Chip Organization, Cache memory, Virtual memory. Parallel Bus Architectures, Internal Communication Methodologies, Serial Bus Architectures, Mass storage, Input and Output Devices.

UNIT V	ADVANCED COMPUTER ARCHITECTURE	9

Parallel processing architectures and challenges, Hardware multithreading, Multicore and shared memory multiprocessors,

Introduction to Graphics Processing Units, Clusters and Warehouse scale computers, Introduction to Multiprocessor network topologies.	
	TOTAL: 45 PERIODS
COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Apply the basics structure of computers, operations and instructions.
CO2:	Apply arithmetic and logic unit.
CO3:	Explain pipelined execution and control unit.
CO4:	Identify the various memory systems and I/O communication.
CO5:	Apply parallel processing architectures.
CO6:	Apply the hardware interface for real time applications.
TEXT BOOKS:	
1	David A. Patterson and John L. Hennessy, Computer Organization and Design: The Hardware/Software Interface, Fifth Edition, Morgan Kaufmann / Elsevier, 2014.
2	Carl Hamacher, Zvonko Vranesic, Safwat Zaky and Naraig Manjikian, Computer Organization and Embedded Systems, Sixth Edition, Tata McGraw Hill, 2012.
REFERENCES:	
1	William Stallings, Computer Organization and Architecture – Designing for Performance, Eighth Edition, Pearson Education, 2010.
2	John P. Hayes, Computer Architecture and Organization, Third Edition, Tata McGraw Hill, 2012.
3	Govindarajalu, “Computer Architecture and Organization, Design Principles and Applications", Second edition, McGraw-Hill Education India Pvt Ltd, 2014.

Cos	POs												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	-	-	-	-	1	1	1	2	3	-	-
2	3	2	1	1	-	-	-	-	2	2	2	2	3	-	-
3	2	1	-	-	-	-	-	-	2	2	1	2	2	-	-
4	3	2	1	1	-	-	-	-	2	2	2	2	3	-	-
5	3	3	2	2	-	-	-	-	2	1	1	2	3	-	-
6	3	2	-	1	-	-	-	-	1	1	1	2	2	-	-
Overall Correlation	3	2	1	2	-	-	-	-	2	2	2	2	3	-	-

23MT062	VIRTUAL INSTRUMENTATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To introduce virtual instrumentation concepts and applications.
- To train to program virtual instrumentation software for biomedical applications
- To understand the data acquisition and control in VI
- To obtain the knowledge in instrument interfaces
- To analyze the applications of VI in Bio Medical Engineering

UNIT I	INTRODUCTION	9

History of Virtual Instrumentation (VI), advantages, block diagram and architecture of a virtual instrument, Programming paradigms – Virtual Instrumentation – Lab VIEW software – Lab View basics – Lab VIEW environment.

UNIT II	VI USING LABVIEW	9

Creating, Editing and debugging a VI in Lab VIEW – Creating a sub VI – Loops and charts – Case and sequence structures – File I/O – VI customization.

UNIT III	DATA ACQUISITION AND CONTROL IN VI	9

Plug-in DAQ boards – Organization of the DAQ VI System – Performing analog input and analog output – Scanning multiple analog channels – Driving the digital I/Os – Buffered data acquisition – Simple problems.

UNIT IV	INSTRUMENT INTERFACES	9

Current loop, RS 232C/RS 485, GPIB, System basics, Interface basics: USB, PCMCIA, networking basics for office & industrial application VISA & IVI, image acquisition & processing, Motion Control. ADC, DAC, DIO, DMM, waveform generator.

UNIT V	APPLICATION OF VI IN BIOMEDICAL ENGINEERING	9
Design of virtual applications for Electrocardiography (ECG), Electromyography (EMG), Air Flow and Lung Volume, Heart Rate variability analysis, Noninvasive Blood Pressure Measurement, Biofeedback, Virtual Reality & 3D graphical modeling, Virtual Prototyping.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:

After completion of the course, the students will be able to:

CO1:	Explain virtual instrumentation concepts and applications
CO2:	Explain the virtual instrumentation software examples
CO3:	Explain the data acquisition and control in VI
CO4:	Explain the technologies involved in instrument interfaces
CO5:	Identify the applications of VI in Bio Medical Engineering
CO6:	Identify the applications of VI in Virtual Reality & 3D Graphical Modeling

TEXT BOOKS:

1	Gary Johnson, "LABVIEW Graphical Programming", McGraw Hill, 4th edition, 2006.
2	Lisa K. Wells and Jeffrey Travis, "LABVIEW for Everyone", PHI, 1997.
3	Skolkoff, "Basic concepts of LABVIEW 4", PHI, 1998.
4	Jerome, Jovitha, "Virtual Instrumentation and LABVIEW", PHI Learning, New Delhi, 1st Edition, 2010.
5	Sanjay Gupta and Joseph John, "Virtual Instrumentation using Lab VIEW", Tata Mc Graw – Hill Publishing Company Limited, New Delhi, 1st Edition, 2010.

REFERENCES:

1	Kevin James, "PC Interfacing and Data Acquisition: Techniques for Measurement, Instrumentation and Control", Newnes, 2003.

2	S. Gupta, J.P. Gupta, "PC Interfacing for Data Acquisition and Process Control", ISA, 2nd Edition, 1994.
3	Technical Manuals for DAS Modules of Advantech and National Instruments.
4	Jon B. Olansen, Eric Rosow, "Virtual Bio-Instrumentation: Biomedical, Clinical, and Healthcare Applications in Lab VIEW" Pearson Education, 2001.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	-	-	-	2	-	1	-	-	1	1	3	2	1
2	2	1	-	-	-	2	-	1	-	-	1	1	3	2	1
3	2	1	-	-	-	2	-	1	-	-	1	1	3	2	1
4	2	1	-	-	-	2	-	1	-	-	1	1	3	2	1
5	3	2	1	1	-	2	-	1	-	-	1	1	3	2	1
6	3	2	1	1	-	2	-	1	-	-	1	1	3	2	1
Overall Correlation	2	2	1	1	-	2	-	1	-	-	1	1	3	2	1

23MT063	INDUSTRIAL NETWORK PROTOCOLS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To study the various types of wired protocols for electronic systems.
- To know the various types of wireless protocols for electronic systems.
- To know the various industrial wired protocols in automation.
- To study the various types of wireless protocols for industrial automation.
- To develop the wired and wireless functions of various protocols.

UNIT I	WIRED BUSES AND PROTOCOLS	9

Wireless - Wired Networks Comparison - Serial Communication Protocols - RS232-UART-SPI - I2C –UNI/O Bus -1 Wire -Camera Link - Parallel Communication -PPI - Wishbone Bus – AMBA – JTAG - Firmware IEEE 1394 Bus - Ethernet Overview - RS485

UNIT II	WIRELESS PROTOCOLS	9

Antenna Technology- Network Topologies - Wireless Local Area Networks (WLAN) - Wireless Personal Area Networks (WPAN) - Wimedia – Wimax - RF – Bluetooth- Wi-Fi – Zigbee – Wireless Industrial Automation Protocols.

UNIT III	INDUSTRIAL AND AUTONOMOUS SYSTEMS WIRED NETWORKS	9

Overview of Industrial Wired Networks – Terminal Bus- Modbus - HART Network - Mechatrolink-II – EtherCAT- Sercos II/III – CAN- Canopen - Modbus IDA-PROFINET- PROFIBUS-Ethernet/IP- Ethernet Powerlink- AG Automation and Drives (AS-I) - Device Net.

UNIT IV	**INDUSTRIAL WIRELESS NETWORKS**	**9**
Overview of Industrial Wireless Networks - IWLAN - ISA100 Standards – Remote Networks- Controller-Based Networks - Wireless HART Technology - 3G/4G for Automation – RFID Data Tags.		
UNIT V	**APPLICATION OF COMMUNICATION PROTOCALS**	**9**
Wired Machine Networking of Sub-elements and Machines - Wireless Machine Networking of Sub-elements and Machines – Networking of Industry - Communication Network Layout Design - Networking for TIA- Cloud Computing – IOT - Case Studies in Automation Applications.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
	After completion of the course, the students will be able to:
CO1:	Explain the wired protocols for electronic systems.
CO2:	Explain the wireless protocols for electronic systems.
CO3:	Explain the industrial wired protocols in automation.
CO4:	Explain wireless protocols for industrial automation.
CO5:	Explain the wired functions of various protocols in application, development.
CO6:	Apply the wireless functions of various protocols in applications.
TEXT BOOKS:	
1	Borko Furht, “Encyclopaedia of Wireless and Mobile Communications - Three Volume Set”, CRC Press, 2012.
2	Dick Caro, “Wireless Networks for Industrial Automation”, 2014.
REFERENCES:	
1	MMC-SD SERCOS Drive, “G&L Motion Control”, Hardware Manual, 2005.

2	Olaf Pfeiffer, Andrew Ayre and Christian Keydel, "Embedded networking with CAN and CANopen", Copperhill Technologies Corporation, 2016.
3	Richard Zurawski, "Industrial Communication Technology", CRC Press, 2017.
4	Siemens IK, "Industrial Ethernet: IEEE 802.3", 2005.
5	Wolfram Behardt and Jorg Wollert, "The wireless B: Evolution and Communication", Stetue Germany, 2016.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	-	-	-	-	-	2	-	-	-	2	1	-	3
2	2	1	-	-	-	-	-	2	-	-	-	2	1	-	3
3	2	1	-	-	-	-	-	2	-	-	-	2	1	-	3
4	2	1	-	-	-	-	-	2	-	-	-	2	1	-	3
5	2	1	-	-	-	-	-	2	-	-	-	2	1	-	3
6	3	2	1	1	-	-	-	2	-	-	-	2	1	-	3
Overall Correlation	2	1	1	1	-	-	-	2	-	-	-	2	1	-	3

<table>
<tr><td rowspan="2">23MT064</td><td rowspan="2">MOTION CONTROL SYSTEM</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="6">COURSE OBJECTIVES:</td></tr>
<tr><td colspan="6">• To introduce the basics in motion control system
• To knowledge about on architecture of motion control system
• To understand the features and specifications in motion control drives
• To learn about intelligent motors and integrated drive
• To ability to know about the programming of motion controller</td></tr>
<tr><td>UNIT I</td><td colspan="4">INTRODUCTION MOTION CONTROL SYSTEMS</td><td>9</td></tr>
<tr><td colspan="6">Introduction to Motion Control System - Dynamic System Modeling - Control System Design Fundamentals – Parameters in Control – Actuators and Measurement in Motion Control Systems -Multi-Body Dynamics – Need for Motion Controller – Specification of Motion Control</td></tr>
<tr><td>UNIT II</td><td colspan="4">ARCHITECTURE OF MOTION CONTROL SYSTEM</td><td>9</td></tr>
<tr><td colspan="6">Introduction to Motion Controller – Programmable Automation Controllers – Features & Specification of Motion Controllers – Digital I/O – Analog I/O – Standards in I/O – I/O Specific to Sensors – Modular and Expansion Concepts – Drives</td></tr>
<tr><td>UNIT III</td><td colspan="4">MOTION CONTROL DRIVES</td><td>9</td></tr>
<tr><td colspan="6">Programmable Automation Controllers – Features & Specification of Motion Controllers – Digital I/O – Analog I/O – Standards in I/O – I/O Specific to Sensors – Modular and Expansion Concepts - Drives</td></tr>
<tr><td>UNIT IV</td><td colspan="4">INTELLIGENT MOTORS WITH INTEGRATED DRIVE</td><td>9</td></tr>
<tr><td colspan="6">Intelligent motors – intelligent drives – features of drives – programmable I/Os- communication protocols – features –</td></tr>
</table>

Software - Programming – current, position and speed loops – Application in robots and portable systems.		
UNIT V	**PROGRAMMING OF MOTION CONTROLLER**	**9**
IEC 61131 standards and Its Programming Languages overview-CoDeSys Platform - status Diagram – PLC Open - Motion Planer - PID - Servo Tuning – Position- velocity, Acceleration and Torque Profiling – CAM Profiling – Multi- Axis Motion Controllers – CNC Machines – Robot case study.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
	After completion of the course, the students will be able to:
CO1:	Explain the basics concepts in motion control system.
CO2:	Explain the architecture of motion control system.
CO3:	Analyze the features and specifications in motion control drives.
CO4:	Explain the concepts about on intelligent motors and integrated drive.
CO5:	Explain the various application of robots and portable systems.
CO6:	Explain the programming of motion controller.
TEXT BOOKS:	
1	M. Nakamura .S. Gata & N. Kyura, Mechatronic Servo System Control, Springer, 2004.
2	Sabanovic Asif, Motion Control Systems, John Wiley & Sons Inc, 2011
REFERENCES:	
1	Model 4000 indexer user Guide, Parker Hannifin Corporation, 1994.
2	2-Axis Motion Controller User Guide, Parker Hannifin Corporation, 1995.
3	Operating instructions Compax3 T30 Programmable motion control according to IEC61131- 3, Parker Hannifin Corporation, 2008.

4	Programming with Easy Motion Studio – User's Manual, online, technosoftmotion.com.
5	Technical Reference, IPOS4808 BX-CAT-STO Intelligent Servo Drive for Step, DC, Brushless DC and AC Motors, Techno soft, 2022.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	-	-	-	-	-	2	-	-	-	2	2	1	2
2	2	1	-	-	-	-	-	2	-	-	-	2	2	1	2
3	3	3	2	2	-	-	-	3	-	-	-	3	3	1	3
4	2	1	-	-	-	-	-	2	-	-	-	2	2	1	2
5	2	1	-	-	-	-	-	2	-	-	-	2	2	1	2
6	2	1	-	-	-	-	-	2	-	-	-	2	2	1	2
Overall Correlation	2	2	2	2	-	-	-	2	-	-	-	2	2	1	2

23MT065	TOTAL INTEGRATED AUTOMATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To gain knowledge in automation in industries.
- To gain knowledge in various electrical and electronic programmable automations and their applications.
- To know about the basic in SCADA and DCS systems.
- To gain knowledge in communication protocols in an integrated system
- To know about the advanced in automation industries

UNIT I	TOTALLY INTEGRATED AUTOMATION	9

Need, components of TIA systems, advantages, Programmable Automation Controllers (PAC), Vertical Integration structure.

UNIT II	HUMAN MACHINE INTERFACE (HMI)	9

Necessity and Role in Industrial Automation, Need for HMI systems. Types of HMI- Text display - operator panels - Touch panels - Panel PCs - Integrated displays (PLC & HMI).

UNIT III	SUPERVISORY CONTROL AND DATA ACQUISITION (SCADA)	9

Overview – Developer and runtime packages – architecture – Tools – Tag – Internal & External graphics, Alarm logging – Tag logging – structured tags– Trends – history– Report generation, VB & C Scripts for SCADA application.

UNIT IV	COMMUNICATION PROTOCOLS OF SCADA	9

Proprietary and open Protocols – OLE/OPC- UPC UA/DA – DDE – server/Client Configuration – Messaging – Recipe – User administration – Interfacing of SCADA with PLC, drive, and other field device.

UNIT V	DISTRIBUTED CONTROL SYSTEMS (DCS)	9

DCS – architecture – local control unit- programming language –

communication facilities – operator interface – engineering interfaces. APPLICATIONS OF PLC & DCS: Case studies of Machine automation, Process automation, Introduction to SCADA Comparison between SCADA and DCS.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After completion of the course, the students will be able to:

CO1:	Explain the concepts of totally integrated system
CO2:	Explain Human Machine Interface systems.
CO3:	Apply concepts of SCADA and C programming for report generation
CO4:	Explain the information's on communication protocols in automation systems
CO5:	Develop the automatic control system using distributed control systems.
CO6:	Explain the Distributed Control System.

TEXT BOOKS:

1	John. W. Webb& Ronald A. Reis, "Programmable logic controllers: Principles and Applications", Prentice Hall India, 2009.
2	Michael P. Lukas, "Distributed Control systems", "Van Nostrand Reinfold Company"1995 .

REFERENCES:

1	Win C C Software Manual, Siemens, 2003
2	RS VIEW 32 Software Manual, Allen Bradly, 2005
3	CIMPLICITY SCADA Packages Manual, Fanuc India Ltd, 2004

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	-	-	-	-	-	2	-	-	-	2	2	1	2
2	2	1	-	-	-	-	-	2	-	-	-	2	2	1	2
3	3	2	1	1	-	-	-	3	-	-	-	3	3	1	3
4	2	1	-	-	-	-	-	2	-	-	-	2	2	1	2
5	3	2	1	1	-	-	-	3	-	-	-	3	3	1	3
6	2	1	-	-	-	-	-	2	-	-	-	2	2	1	2
Overall Correlation	2	2	1	1	-	-	-	2	-	-	-	2	2	1	2

23ME061	DIGITAL TWIN AND INDUSTRY 5.0	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the basics concepts in digital twin
- To introduce the concepts in digital twin in a discrete Industry
- To introduce the concepts in digital twin in a process Industry
- To obtain the knowledge in industry 5.0
- To know about the advantages in industry 5.0

UNIT I	INTRODUCTION	9

Digital twin – Definition, types of Industry and its key requirements, Importance, Application of Digital Twin in process, product, service industries, History of Digital Twin, DTT role in industry innovation, Technologies/tools enabling Digital Twin – Virtual CAD Models – control Parameters- Real time systems – control Parameters – Handshaking Through Internet – cyber physical systems.

UNIT II	DIGITAL TWIN IN A DISCRETE INDUSTRY	9

Basics of Discrete Industry, Trends in the discrete industry, control system requirements in a discrete industry, Digital Twin of a Product, Digital Thread in Discrete Industry, Data collection and analysis for product and production improvements, Automation simulation, Digital Enterprise.

UNIT III	DIGITAL TWIN IN A PROCESS INDUSTRY	9

Basics of Process Industry, Trends in the process industry, control system requirements in a process industry, Digital Twin of a plant, Digital Thread in process Industry, Data collection and analysis for process improvements, process safety, Automation simulation, Digital Enterprise

UNIT IV	INDUSTRY 5.0	9
Industrial Revolutions, Industry 5.0 – Definition, principles, Application of Industry 5.0 in process and discrete industries, Benefits of Industry 5.0, challenges in Industry 5.0, Smart manufacturing, Internet of Things 5.0, Industrial Gateways, Basics of Communication requirements – cognitive systems 5.0		
UNIT V	**ADVANTAGES OF DIGITAL TWIN**	**9**
Improvement in product quality, production process, process Safety, identify bottlenecks and improve efficiency, achieve flexibility in production, continuous prediction and tuning of production process through Simulation, reducing the time to market.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
	After completion of the course, the students will be able to:
CO1:	Apply the basics concepts in digital twin.
CO2:	Explain the concepts in digital twin in a discrete Industry
CO3:	Summarize the knowledge in industry 5.0
CO4:	Interpret the benefits of digital twin technology.
CO5:	Explain the benefits of digital twin technology.
CO6:	Explain digital twins to enhance production processes.

TEXT BOOKS:

1	Alp Ustundag and Emre Cevikcan, “Industry 4.0: Managing The Digital Transformation”, Springer Series in Advanced Manufacturing., Switzerland, 2018
2	Andrew Yeh Chris Nee, Fei Tao, and Meng Zhang, “Digital Twin Driven Smart Manufacturing”, Elsevier Science., United States, 2019

REFERENCES:

1	Uthayan Elangovan,” Industry 5.0: The Future of the Industrial Economy”, CRC Press, 2022.

2	Alasdair Gilchrist, "Industry 4.0: The Industrial Internet of Things", Apress., United States, 2015.
3	Christoph Jan Bartodziej, "The Concept Industry 4.0 an Empirical Analysis of Technologies and Applications in Production Logistics", Springer Gambler., Germany, 2017.
4	Ibrahim Garbie, "Sustainability in Manufacturing Enterprises, Concepts, analyses and assessments for Industry 4.0", Springer., Switzerland, 2016.
5	Ronald R. Yager and Jordan Pascual Espada, "New Advances in the Internet of Things", Springer., Switzerland, 2018
6	Ulrich Sendler, "The Internet of Things, Industries 4.0 Unleashed", Springer., Germany, 2018.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1
2	2	1	-	-	1	1	-	1	-	-	-	-	2	1	1
3	2	1	-	-	1	1	-	1	-	-	-	-	2	1	1
4	2	1	-	-	1	1	-	1	-	-	-	-	2	1	1
5	2	1	-	-	1	1	-	1	-	-	-	-	2	1	1
6	2	1	-	-	1	1	-	1	-	-	-	-	2	1	1
Overall Correlation	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1

VERTICAL 6 – DIVERSIFIED GROUP

23MT066	FOUNDATIONS OF LINEAR INTEGRATED CIRCUITS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To introduce the basic building blocks of Linear integrated circuits
- To learn the linear and non-linear applications of operational amplifiers
- To introduce the theory and applications of analog multipliers and PLL
- To learn the theory of ADC and DAC
- To introduce the concepts of waveform generation and introduce some special function IC's.

UNIT I	BASICS OF OPERATIONAL AMPLIFIERS	9

Introduction to Operational Amplifier(OPAMP) – Ideal Operational Amplifier – General operational amplifier stages - and internal circuit diagrams of IC 741, DC and AC performance characteristics, slew rate, Open and closed loop configurations

UNIT II	APPLICATIONS OF OPERATIONAL AMPLIFIERS	9

Sign Changer, Scale Changer, Phase Shift Circuits, Voltage Follower, V-to-I and I-to-V converters, adder, subtractor, Instrumentation amplifier, Integrator, Differentiator, Logarithmic amplifier, Antilogarithmic amplifier, Comparators, Schmitt trigger, Precision rectifier, Peak detector, Clipper and Clamper.

UNIT III	ANALOG MULTIPLIER AND PLL	9

Introduction Analog multiplier ,Analog MultiplierICs and their applications, Operation of the basic PLL, Closed loop analysis, Voltage controlled oscillator, Monolithic PLL IC 565.

UNIT IV	ANALOG TO DIGITAL AND DIGITAL TO ANALOG CONVERTERS	9
Analog and Digital Data Conversions, D/A converter – specifications – weighted resistor type, R-2 Ladder type, Voltage Mode and Current-Mode R – 2R Ladder types – switches for D/A converters high speed sample-and-hold circuits, A/D Converters – specifications – Flash type – Successive Approximation type.		
UNIT V	**WAVEFORM GENRATORS AND SPECIALFUNCTION ICs**	**9**
Sine-wave generators, Multivibrators and Triangular wave generator, Saw-tooth wave generator,ICL8038 function generator, Timer IC 555, IC Voltage regulators – Three terminal fixed and adjustable voltage regulators – IC 723 general purpose regulator – Monolithic switching regulator.		
		TOTAL: 45 PERIODS
COURSE OUTCOMES:		
	After completion of the course, the students will be able to:	
CO1:	Explain the basic concepts of OPAMP.	
CO2:	Explain the basic application of OPAMP.	
CO3:	Explain the basic concepts and applications of analog multiplier and basic operation of PLL.	
CO4:	Explain the various types of A/D & D/A converters	
CO5:	Apply the various concepts of waveforms generators using OPAMP.	
CO6:	Explain the basic concepts of special function ICs.	
TEXT BOOKS:		
1	D.Roy Choudhry, Shail Jain, —Linear Integrated Circuits‖, New Age International Pvt. Ltd., 2018, Fifth Edition.	
2	Sergio Franco, —Design with Operational Amplifiers and Analog Integrated Circuits‖, 4th Edition, Tata Mc Graw-Hill, 2016	

REFERENCES:	
1	Ramakant A. Gayakwad, ―OP-AMP and Linear ICs‖, 4th Edition, Prentice Hall / Pearson Education, 2015.
2	Robert F.Coughlin, Frederick F.Driscoll, ―Operational Amplifiers and Linear Integrated Circuits‖, Sixth Edition, PHI, 2014.
3	B.S.Sonde, ―System design using Integrated Circuits‖ , 2nd Edition, New Age Pub, 2001.
4	Gray and Meyer, ― Analysis and Design of Analog Integrated Circuits‖, Wiley International, 5th Edition, 2011.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	-	-	-	-	-	2	-	-	-	1	1	2	3
2	2	1	-	-	-	-	-	2	-	-	-	1	1	2	3
3	2	1	-	-	-	-	-	2	-	-	-	1	1	2	3
4	2	1	-	-	-	-	-	2	-	-	-	1	1	2	3
5	3	2	1	1	-	-	-	2	-	-	-	1	1	2	3
6	2	1	-	-	-	-	-	2	-	-	-	1	1	2	3
Overall Correlation	3	2	1	1	-	-	-	2	-	-	-	1	1	2	3

23MT067	SINGLE BOARD COMPUTERS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To know the architecture Single board computers
- To understand the function and uses of Real time operating system
- To familiar the python programming
- To develop the embedded based python programming
- To experiment the application development in SBC using python programming.

UNIT I	INTRODUCTION TO SINGLE BOARD COMPUTERS	9

On-Board System Architecture - Processor- Architecture – Features - SPI-I2C- UART- USB - Ethernet- CAN Protocol - Wi-Fi – Bluetooth - HDMI- GPIO- Memory- Input Devices – Camera Interfacing.

UNIT II	REAL TIME OPERATING SYSTEM	8

Operating System Architecture – File Systems- Resource Management – Process Scheduling – Applications.

UNIT III	PYTHON PROGRAMMING	10

Python Language – Using the Interpreter – Python Data Types And Functions – Working With Data – List, Dictionary And Set – Processing Primitives – List Comprehensions – File Handling – Object Model Including Variables, Reference Counting, Copying, and Type Checking – Error Handling Iterative Statement- Conditional Statement – Operators – Arrays Libraries- Library - GUI Development.

UNIT IV	EMBEDDED PYTHON PROGRAMMING	9

GPIO Programming – Numerical Library- Communication Library- Image Processing – Machine Learning.

UNIT V	APPLICATIONS	9
Automotive – Mobile Robotics - IOT- Factory Automation - Home Automation.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:

After completion of the course, the students will be able to:

CO1:	Explain the Single board computers and its components
CO2:	Identify single board computers for mechatronics system development
CO3:	Identify the library and functions for Real time operating system
CO4:	Write the python programming for various applications
CO5:	Identify the GPIO and peripherals using embedded based python programming
CO6:	Develop the application in SBC using python programming.

TEXT BOOKS:

1	Kanagachidambaresan, G. R. Role of Single Board Computers (SBCs) in rapid IoT Prototyping. Cham, Switzerland: Springer, 2021.
2	Kanagachidambaresan, G. R. "Internet of Things Using Single Board Computers." Cham, Switzerland: Springer, 2022.
3	Luetzow, Robert H. Interfacing Test Circuits with Single-board Computers. McGraw-Hill Professional, 1983.

REFERENCES:

1	David Beazley and Brian K. Jones, "Python Cookbook", O'Reilly Media, 2014
2	Gabriele Manduchi and Ivan CibrarioBertolotti, "Real-Time Embedded Systems: Open- Source Operating Systems", CRC Press, 2017.

3	Guttag, John. "Introduction to Computation and Programming Using Python", MIT Press, 2021.
4	NinadSathaye, "Learning Python Application Development", Packt Publishing, 2016
5	Sai Yamanoor, Srihari Yamanoor, "Raspberry-Pi Mechatronics Projects", Packt Publishing, 2016.
6	Warren Gay, "Mastering the Raspberry Pi", A press, 2017

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	-	-	-	-	-	2	-	-	-	2	2	2	3
2	3	2	1	1	-	-	-	2	-	-	-	2	2	2	3
3	3	2	1	1	-	-	-	2	-	-	-	2	2	2	3
4	2	1	-	-	-	-	-	2	-	-	-	2	2	2	3
5	3	2	1	1	-	-	-	2	-	-	-	2	2	2	3
6	3	2	1	1	-	-	-	2	-	-	-	2	2	2	3
Overall Correlation	3	2	1	1	-	-	-	2	-	-	-	2	2	2	3

<table>
<tr><td rowspan="2">23MT068</td><td rowspan="2">RELIABILITY AND MAINTENANCE ENGINEERING</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="6">COURSE OBJECTIVES:</td></tr>
<tr><td colspan="6">
• To impart knowledge about basic concepts of reliability
• To learn about various models of reliability
• To know about maintenance functions and objectives, maintenance planning and scheduling, maintenance organization.
• To impart knowledge about Principles of CBM, pillars of condition monitoring, CBM implementation and benefits
• To learn about reliability centered maintenance, TPM and FMECA
</td></tr>
<tr><td>UNIT I</td><td colspan="4">BASIC CONCEPTS OF RELIABILITY</td><td>9</td></tr>
<tr><td colspan="6">Probability distributions used in maintenance engineering-Binomial, Poisson, Exponential, Normal, Log-normal, Gamma and Weibull distribution; failure rate, hazard rate, failure modes, MTTR, MTBF, MTTF</td></tr>
<tr><td>UNIT II</td><td colspan="4">SYSTEM RELIABILITY MODELS</td><td>9</td></tr>
<tr><td colspan="6">System reliability–n-component series systems, m-component parallel systems and combined system;standby systems; K-out-of-m systems; redundancy techniques. in system design; event space, decomposition (Key Stone), cut and tie sets, Markov analysis, reliability and quality, unreliability, maintainability, availability</td></tr>
<tr><td>UNIT III</td><td colspan="4">MAINTENANCE CONCEPTS AND STRATEGIES</td><td>9</td></tr>
<tr><td colspan="6">Introduction, maintenance functions and objectives, maintenance planning and scheduling, maintenance organization. General Introduction to Maintenance Types: Breakdown, emergency, corrective, predictive, and preventive; maintenance prevention; design-out maintenance, productive</td></tr>
</table>

maintenance, shutdown maintenance and scheduled maintenance.		
UNIT IV	**CONDITION BASED MAINTENANCE**	**9**
Principles of CBM, pillars of condition monitoring, CBM implementation and benefits; condition monitoring techniques-visual monitoring, vibration monitoring, wear debris monitoring, corrosion monitoring, performance monitoring.		
UNIT V	**RELIABILITY CENTERED MAINTENANCE (RCM)**	**9**
Concept, methodology, benefits; Total Productive Maintenance: Evolution of TPM, TPM objectives, concept, pillars of TPM. Failure Modes and Effects Analysis (FMEA)/ Failure Modes, Effects and Criticality Analysis (FMECA): Overview, elements of FMECA, applications and benefits, risk evaluation, risk priority numbers, criticality analysis, process FMEA, qualitative and quantitative approach to FMECA; design FMEA and steps for carrying out design FMEA.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Explain the basic concepts of reliability
CO2:	Explain the various models of reliability
CO3:	Apply the various maintenance functions and objectives, maintenance planning and scheduling, maintenance organization.
CO4:	Explain the Principles of CBM, pillars of condition monitoring, CBM implementation
CO5:	Apply the reliability centered maintenance, TPM.
CO6:	Apply the FMECA process.

TEXT BOOKS:	
1	Ebeling CE, An Introduction To Reliability & Maintainability Engg McGraw Hill Education; 12th edition , 2017
2	Srinath L.S, Reliability Engineering; East West Press, 2005
REFERENCES:	
1	Naikan, V.N.A., Reliability engineering and life testing; PHI,2008
2	Kapur KC and Lamberson LR; Reliability in Engineering Design; Wiley India 1997
3	Telang AD and Telang A; Comprehensive Maintenance Management; PHI
4	Mishra R.C; Reliability and Maintenance Engineering; New age International publisher 2006.
5	Balaguruswamy .E., Reliability Engg; TMH,2017
6	Dhillon; Engg Maintainability- How to design for Reliability and easy maintenance; PHI, 1999.
7	Davidson John; The Reliability of mechanical system; Institution of Mech. Engineers, London 1994
8	Patrick D.T and O.'Connor; Practical Reliability Engineering; John Wiley and Sons,1991
9	Terje Aven; Reliability and Risk Analysis, Springer Netherlands, 2000

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	1	-	-	-	-	-	2	-	-	-	2	2	1	3
2	2	1	-	-	-	-	-	2	-	-	-	2	2	1	3
3	3	2	1	1	-	-	-	2	-	-	-	2	2	1	3
4	2	1	-	-	-	-	-	2	-	-	-	2	2	1	3
5	3	2	1	1	-	-	-	2	-	-	-	2	2	1	3
6	3	2	1	1	-	-	-	2	-	-	-	2	2	1	3
Overall Correlation	3	2	1	1	-	-	-	2	-	-	-	2	2	1	3

23MT069	MEDICAL MECHATRONICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand how to measure biochemical parameters and various physiological information.
- To study the need and technique of electrical safety in Hospitals.
- To study the use of radiation for diagnostic and therapy.
- To study about recorders and advanced equipment in medicine

UNIT I	INTRODUCTION	9

Cell structure – electrode – electrolyte interface, electrode potential, resting and action potential –electrodes for their measurement, ECG, EEG, EMG – machine description – methods of measurement – three equipment failures and trouble shooting

UNIT II	TRANSDUCERS FOR BIO-MEDICAL INSTRUMENTATION	9

Basic transducer principles Types – source of bioelectric potentials – resistive, inductive, capacitive, fiber-optic, photoelectric and chemical transducers – their description and feature applicable for biomedical instrumentation – Bio & Nano sensors & application.

UNIT III	SIGNAL CONDITIONING, RECORDING AND DISPLAY	9

Input isolation, DC amplifier, power amplifier, and differential amplifier – feedback, op-Amp- Electrometer amplifier, carrier Amplifier – instrument power supply. Oscillographic – galvanometric - X-Y, magnetic recorder, storage oscilloscopes – electron microscope – PMMC writing systems –Telemetry principles – Bio telemetry

UNIT IV	MEDICAL SUPPORT	9
Electrocardiograph measurements – blood pressure measurement: by ultrasonic method – Plethysmography – blood flow measurement by electromagnetic flow meter - cardiac output measurement by dilution method – phonocardiography – vector cardiography Heart lung machine – artificial ventilator – Anesthetic machine – Basic ideas of CT scanner – MRI and ultrasonic scanner – Bio-telemetry – laser equipment and application – cardiac pacemaker – DC– defibrillator patient safety - electrical shock hazards. Centralized patient monitoring system.		
UNIT V	**BIO-MEDICAL DIAGNOSTIC INSTRUMENTATION**	**9**
Introduction – computers in medicine – basis of signal conversion and digital filtering data Reduction techniques – time and frequency domain techniques – ECG Analysis.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Explain different measurement techniques used in physiological parameters measurement.
CO2:	Explain the sensors and signal conditioning circuits used in biomedical engineering.
CO3:	Analyze various amplifiers, recording and display devices.
CO4:	Explain the concepts and working of recorders in Real time applications
CO5:	Explain the advanced systems used in medicine
CO6:	Explain about various Bio- medical diagnostics instrumentation.
TEXT BOOKS:	
1	Arumugam M., “Bio Medical Instrumentation”, Anuradha agencies Pub., 2003

2	Cromwell, Weibell and Pfeiffer, “Biomedical Instrumentation and Measurements”, 2nd Edition, Printice Hall of india , 2014.
3	Siamak Najarian“ Mechatronics in Medicine – A Bio medical engg approach" , McGraw – Hill Education , 2011.

REFERENCES:

1	Geddes L.A., and Baker, L.E., “Principles of Applied Bio-medical Instrumentation”, 3rd Edition, John Wiley and Sons, 2010
2	Khandpur, R.S., “Handbook of Biomedical Instrumentation”, TMH, 2009.
3	Tompkins W.J., “Biomedical Digital Signal Processing”, Prentice Hall of India, 1998.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	-	-	-	-	-	1	-	-	-	1	2	1	1
2	2	1	-	-	-	-	-	1	-	-	-	1	1	1	1
3	3	3	2	2	-	-	-	1	-	-	-	1	2	1	1
4	2	1	-	-	-	-	-	1	-	-	-	1	1	1	1
5	2	1	-	-	-	-	-	1	-	-	-	1	2	1	1
6	2	1	-	-	-	-	-	1	-	-	-	1	2	1	1
Overall Correlation	2	1	2	2	-	-	-	1	-	-	-	1	2	1	1

23MT070	INTEGRATED PRODUCT DEVELOPMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the global trends and development methodologies of various types of products and services
- To conceptualize, prototype and develop product management plan for a new product based on the type of the new product and development methodology integrating the hardware, software, controls, electronics and mechanical systems
- To understand requirement engineering and know how to collect, analyze and arrive at requirements for new product development and convert them into design specification
- To understand system modeling for system, sub-system and their interfaces and arrive at the optimum system specification and characteristics
- To develop documentation, test specifications and coordinate with various teams to validate and sustain up to the EoL (End of Life) support activities for engineering customer

UNIT I	FUNDAMENTALS OF PRODUCT DEVELOPMENT	9

Global Trends Analysis and Product decision - Social Trends - Technical Trends-Economic Trends - Environmental Trends - Political/Policy Trends - Introduction to Product Development Methodologies and Management - Overview of Products and services - Types of Product Development - Overview of Product Development methodologies- Product Life Cycle – Product Development Planning and Management.

UNIT II	REQUIREMENTS AND SYSTEM DESIGN	9

Requirement Engineering - Types of Requirements - Requirement Engineering -traceability Matrix and Analysis - Requirement Management - System Design & Modeling -

Introduction to System Modeling - System Optimization - System Specification - Sub-System design - Interface Design		
UNIT III	**DESIGN AND TESTING**	**9**
Conceptualization - Industrial Design and User Interface Design - Introduction to Concept generation Techniques – Challenges in Integration of Engineering Disciplines – Concept Screening & Evaluation - Detailed Design - Component Design and Verification –Mechanical, Electronics and Software Subsystems - High Level Design/Low Level Design of S/W Program - Types of Prototypes, S/W Testing- Hardware Schematic, Component design, Layout and Hardware Testing – Prototyping - Introduction to Rapid Prototyping and Rapid Manufacturing - System Integration, Testing, Certification and Documentation.		
UNIT IV	**SUSTENANCE ENGINEERING AND END-OF-LIFE (EOL) SUPPORT**	**9**
Introduction to Product verification processes and stages - Introduction to Product Validation processes and stages - Product Testing Standards and Certification - Product Documentation - Sustenance -Maintenance and Repair – Enhancements - Product EOL – Obsolescence Management – Configuration Management - EOL Disposal.		
UNIT V	**BUSINESS DYNAMICS – ENGINEERING SERVICES INDUSTRY**	**9**
The industry - Engineering Services Industry - Product Development in Industry versus Academia –The IPD Essentials - Introduction to Vertical Specific Product Development processes -Manufacturing/Purchase and Assembly of Systems - Integration of Mechanical, Embedded and Software Systems – Product Development Trade-offs - Intellectual Property Rights and Confidentiality – Security and Configuration Management.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
	After completion of the course, the students will be able to:
CO1:	Explain the fundamentals of product development
CO2:	Explain the various types of Requirement Engineering & concept of system modelling.
CO3:	Apply the concept of system design and testing
CO4:	Explain the concept of sustenance engineering and product EOL
CO5:	Explain the concept of Business dynamic in engineering service industry
CO6:	Explain the concept of IPR and confidentiality & management.
TEXT BOOKS:	
1	Book specially prepared by NASSCOM as per the MoU. Karl T Ulrich and Stephen D Eppinger, "Product Design and Development", TMH, Fifth Edition, 2020.
2	John W Newstorm and Keith Davis, "Organizational Behavior", TMHl, Eleventh Edition.
REFERENCES:	
1	Hiriyappa B, "Corporate Strategy – Managing the Business", Author House, 2013.
2	Peter F Drucker, "People and Performance", Butterworth – Heinemann [Elsevier], Oxford, 2004.
3	Vinod Kumar Garg and Venkita Krishnan N K, "Enterprise Resource Planning – Concepts", Second Edition, Prentice Hall, 2003.
4	Mark S Sanders and Ernest J McCormick, "Human Factors in Engineering and Design", McGraw Hill Education, Seventh Edition, 20131. Hiriyappa B, "Corporate Strategy – Managing the Business", Author House, 2015.

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	1	-	-	-	-	-	2	-	-	-	1	1	1	3
2	2	1	-	-	-	-	-	2	-	-	-	1	1	1	3
3	3	2	1	1	-	-	-	2	-	-	-	1	1	1	3
4	2	1	-	-	-	-	-	2	-	-	-	1	1	1	3
5	2	1	-	-	-	-	-	2	-	-	-	1	1	1	3
6	2	1	-	-	-	-	-	2	-	-	-	1	1	1	3
Overall Correlation	2	1	1	1	-	-	-	2	-	-	-	1	1	1	3

23AD301	OBJECT ORIENTED PROGRAMMING IN C++ AND JAVA	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- Understand the concepts of Object-oriented Programming and discuss the important elements of C++.
- To understand and apply the concepts of classes, Inheritance, and exception handling.
- To understand and apply the concepts of packages, interfaces, and Multithread.
- To develop applications using Event Driven Programming.
- To develop applications using Swing Programming.

UNIT I	OBJECT ORIENTED PROGRAMMING AND C++	12

Basic Concepts of Objects Oriented Programming - Operators - Control Structures Functions in C++ - Function Overloading - Class - Member Function - Nesting of Member function - Constructors - Destructors - Array with Class - Static Data Member - Friend functions - Returning Objects - Operator Overloading - Type Conversion - Basic type to Class – Class to Basic - Class to Class.

UNIT II	OVERVIEW OF JAVA AND EXCEPTION HANDLING	9

An overview of Java, data types, variables and arrays, operators, control statements, classes, objects, methods – Inheritance. Exceptions – exception hierarchy – throwing and catching exceptions – built-in exceptions, creating own exceptions.

UNIT III	JAVA PROGRAMMING	6

Packages and Interfaces, Multithreaded programming, Strings, Input /Output, Generic Programming – Generic classes – generic methods.

UNIT IV	**EVENT DRIVEN PROGRAMMING**	**9**
Graphics programming – Frame – Components – working with 2D shapes – Using color, fonts, and images – Basics of event handling – event handlers – adapter classes – actions – mouse events – AWT event hierarchy.		
UNIT V	**JAVA PROGRAMMING USING SWING**	**9**
Introduction to Swing – layout management – Swing Components – Text Fields, Text Areas – Buttons- Check Boxes – Radio Buttons – Lists- choices- Scrollbars – Windows –Menus – Dialog Boxes.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
	After completion of the course, the students will be able to:
CO1:	Develop C++ programs using OOP principles.
CO2:	Develop Java programs with the concepts of inheritance and interfaces.
CO3:	Build Java applications using exceptions, threads and generics classes.
CO4:	Develop Java applications with event driven program.
CO5:	Develop interactive Java programs using swings.
CO6:	Develop and understand exception handling, multithreaded applications with synchronization.
TEXT BOOKS:	
1	K.R. Venugopal, Rajkumar Buyya, Ravishankar, “Mastering Develop interactive Java programs using swings++”, TMH, 2017. (Unit I)
2	Herbert Schildt, “The Java 2: Complete Reference”, Eighth Edition, TMH, 2018. (Unit II, Unit III, Unit IV, and Unit-V)
REFERENCES:	
1	Ira Pohl, “Object oriented programming using C++”, Pearson Education Asia,2003.
2	Bjarne Stroustrup, "The C++ programming language" Addison Wesley, 2000

3	John Hubbard, "Programming with C++", Schaums outline series, TMH, 2003.
4	H.M. Deitel, P.J. Deitel, "Java: how to program", Fifth edition, Prentice Hall of India private limited.
5	E. Balagurusamy "Object Oriented Programming with C++", TMH 2/e.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	1	-	1	1	1	1	1	1	3	1	1
2	3	2	1	1	1	-	-	-	1	-	1	1	3	1	-
3	3	2	1	1	1	-	-	-	1	-	1	1	3	1	-
4	3	2	1	1	1	-	-	-	1	-	1	1	3	1	-
5	3	2	1	1	1	-	-	-	1	-	1	1	3	1	-
6	3	2	1	1	1	1	-	-	1	-	1	1	3	1	-
Overall Correlation	3	2	1	1	1	1	1	1	1	1	1	1	3	1	1

23ME035	PROCESS PLANNING AND COST ESTIMATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To introduce the process planning concepts to make cost estimation for various products after process planning
- To learn the various Process Planning Activities
- To provide the knowledge of importance of costing and estimation.
- To provide the knowledge of estimation of production costing.
- To learn the knowledge of various Machining time calculations

UNIT I	INTRODUCTION TO PROCESS PLANNING	9

Introduction- methods of process planning-Drawing Interpretation-Material evaluation – steps in process selection-. Production equipment and tooling selection

UNIT II	PROCESS PLANNING ACTIVITIES	9

Process parameters calculation for various production processes-Selection jigs and fixture selection of quality assurance methods - Set of documents for process planning-Economics of process planning- case studies

UNIT III	INTRODUCTION TO COST ESTIMATION	9

Importance of costing and estimation – methods of costing – elements of cost estimation – Types of estimates – Estimating procedure – Estimation labor cost, material cost – allocation of overhead charges – Calculation of depreciation cost

UNIT IV	PRODUCTION COST ESTIMATION	9

Estimation of Different Types of Jobs - Estimation of Forging Shop, Estimation of Welding Shop, Estimation of Foundry Shop

UNIT V	MACHINING TIME CALCULATION	9

Estimation of Machining Time - Importance of Machine Time

Calculation- Calculation of Machining Time for Different Lathe Operations, Drilling and Boring - Machining Time Calculation for Milling, Shaping and Planning -Machining Time Calculation for Grinding.	
	TOTAL: 45 PERIODS
COURSE OUTCOMES:	
	After completion of the course, the students will be able to:
CO1:	Explain the process, equipment and tools for various industrial products.
CO2:	Illustrate the process planning activity chart
CO3:	Explain the concept of cost estimation.
CO4:	Solve the job order cost problems for different type of shop floor.
CO5:	Solve the machining time problems for various machining operations.
CO6:	Analyze the process plan and do the cost estimation of any one industry
TEXT BOOKS:	
1	Peter scalon, "Process planning, Design/Manufacture Interface", Elsevier science technology Books, Dec 2002.
2	Sinha B.P, "Mechanical Estimating and Costing", Tata-McGraw Hill publishing co, 1995.
REFERENCES:	
1	Chitale A.V. and Gupta R.C., "Product Design and Manufacturing", 2nd Edition, PHI, 2002.
2	Ostwalal P.F. and Munez J., "Manufacturing Processes and systems", 9th Edition, John Wiley, 1998.
3	Russell R.S and Tailor B.W, "Operations Management", 4th Edition, PHI, 2003.
4	Mikell P. Groover, "Automation, Production, Systems and Computer Integrated Manufacturing", Pearson Education 2001.

5	K.C. Jain and L.N. Aggarwal, “Production Planning Control and Industrial Management”, Khanna Publishers 1990.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	-	-	1	-	-	1	-	-	1	-	2	1	1
2	2	1	-	-	1	-	-	1	-	-	1	-	2	1	1
3	2	1	-		1	-	-	1	-	-	1	-	2	1	1
4	3	2	1	1	1	-	-	1	-	-	1	-	3	1	1
5	3	2	1	1	1	-	-	1	-	-	1	-	3	1	1
6	3	3	2	2	1	-	-	1	-	-	1	-	3	1	1
Overall Correlation	3	2	1	1	1	-	-	1	-	-	1	-	3	1	1

23MT071	VLSI AND FPGA	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To introduce the features of programmable logic devices
- To learn the features of various FPGAs and FPAA
- To understand the concepts of synchronous and asynchronous FSMs
- To provide the system design experience with FSMs using PLDs
- To introduce pulse mode approach to asynchronous FSM

UNIT I	PROGRAMMABLE LOGIC DEVICES	9

Logic implementation options - Technology trends - Design with Field programmable devices - ROM, PLA, PAL - CPLD - XC9500 family - Erasable Programmable Logic Devices - MAX5000, MAX7000 families.

UNIT II	FPGA AND FPAA	9

Programming Technology, Logic blocks, routing architectures of SRAM-Programmable FPGA Architectures - XC2000, XC3000, XC4000 – Anti-fuse Programmed FPGAs - Routing Architecture of the Actel FPGAs - ProASIC plus - Design Applications - Current FPGA Technologies - FPAA architecture and its reconfiguration.

UNIT III	SYNCHRONOUS FSM DESIGN	9

Choice of Components to be Considered - Architecture Centered around Nonregistered PLDs - State Machine Designs - Centered around a Shift Register, Centered around a Parallel Loadable Up/Down Counter - One hot design method - Use of Algorithmic State Machine, Application of one hot design to serial 2's complementer, parallel to serial adder/subtractor controller- System-level design: controller, data path, and functional partition.

UNIT IV	**ASYNCHRONOUS STATE MACHINE DESIGN**	**9**
Features and need for Asynchronous FSMs - Lumped path delay models for asynchronous FSMs - Excitation table, state diagrams, K-maps, and state tables - Design of the basic cells by using the LPD model - design examples - Hazards in Asynchronous FSMs - One-hot design of asynchronous state machines - Design of fundamental mode FSMs by using PLDs.		
UNIT V	**PULSE MODE APPROACH TO ASYNCHRONOUS FSM DESIGN**	**9**
Pulse Mode Models and System Requirements - Choice of Memory Elements - Other Characteristics of Pulse Mode FSMs - Design Examples - Analysis of Pulse Mode FSMs - One-Hot Programmable Asynchronous Sequencers.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
	After completion of the course, the students will be able to:
CO1:	Explain the basic concepts of programmable logic devices.
CO2:	Explain the architectural features of FPGA and FPAA
CO3:	Explain the concept of synchronous FSMs design.
CO4:	Apply the concept of feature Asynchronous state machine design.
CO5:	Explain the various design examples of FSM.
CO6:	Explain the Pulse mode approach of asynchronous FSMs design.

TEXT BOOKS:	
1	Stephen M. Trimberger, Edr.,"Field Programmable Gate Array Technology", Springer Science Business media, LLC, 2012.
2	Richard F. Tinder, "Engineering Digital Design, Revised Second Edition", Academic Press, 2000.

REFERENCES:	
1	Roger Woods, John McAllister, Gaye Light body and Ying Yi, "FPGA-based implementation of Signal Processing Systems", A John Wiley and Sons, Ltd., Publication, 2008.
2	John V. Oldfield, Richard C.Dorf, "Field Programmable Gate Arrays – Reconfigurable logic for rapid prototyping and implementation of digital systems", John Wiley & Sons, Reprint, 2008.
3	P. K .Chan& S. Mourad, "Digital Design Using Field Programmable Gate Array", Prentice Hall, 1994.
4	Thomas L. Floyd, "Electronic Devices", Pearson Education Ltd., 8th Edition, 2008.

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	1	-	-	-	-	-	2	-	-	-	1	1	2	3
2	2	1	-	-	-	-	-	2	-	-	-	1	1	2	3
3	2	1	-	-	-	-	-	2	-	-	-	1	1	2	3
4	3	2	1	1	-	-	-	2	-	-	-	1	1	2	3
5	2	1	-	-	-	-	-	2	-	-	-	1	1	2	3
6	2	1	-	-	-	-	-	2	-	-	-	1	1	2	3
Overall Correlation	2	1	2	1	-	-	-	2	-	-	-	1	1	2	3