Kathir College of Engineering
[Autonomous]
[Approved by AICTE | Affiliated to Anna University | Accredited by NAAC with 'A+' Grade]
Wisdom Tree, Avinashi Road, Neelambur, Coimbatore 641062
Phone: 0422-2203787 | Fax:08030723600 | Email: kathirce@gmail.com | Web: www.kathir.ac.in

DEPARTMENT OF MECHANICAL ENGINEERING

CURRICULUM AND SYLLABI

Regulation 2024

V and VI semester

For batches

2024-28, 2025-29

Credits 170

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INSTITUTE VISION AND MISSION

VISION

Strive to promote Excellence in Engineering Education and Research by developing our students as Real-Time Problem solvers thereby contributing to the Societal needs.

MISSION

- Promote excellence in Core and allied studies through Technology enabled Teaching and active learning practices
- Develop multi-talented and committed human resources by providing research and development environment to innovate and find solutions for Real-Time Problems.
- Create socially responsible engineers with team-spirit / entrepreneurs with necessary leadership skills thus contributing towards a better world.

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CORE VALUES

- Our motto is to serve the society through producing responsible citizens by imparting integrity and ethics
- We strongly believe in inclusivity and consider every stake holder as responsible to set benchmark in each of our activities
- Our faculty members exhibit excellent team-spirit and achieve excellence in each of our curricular, co-curricular and extra-curricular activities.
- We see every student of our Institution as a problem solver and our start-up studios help them to become entrepreneurs and provide solutions for the societal needs
- We promote the sense of social responsibilities in students by providing ample opportunities to participate in various social activities
- We create an eco-system where every faculty member and student accepts responsibility for personal and professional growth and development.

DEPARTMENT OF MECHANICAL ENGINEERING

VISION

To provide excellent education, entrepreneurial skills and advanced domain knowledge to meet the evolving demands in mechanical engineering field and relevant societal needs.

MISSION

M1: Impart quality education including strong foundation in fundamental theory and versatile exposure to practical applications in mechanical engineering.

M2: Enhance skills in engineering fields to make graduates globally competitive mechanical engineers.

M3: Inculcate entrepreneurial skills and ethical values with opportunities to meet societal needs.

PROGRAM EDUCATIONAL OBJECTIVES

PEO1: Graduates will be successful professionals in mechanical and related industries, academics and entrepreneurial ventures.

PEO2: Graduates will possess leadership attitudes and competencies to respond to the dynamic global scenario. PEO3: Graduates will exhibit professional integrity and ethical values to lead as good human beings, and responsible citizens.

PROGRAM OUTCOMES (POs)

PO	Graduate Attribute
1	**Engineering Knowledge:** Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.
2	**Problem Analysis:** Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.
3	**Design/Development of Solutions:** Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole life cost, net zero carbon, culture, society and environment as required.
4	**Conduct Investigations of Complex Problems:** Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.
5	**Engineering Tool Usage:** Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.
6	**The Engineer and The World:** Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its

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	impact on sustainability with reference to economy, health, safety, legal framework, culture and environment.
7	**Ethics:** Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws.
8	**Individual and Collaborative Team work:** Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.
9	**Communication:** Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences.
10	**Project Management and Finance:** Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.
11	**Life-Long Learning:** Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSOs)

- Ability to apply fundamental mechanical engineering principles to analyse, investigate and develop solutions for problems related Mechanical systems.
- Ability to demonstrate technical competence and creativity by applying advanced Mechanical Engineering knowledge and adapting to emerging technologies.
- Ability to exhibit professional ethics, an entrepreneurial mind-set, and social responsibility in professional practice.

SCHEME OF CREDIT DISTRIBUTION

STREAM	Credits/Semester								Total No. of Credits
	I	II	III	IV	V	VI	VII	VIII	
Humanities (HS)	3	3					5		**11**
Basic Sciences (BS)	8	8	4	4					**24**
Engineering Sciences (ES)	7	6	4			3	3		**23**
Professional Core (PC)		4	17	19	19	3	4		**66**
Professional Electives (PE)					6	9	3		**18**
Open Electives (OE)					3	6	3		**12**
Project Work (PW)							2	12	**14**
Mandatory Course (MC)									**0**
Industry Practices (IP)						2			**2**
Total	**18**	**21**	**25**	**23**	**28**	**23**	**20**	**12**	**170**

SCHEME OF COURSE DISTRIBUTION

STREAM	No. of Courses								Total No. of courses
	I	II	III	IV	V	VI	VII	VIII	
Humanities (HS)	**1**	**1**					**2**		**4**
Basic Sciences (BS)	**2**	**2**	**1**	**1**					**6**
Engineering Sciences (ES)	**3**	**2**	**1**			**1**	**1**		**8**
Professional Core (PC)		**1**	**5**	**6**	**6**		**2**		**20**
Professional Electives (PE)					**2**	**3**	**1**		**6**
Open Electives (OE)					**1**	**2**	**1**		**4**
Project Work (PW)							**1**	**1**	**2**
Mandatory Course (MC)	**1**	**1**	**1**	**1**					**4**
Industry Practices (IP)						**1**			**1**
Total	**7**	**7**	**8**	**8**	**9**	**7**	**8**	**1**	**55**

DEPARTMENT OF MECHANICAL ENGINEERING

CURRICULUM AND SYLLABI (APPLICABLE FOR STUDENTS ADMITTED FROM 2024-2025)

SEMESTER I							
S No.	Course Code	Course	L/T/P	Contact hrs/week	Credits	Ext/Int	Category
THEORY							
1	24MA211	Matrices and Calculus	3/1/0	4	4	60/40	BS
2	24CS312	Programming in C	3/0/0	3	3	60/40	ES
THORY CUM PRACTICAL							
3	24CP213	Physics for Mechanical Sciences	3/0/2	5	4	40/60	BS

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4	24HS114	Technical English	2/0/2	4	3	40/60	HS
PRACTICAL							
5	24EP315	Engineering Practices Laboratory	0/0/4	4	2	40/60	ES
6	24CS316	Programming in C Laboratory	0/0/4	4	2	40/60	ES
MANDATORY COURSE							
7	24MC901	Mandatory Course I Induction Program	Three weeks program		0	0	MC
		Total	11/1/12	24	18	600	

SEMESTER II							
S No.	Course Code	Course	L/T/P	Contact hrs/week	Credits	Ext/Int	Category
THEORY							
1	24MA221	Differential Equations And Complex Functions	3/1/0	4	4	60/40	BS
2	24EE312	Basic Electrical and Electronics Engineering	3/0/0	3	3	60/40	ES
3	24ME423	Engineering Mechanics	3/1/0	4	4	60/40	PC
THEORY CUM PRACTICAL							
4	24HS124	Professional English	2/0/2	4	3	40/60	HS
5	24EG315	Engineering Graphics	1/0/4	5	3	40/60	ES
6	24CC226	Chemistry for Mechanical Sciences	3/0/2	5	4	40/60	BS
MANDATORY COURSE							
7	24MC902	Mandatory Course II □□□□□□□□□□/ Heritage of Tamils	2/0/0	2	0	0	MC
Total			17/2/8	27	21	600	

SEMESTER III							
S No.	Course Code	Course	L/T/P	Contact hrs/week	Credits	Ext/Int	Category
THEORY							
1	24MA232	Transforms and Partial Differential Equations	3/1/0	4	4	60/40	BS
2	24ME432	Engineering Thermodynamics	3/1/0	4	4	60/40	PC
3	24ME433	Manufacturing Technology	3/0/0	3	3	60/40	PC
4	24ME434	Kinematics of Machinery	3/1/0	4	4	60/40	PC
THEORY CUM PRACTICAL							
5	24ME435	Fluid Mechanics and Machinery	3/0/2	5	4	40/60	PC
6	24CS336	Problem Solving and Python	3/0/2	5	4	40/60	ES

		Programming					
PRACTICAL							
7	24ME437	Manufacturing Technology Laboratory	0/0/4	4	2	40/60	PC
MANDATORY COURSE							
8	24MC903	Mandatory Course III Environmental Science and Sustainability	2/0/0	2	0	0	MC
Total			20/4/8	32	25	700	

SEMESTER IV							
S No.	Course Code	Course	L/T/P	Contact hrs/week	Credits	Ext/Int	Category
THEORY							
1	24MA244	Statistics And Numerical Methods	3/1/0	4	4	60/40	BS
2	24ME442	Engineering Materials and Metallurgy	3/0/0	3	3	60/40	PC
3	24ME443	Dynamics of Machinery	3/1/0	4	4	60/40	PC
THEORY CUM PRACTICAL							
4	24ME444	Mechanics of Materials and Material Testing	3/0/2	5	4	40/60	PC
5	24ME445	Thermal Engineering and Testing	3/0/2	5	4	40/60	PC
PRACTICAL							
6	24ME446	Computer Aided Machine Drawing	0/0/4	4	2	40/60	PC
7	24ME447	Kinematics and Dynamics Laboratory	0/0/4	4	2	40/60	PC
MANDATORY COURSE							
8	24MC904	Mandatory Course IV Introduction to Women and Gender Studies	2/0/0	2	0	0	MC
Total			17/4/12	33	23	700	
SEMESTER V							
S No.	Course Code	Course	L/T/P	Contact hrs/week	Credits	Ext/Int	Category
THEORY							
1	24ME451	Design of Machine Elements	3/1/0	4	4	60/40	PC
2	24ME452	Heat and Mass Transfer	3/1/0	4	4	60/40	PC
3	24ME453	Metrology and Measurements	3/0/0	3	3	60/40	PC
4	24ME5XX	Professional Elective I	3/0/0	3	3	60/40	PE
5	24ME5XX	Professional Elective II	3/0/0	3	3	60/40	PE
6	24OE6XX	Open Elective I	3/0/0	3	3	60/40	OE
THEORY CUM PRACTICAL							
7	24ME457	Computer Aided Design and Computer Aided Manufacturing	3/0/2	5	4	40/60	PC
PRACTICL							
8	24ME458	Heat and Mass Transfer Laboratory	0/0/4	4	2	40/60	PC

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9	24ME459	Metrology and Measurements Laboratory	0/0/4	4	2	40/60	PC
Total			21/2/10	33	28	900	

SEMESTER VI							
S No.	Course Code	Course	L/T/P	Contact hrs/week	Credits	Ext/Int	Category
THEORY							
1	24AM461	Machine Learning for Intelligent Systems	3/0/0	3	3	60/40	ES
2	24AM462	Renewable Energy Technologies	3/0/0	3	3	60/40	PC
3	24ME5XX	Professional Elective III	3/0/0	3	3	60/40	PE
4	24ME5XX	Professional Elective IV	3/0/0	3	3	60/40	PE
5	24ME5XX	Professional Elective V	3/0/0	3	3	60/40	PE
6	24OE6XX	Open Elective II	3/0/0	3	3	60/40	OE
7	24OE6XX	Open Elective III	3/0/0	3	3	60/40	OE
PRACTICAL							
8	24ME861	Summer Internship	0	0	2	0/100	IP
Total			18/0/0	18	23	700	

SEMESTER VII							
S No.	Course Code	Course	L/T/P	Contact hrs/week	Credits	Ext/Int	Category
THEORY							
1	24HS171	Human Values and Ethics	2/0/0	2	2	60/40	HS
2	24EE532	Electric vehicle design	3/0/0	3	3	60/40	ES
3	24MB151	Principles of Management	3/0/0	3	3	60/40	HS
4	24ME5XX	Professional Elective VI	3/0/0	3	3	60/40	PE
5	24OE6XX	Open Elective IV	3/0/0	3	3	60/40	OE
THEORY CUM PRACTICAL							
6	24ME476	Mechatronics and Internet of Things	3/0/2	5	4	40/60	PC
PRACTICAL							
7	24ME771	Project Work Phase I	0/0/4	4	2	40/60	PW
Total			17/0/6	23	20	700	

SEMESTER VIII							
S No.	Course Code	Course	L/T/P	Contact hrs/week	Credits	Ext/Int	Category
PRACTICAL							

1	24ME781	Project Work Phase II	0/0/24	24	12	40/60	PW
Total			0/0/24	24	12	100	

PROFESSIONAL ELECTIVE COURSE (18 Credits)

Vertical I	Vertical II	Vertical III	Vertical IV	Vertical V
MODERN MOBILITY SYSTEMS	**ROBOTICS AND AUTOMATION**	**DIGITAL AND GREEN MANUFACTURING**	**Industry 4.0**	**DIVERSIFIED COURSES GROUP**
Automotive Materials, Components , Design and Testing	Sensors and Instrumentation	Digital Manufacturing and Internet of Things	Intelligent Machining	Automobile Engineering
Conventional and Futuristic Vehicle Technology	Electrical Drives and Actuators	Lean Manufacturing	Machine Diagnostics and Condition Monitoring	Composite Materials and Mechanics
Renewable Powered Off Highway Vehicles and Emission Control Technology	Drone Technology	Modern Robotics	Artificial Intelligence Applications in Mechanical Engineering	Design for Manufacturing
Vehicle Health Monitoring, Maintenance and Safety	Robotics	Green Supply Chain Management	Soft Robotics	Casting and Welding Processes
CAE and CFD Approach in Future Mobility	Smart Mobility and Intelligent Vehicles	3D printing	Advanced Machining and Automation	Process Planning and Cost Estimation
Hybrid and Electric Vehicle Technology	Haptics and Immersive Technologies	Additive Manufacture	Intelligent Machines	Surface Engineering

MANDATORY COURSES (Non-Credit)

S. No	Course Code	Course Title	L/T/P	Contact Hrs/Wk	Credits
1	24MC901	Induction program	3 Weeks Program	2	0
2	24MC902	Heritage of Tamils	2/0/02	2	0

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3	24MC903	Environmental Sciences and Sustainability	2/0/02	2	0
4	24MC904	Introduction to Women and Gender Studies	2/0/02	2	0

OPEN ELECTIVE COURSES (15 Credits)

S No.	Course Code	Course Title	L/T/P	Contact Hrs./Wk.	Credits
1.	24OE631	Foundations of Robotics	3/0/0	3	3
2.	24OE632	Basics of Drone Technology	3/0/0	3	3
3.	24OE633	3D Printing	3/0/0	3	3
4.	24OE634	Digital Manufacturing	3/0/0	3	3
5.	24OE635	Composite Materials	3/0/0	3	3

HUMANITIES SCIENCES (11 Credits)

S. No	Course Code	Course Title	L/T/P	Contact Hrs/Wk	Credits
1.	24HS114	Technical English	2/0/2	4	3
2.	24HS124	Professional English	2/0/2	4	3
3.	24HS171	Human Values and Ethics	2/0/0	2	2
4.	24MB151	Principles of Management	3/0/0	3	3

BASIC SCIENCES (BS) (24 Credits)

S. No	Course Code	Course Title	L/T/P	Contact Hrs/Wk	Credits
1.	24MA211	Matrices and Calculus	3/1/0	4	4
2.	24CP213	Physics for Mechanical Sciences	3/0/2	5	4
3.	24MA221	Differential Equations And Complex Functions	3/1/0	4	4
4.	24CC226	Chemistry for Mechanical Sciences	3/0/2	5	4
5.	24MA232	Transforms and Partial Differential Equations	3/1/0	4	4
6.	24MA244	Statistics and Numerical Methods	3/1/0	4	4

ENGINEERING SCIENCES (ES) (23 Credits)

S. No	Course Code	Course Title	L/T/P	Contact Hrs/Wk	Credits

1.	24CS312	Programming in C	3/0/0	3	3
2.	24EP315	Engineering Practices Laboratory	0/0/4	4	2
3.	24CS316	Programming in C Laboratory	0/0/4	4	2
4.	24EE312	Basic Electrical and Electronics Engineering	3/0/0	3	3
5.	24EG315	Engineering Graphics	1/0/4	5	3
6.	24CS336	Problem Solving and Python Programming	3/0/2	5	4
7.	24AM361	Machine Learning for Intelligent Systems	3/0/0	3	3
8.	24EE532	Electric vehicle design	3/0/0	3	3

PROFESSIONAL CORE (PC) (66 Credits)

S. No	Course Code	Course Title	L/T/P	Contact Hrs/Wk	Credits
1.	24ME423	Engineering Mechanics	3/1/0	4	4
2.	24ME432	Engineering Thermodynamics	3/1/0	4	4
3.	24ME433	Introduction to Manufacturing Technology	3/0/0	3	3
4.	24ME434	Kinematics of Machinery	3/1/0	4	4
5.	24ME435	Fluid Mechanics and Machinery	3/1/2	6	5
6.	24ME437	Manufacturing Technology Laboratory	0/0/4	4	2
7.	24ME442	Engineering Materials and Metallurgy	3/1/0	4	4
8.	24ME443	Dynamics of Machinery	3/1/0	4	4
9.	24ME444	Mechanics of Materials and Material Testing	3/0/2	5	4
10.	24ME445	Thermal Engineering and Testing	3/1/2	6	5
11.	24ME446	Computer Aided Machine Drawing	0/0/4	4	2
12.	24ME447	Kinematics and Dynamics Laboratory	0/0/4	4	2
13.	24ME451	Design of Machine Elements	3/1/0	4	4
14.	24ME452	Heat and Mass Transfer	3/1/0	4	4
15.	24ME453	Metrology and Measurements	3/0/0	3	3
16.	24ME457	Computer Aided Design	3/0/2	5	4
17.	24ME458	Heat and Mass Transfer Laboratory	0/0/4	4	2
18.	24ME459	Metrology and Measurements Laboratory	0/0/4	4	2
19.	24ME476	Mechatronics and Internet of Things	3/0/2	5	4

PROFESSIONAL ELECTIVE COURSE -PE (18 Credits)

S. No	Course Code	Course Title	L/T/P	Contact Hrs/Wk	Credits
Vertical I: Modern Mobility Systems					
1.	24ME501	Automotive Materials Components Design and Testing	3/0/0	3	3
2.	24ME502	Conventional and Futuristic Vehicle Technology	3/0/0	3	3
3.	24ME503	Renewable Powered Off Highway Vehicles and Emission Control Technology	3/0/0	3	3
4.	24ME504	Vehicle Health Monitoring Maintenance and Safety	3/0/0	3	3
5.	24ME505	Computer-Aided Engineering and Computational Fluid Dynamics Approach in Future Mobility	3/0/0	3	3
6.	24ME506	Hybrid and Electric Vehicle Technology	3/0/0	3	3

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S No.	Course Code	Course Title	L/T/P	Contact Hrs./Wk.	Credits
Vertical II: Robotics and Automation					
1	24ME507	Sensors and Instrumentation	3/0/0	3	3
2	24ME508	Electrical Drives and Actuators	3/0/0	3	3
3	24ME509	Drone Technology	3/0/0	3	3
4	24ME510	Robotics	3/0/0	3	3
5	24ME511	Smart Mobility and Intelligent Vehicles	3/0/0	3	3
6	24ME512	Haptics and Immersive Technologies	3/0/0	3	3

S No.	Course Code	Course Title	L/T/P	Contact Hrs./Wk.	Credits
Vertical III: Digital and Green Manufacturing					
1	24ME513	Digital Manufacturing and Internet of Things	3/0/0	3	3
2	24ME514	Lean Manufacturing	3/0/0	3	3
3	24ME515	Modern Robotics	3/0/0	3	3
4	24ME516	Green Supply Chain Management	3/0/0	3	3
5	24ME517	3D printing	3/0/0	3	3
6	24ME518	Additive Manufacturing	3/0/0	3	3

S No.	Course Code	Course Title	L/T/P	Contact Hrs./Wk.	Credits
Vertical IV: INDUSTRY 4.0					
1	24ME519	Intelligent Machining	3/0/0	3	3
2	24ME520	Machine Diagnostics and Condition Monitoring	3/0/0	3	3
3	24ME521	Artificial Intelligence Applications in Mechanical Engineering	3/0/0	3	3
4	24ME522	Soft Robotics	3/0/0	3	3
5	24ME523	Advanced Machining and Automation	3/0/0	3	3
6	24ME524	Intelligent Machines	3/0/0	3	3

S No.	Course Code	Course Title	L/T/P	Contact Hrs./Wk.	Credits
Vertical V: DIVERSIFIED COURSES					
1	24ME525	Automobile Engineering	3/0/0	3	3
2	24ME526	Composite Materials and Mechanics	3/0/0	3	3
3	24ME527	Design for Manufacturing	3/0/0	3	3
4	24ME528	Casting and Welding Processes	3/0/0	3	3
5	24ME529	Process Planning and Cost Estimation	3/0/0	3	3
6	24ME530	Surface Engineering	3/0/0	3	3

PROJECT WORK (PW) (16 Credits)

S. No	Course Code	Course Title	L/T/P	Contact Hrs/Wk	Credits
1.	24ME861	Summer Internship	0/0/0	0	2
2.	24ME771	Project Work Phase I	0/0/4	4	2
3.	24ME781	Project Work Phase II	0/0/24	24	12

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SYLLABUS OF FIFTH SEMESTER

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24ME451	DESIGN OF MACHINE ELEMENTS	ES	3	1	0	4
Regulation	Nature of the Course	Semester	Data Book/Codes/Standards			
	Analytical	V	PSG Design Data Book			
Pre-requisite Course(s)		**Co-requisite Course(s)**				
Engineering Mechanics and Strength of Materials						

Course Objectives

1	To imparts the design of machine components like shaft, coupling, springs, bearing and its failure criteria to meet the desired needs.
2	To give an ability to discuss and explore the design of fasteners and joints.

Course Outcomes

Upon completion of the course, students will be able to

CXXX.1	Design the machine components subjected to steady stress and variable stress under various Loading conditions.	[AP]
CXXX.2	Select and design the shafts and couplings for different applications	[AP]
CXXX.3	Design the screw fasteners and welded joints for different applications	[AP]
CXXX.4	Design the helical, leaf springs and power screws for different applications	[AP]
CXXX.5	Identify, design and predict the life of bearings for different applications	[AP]

Course Contents

Unit – 1	**INTRODUCTION TO FUNDAMENTAL CONCEPTS IN DESIGN**	**CO1**	**12 Hrs**

Design Procedure – Factor influencing Machine Design - Selection of Materials based on Mechanical Properties –Direct Bending and Torsion Stress Equations – Calculation of Principal Stresses for various Load Combinations- Eccentric Loading – Factor of Safety -Theories of Failure – Stress Concentration – Design for Variable Loading : Stress concentration, fatigue failure, endurance limit, design equations – Soderberg, Goodman and Gerber Relations, combined stresses.

Unit – 2	**DESIGN OF SHAFTS AND COUPLINGS**	**CO2**	**12 Hrs**

Design of Solid and Hollow Shafts based on Strength , Rigidity , Stiffness - critical speed – types of keys,Design of Keys and Key Ways – Failure of keys - Couplings- Rigid and Flexible.

Unit – 3	**DESIGN OF THREADED JOINTS AND PERMANENT JOINTS**	**CO3**	**12 Hrs**

Threaded Fasteners – Design of Bolted Joints, Eccentric Loading – Design of Welded Joints – Axially Loaded Unsymmetrical Welded Joints - Eccentric Load in the Plane of Welds - Welded Joint Subjected to Bending Moment and Twisting Moment- Design of Riveted Joints -modes of failure, strength and efficiency.

Unit – 4	**DESIGN OF SPRINGS and BEARINGS**	**C04**	**12 Hrs**

Design of Helical Spring - Design of Leaf Spring - - Design of Torsional Spring, Constant Loads and varying loads –. Design Of Bearings, Preloading-Design Of Rolling Contact Bearings, Load Carrying Capacity , Bearing Life, Cubic Mean Load - Design of Journal Bearing, Mckee'S Equation,Bearing Materials.

Unit – 5	**DESIGN OF Jig, fixture and Die set**	**C05**	**12 Hrs**

Design of jigs – design of fixtures – design of punch and die set- design of patterns – design of molding-Introduction about forming dies-introduction of mold flow software.

Total Hours	**45**

Textbooks:

1	Bhandari V.B., "Design of Machine Elements", 5th Edition, Tata McGraw-Hill, New Delhi, 2020.
2	Richard G Budynas, J Keith Nisbett , "Shigley's Mechanical Engineering Design", 10th Edition,McGraw Hill Publishers Co. Ltd, 2017.

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Reference Books:	
1	Shigley J.E. and Mischke C.R., "Mechanical Engineering Design", 11th Edition, McGraw Hill International Education,New York, 2020.
2	Robert L. Norton., "Machine Design", 5th Edition, Pearson, Chennai, 2018.
Web References:	
1	

Assessment based on Continuous and End Semester Examination						
Bloom's Level	**Continuous Assessment**			**Assignment**	**Attendance**	**End Semester Examination**
	CIA1 (6 Marks)	**CIA2 (6 Marks)**	**Model Exam (8 Marks)**			
Remember				**(10 Marks)**	**(10 Marks)**	**(60 Marks)**
Understand	6	2	2			
Apply		4	6			
Analyze						
Evaluate						
Create						
Total (100 Marks)	**6**	**6**	**8**	**10**	**10**	**60**

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject.

COs/ POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PS O3**
C101.1	**3**	**3**	**3**	**3**								**3**	**3**	**3**	
C101.2	**3**	**3**	**3**	**3**								**3**	**3**	**3**	
C101.3	**3**	**3**	**3**	**3**								**3**	**3**	**3**	
C101.4	**3**	**3**	**3**	**3**								**3**	**3**	**3**	
C101.5	**3**	**3**	**3**	**3**								**3**	**3**	**3**	

Course Code	**Course Name**	**Category**	**Hours/Week**			**C**
			L	**T**	**P**	
24ME452	Heat and Mass Transfer	PC	3	1	0	4
Regulation	Nature of the Course	Semester	Data Book/Codes/Standards			
	Analytical	V	HMT Data Book			

Pre-requisite Course(s)	Co-requisite Course(s)
Engineering Thermodynamics	

Course Objectives

1	To Learn the principal mechanism of heat transfer under steady state and transient conditions.
2	To learn the fundamental concept and principles in convective heat transfer.
3	To learn the theory of phase change heat transfer and design of heat exchangers.
4	To study the fundamental concept and principles in radiation heat transfer.
5	To develop the basic concept and diffusion, convective di mass transfer.

Course Outcomes

Upon completion of the course, students will be able to

CXXX.1	Apply heat conduction equations to different surface configurations under steady state and transient conditions and solve problems.	[AP]
CXXX.2	Apply free and forced convective heat transfer correlations to internal and external flows through/over various surface configurations and solve problems.	[AP]
CXXX.3	Explain the phenomena of boiling and condensation, apply LMTD and NTU methods of thermal analysis to different types of heat exchanger configurations and solve problems.	[AP]
CXXX.4	Explain basic laws for Radiation and apply these principles to radiative heat transfer between different types of surfaces to solve problems.	[AP]
CXXX.5	Apply diffusive and convective mass transfer equations and correlations to solve problems for different applications.	[AP]

Course Contents

Unit – 1	**CONDUCTION**	**CO1**	**12 Hrs**
Conduction General Differential equations, Steady and Unsteady State Heat Conduction, Conduction with Internal Heat Generation, Extended Surfaces, Lumped Analysis Semi Infinite and Infinite Solids.			
Unit – 2	**CONVECTION**	**CO2**	**12 Hrs**
Conservation Equations, Boundary Layer Concept – Forced Convection: External Flow – Flow over Plates, Cylinders Spheres and Bank of tubes. Internal Flow – Entrance effects. Free Convection – Flow over Vertical Plate, Horizontal Plate, Inclined Plate, Cylinders and Spheres. Mixed Convection.			
Unit – 3	**PHASE CHANGE HEAT TRANSFER AND HEAT EXCHANGERS**	**CO3**	**12 Hrs**
Nusselt's theory of condensation- Regimes of Pool boiling and Flow boiling - Correlations in boiling and condensation. Heat Exchanger Types – TEMA Standards - Overall Heat Transfer Coefficient – Fouling Factors. LMTD and NTU methods. Fundamentals of Heat Pipes and its applications.			
Unit – 4	**RADIATION**	**C04**	**12 Hrs**
Introduction to Thermal Radiation - Radiation laws and Radiative properties - Black Body and Gray body Radiation - Radiosity - View Factor Relations. Electrical Analogy. Radiation Shields.			
Unit – 5	**MASS TRANSFER**	**C05**	**12 Hrs**
Basic Concepts – Diffusion Mass Transfer – Fick's Law of Diffusion – Steady state and Transient Diffusion - Stefan flow –Convective Mass Transfer – Momentum, Heat and Mass Transfer Analogy – Convective Mass Transfer Correlations.			
		Total Hours	**45**

Textbooks:

1	R.C. Sachdeva, "Fundamentals of Engineering Heat & Mass transfer", New Age International Publishers, 2009
2	Yunus A. Cengel, "Heat Transfer A Practical Approach" – Tata McGraw Hill, 5thEdition – 2013.

Reference Books:

1	Frank P. Incropera and David P. Dewitt, "Fundamentals of Heat and Mass Transfer", John Wiley & Sons, 7th Edition, 2014.
2	Holman, J.P., "Heat and Mass Transfer", Tata McGraw Hill, 2010.
3	Kothandaraman, C.P., "Fundamentals of Heat and Mass Transfer", New Age International, New Delhi, 2012.
4	Ozisik, M.N., "Heat Transfer", McGraw Hill Book Co., 1994.
5	S.P. Venkateshan, "Heat Transfer", Ane Books, New Delhi, 2014.

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Web References:	
1	

Assessment based on Continuous and End Semester Examination						
BLOOM'S TAXONOMY LEVEL	**CONTINUOUS ASSESSMENT**			**ASSIGNMENT**	**ATTENDANCE**	**END SEMESTER EXAMINATION**
	CIA1 (6 Marks)	**CIA2 (6 Marks)**	**Model Exam (8 Marks)**	**(10 Marks)**	**(10 Marks)**	**(60 Marks)**
Remember				10	10	60
Understand	2	2	4			
Apply	4	4				
Analyze						
Evaluate						
Create						
Total (100 Marks)	6	6	8	10	10	60

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject.

COs/ POs	**PO 1**		**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**		**PO 11**	**PSO 1**	**PSO 2**	**PSO 3**
CXXX.1	3		3	3	3	3							3	2	2	1
CXXX.2	3		3	3	3	3	3						3	2	2	1
CXXX.3	3		3	3	3	3	3						3	2	2	2
CXXX.4	3		3	3	3	3	3						3	2	2	
CXXX.5	3		3	3	3	3	3						3	2	2	2

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

Course Code	**Course Name**	**Category**	**Hours/Week**			**C**
			L	**T**	**P**	
24ME453	**Metrology and Measurements**	**PCC**	**3**	**0**	**0**	**3**
Regulation	**Nature of the Course**	**Semester**	**Data Book/Codes/Standards**			
R24	**PCC**	**V**	**--------**			
Pre-requisite Course(s)		**Co-requisite Course(s)**				
Engineering Measurements		Manufacturing Technology				
Course Objectives						

1	To develop knowledge of measurement principles, instruments, and techniques for evaluating engineering dimensions and surface characteristics.	
2	To apply concepts of tolerancing, limits & fits, and uncertainty analysis in inspection and quality control.	
3	To understand and utilize advanced metrology systems for modern manufacturing and precision measurement.	
Course Outcomes **Upon completion of the course, students shall have ability to**		
C101.1	Discuss measurement concepts for application in various metrological instruments.	[U]
C101.2	Apply principles of linear and angular measuring instruments for assembly and transmission elements.	[AP]
C101.3	Apply tolerance symbols and perform tolerance analysis in industrial applications.	[AP]
C101.4	Apply principles and methods of form and surface metrology.	[AP]
C101.5	Apply advanced measurement techniques for quality control in manufacturing industries.	[AP]
Course Contents		
Unit – 1	**BASICS OF METROLOGY**	**9**
Measurement – Need, Process, Role in quality control; Factors affecting measurement - SWIPE; Errors in Measurements – Types – Control – Measurement uncertainty – Types, Estimation, Problems on Estimation of Uncertainty, Statistical analysis of measurement data, Measurement system analysis, Calibration of measuring instruments, Principle of air gauging- ISO standards.		
Unit – 2	**MEASUREMENT OF LINEAR, ANGULAR DIMENSIONS**	**9**
Linear Measuring Instruments – Vernier caliper, Micrometer, Vernier height gauge, Depth Micrometer, Bore gauge, Telescoping gauge; Gauge blocks – Use and precautions, Comparators – Working and advantages; Opto-mechanical measurements using measuring microscope and Profile projector - Angular measuring instruments – Bevel protractor, Clinometer, Angle gauges, Precision level, Sine bar, Autocollimator, Angle dekkor, Alignment telescope.		
Unit – 3	**TOLERANCE ANALYSIS**	**9**
Tolerancing– Interchangeability, Selective assembly, Tolerance representation, Terminology, Limits and Fits, Problems (using tables IS919); Design of Limit gauges, Problems. Tolerance analysis in manufacturing, Process capability, tolerance stackup, tolerance charting**.**		
Unit – 4	**METROLOGY OF SURFACES**	**9**
Fundamentals of GD & T- Conventional vs Geometric tolerance, Datums, Inspection of geometric deviations like straightness, flatness, roundness deviations; Simple problems – Measurement of Surface finish – Functionality of surfaces, Parameters, Comparative, Stylus based and Optical Measurement techniques, Filters, Introduction to 3D surface metrology- Parameters.		
Unit – 5	**ADVANCES IN METROLOGY**	**9**
Lasers in metrology - Advantages of lasers – Laser scan micrometers; Laser interferometers – Applications – Straightness, Alignment; Ball bar tests, Computer Aided Metrology - Basic concept of CMM – Types of CMM – Constructional features – Probes – Accessories – Software – Applications – Multisensor CMMs. Machine Vision - Basic concepts of Machine Vision System – Elements – Applications - On-line and in-process monitoring in production - Computed tomography – White light Scanners.		
	Total Hours	**45**
Textbooks:		
1	Gupta, I.C., Engineering Metrology, 7th Edition, Dhanpat Rai Publications, 2020.	
2	Jain, R.K., Engineering Metrology, 22nd Edition, Khanna Publishers, 2009.	
Reference Books:		
1	Raghavendra N.V. and Krishnamurthy. L., Engineering Metrology and Measurements, Oxford University Press, 2013.	
2	Venkateshan, S. P., "Mechanical Measurements", Second edition, John Wiley &Sons, 2015.	
Web References:		
1	https://www.mitutoyo.com/education	
2	https://hexagonmi.com/en/learn	

Assessment based on Continuous and End Semester Examination				
	Continuous Assessment	**Assignm**	**Attenda**	**End Semester**

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Bloom's Level	CIA1 (6 Marks)	CIA2 (6 Marks)	Model Exam (8 Marks)	ent	nce	Examination
Remember				(10 Marks)	(10 Marks)	(60 Marks)
Understand	2	2	2			
Apply	4	4	6			
Analyze						
Evaluate						
Create						
Total (100 Marks)	6	6	8	10	10	60

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject.

COs/ POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PSO 1	PSO 2	PSO3
C101.1	3	2	2									3	3	
C101.2	2	3	2	2								3	3	
C101.3	2	2	3	2	2	2						3	3	2
C101.4	2	2	2	3	2							3	3	2
C101.5	2	2	2	2	3	3	3	3	3	2	3	2	3	3

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24ME457	Computer Aided Design and Computer Aided Manufacturing	PC	3	0	2	4
Regulation	**Nature of the Course**	**Semester**	**Data Book/Codes/Standards**			
2024		V				
Pre-requisite Course(s)		**Co-requisite Course(s)**				
Engineering Graphics		Manufacturing Technology				
Course Objectives						
1	To understand the fundamentals of Computer Aided Design and Computer Aided Manufacturing systems.					

2	To develop 2D and 3D engineering models using CAD software tools.		
3	To understand geometric modeling techniques and engineering drafting concepts.		
4	To learn CNC programming and computer aided manufacturing processes.		
5	To integrate CAD and CAM concepts for modern product design and manufacturing applications.		
Course Outcomes **Upon completion of the course, students will be able to**			
CXXX.1	Understand the basic concepts of CAD/CAM systems and manufacturing automation.		[U]
CXXX.2	Create 2D drawings and 3D models using CAD software.		[AP]
CXXX.3	Prepare engineering drawings and assembly models for mechanical components.		[AP]
CXXX.4	Develop CNC programs and perform machining simulations using CAM software.		[AP]
CXXX.5	Apply CAD/CAM tools in product design and modern manufacturing industries.		[AP]
Course Contents			
Unit – 1	**Introduction to CAD/CAM**	**CO1**	**12 Hrs**
Introduction to CAD/CAM – Product development cycle – CAD hardware and software – Input and output devices – Computer graphics fundamentals – Coordinate systems – Geometric transformations – Applications and benefits of CAD/CAM.			
PRACTICAL: **Study and Practice of basic CAD/CAM software commands and interface.**			
Unit – 2	**Geometric Modeling and Drafting**	**CO2**	**12 Hrs**
Wireframe modeling – Surface modeling – Solid modeling – Curves and surfaces – Bezier curves – B-spline curves – Feature based modeling – Engineering drafting – Dimensioning and tolerancing.			
PRACTICAL: 1. Creation of 2D drawing and 3D solid model of a mechanical component.			
Unit – 3	**Computer Aided Manufacturing**	**CO3**	**12 Hrs**
Introduction to CAM – Group technology – Computer Aided Process Planning (CAPP) – Flexible Manufacturing Systems (FMS) – Computer Integrated Manufacturing (CIM) – Robotics in manufacturing – Automated material handling systems.			
PRACTICAL: Preparation of process planning and machining simulation using CAM software.			
Unit – 4	**CNC Technology and Part Programming**	**CO4**	**12 Hrs**
Introduction to CNC machines – Construction and working of CNC systems – Open loop and closed loop control systems – CNC coordinate systems – Manual part programming – G-codes and M-codes – CNC turning and milling operations.			
PRACTICAL: 1. **Writing and simulation of CNC turning and milling part programs using G-codes and M-codes.**			
Unit – 5	**CAD/CAM Integration and Application**	**CO5**	**12 Hrs**
CAD/CAM integration – Data exchange standards (IGES, STEP) – Tool path generation – Simulation and verification – Reverse engineering – Rapid prototyping and additive manufacturing – Industrial applications of CAD/CAM.			
PRACTICAL: **1. Generation of tool path and NC code for a CAD model using CAM software**			
	Total Theory Hours		**45**
Total Practical Hours			**15**
Textbooks:			
1	P.N. Rao, "CAD/CAM Principles and Applications", McGraw Hill Education,3rd edition,2017.		
2	Ibrahim Zeid, "CAD/CAM Theory and Practice", McGraw Hill, 2nd edtion,2009.		

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Reference Books:	
1	Mikell P. Groover, "Automation, Production Systems and Computer Integrated Manufacturing", Pearson Education, 5th edtion 2022.
2	Chris McMahon and Jimmie Browne, "CAD/CAM Principles, Practice and Manufacturing Management", Pearson Education.
Web References:	
1	https://nptel.ac.in/courses/112102101, https://www.autodesk.com/solutions/cad-cam

BLOOM'S TAXONOMY LEVEL	**ASSESMENT-1**			**ASSESMENT-2**		**ASSIGNMENT**	**ATTENDANCE**	**END SEMESTER EXAMINATION**
	CIA1	**CIA2**	**MODEL**	**LAB EXPERIMENTS**	**MODEL LAB EXAM**			
	6	**6**	**8**	**10**	**10**	**10**	**10**	**40**
Remember								
Understand								
Apply								
Analyze								
Evaluate								
Create								
Total(100Marks)	**6**	**6**	**8**	**10**	**10**	**10**	**10**	**40**

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 marks.
- Experiment wise laboratory completion 10 marks and Model lab exam will be conducted for 100 marks and the same will be converted to 10 marks.
- BTL mark split up may vary based on the nature of the subject.

COs/ POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PSO 1**	**PSO 2**	**PSO 3**
CXXX.1	3	3	3	2	3			2	2		3	3	3	
CXXX.2	3	3	3	2	3			2	2		3	3	3	
CXXX.3	3	3	3	2	3			2	2		3	3	3	
CXXX.4	3	3	3	2	3			2	2		3	3	3	
CXXX.5	3	3	3	2	3			2	2		3	3	3	

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

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24ME458	Heat and Mass Transfer Laboratory	PC	0	0	4	2

Regulation	Nature of the Course	Semester	Data Book/Codes/Standards
	Analytical	V	HMT Data Book

Pre-requisite Course(s)	Co-requisite Course(s)
Engineering Thermodynamics	

Course Objectives

1	To gain experimental knowledge of Predicting the thermal conductivity of solids and liquids.
2	To gain experimental knowledge of Estimating the heat transfer coefficient values of various fluids.
3	To gain experimental knowledge of Testing the performance of tubes in tube heat exchangers.

Course Outcomes

Upon completion of the course, students will be able to

CXXX.1	Conduct experiment on predicting the thermal conductivity of solids and liquids	[AN]
CXXX.2	Conduct experiment on estimating heat transfer coefficient values of various fluids.	[AN]
CXXX.3	Conduct experiment on testing the performance of tube-in-tube heat exchangers	[AN]
CXXX.4	Conduct experiment on evaluating radiative heat transfer properties.	[AN]
CXXX.5	Conduct experiment on calibrating temperature measurement devices.	[AN]

List of Experiments:		CO
1	Thermal conductivity measurement of pipe insulation using lagged pipe apparatus.	CO1
2	Determination of thermal conductivity of a composite wall, insulating powder, oils, and water.	CO1
3	Determination of heat transfer coefficient of air under natural convection and forced convection.	CO2
4	Heat transfer from pin-fin under natural and forced convection.	CO2
5	Determination of heat flux under pool boiling and flow boiling in various regimes.	CO3
6	Determination of heat transfer coefficient in film-wise and drop-wise condensation.	CO3
7	Determination of friction factor, heat transfer coefficient of cold/hot fluid and effectiveness of a tube-in-tube heat exchanger.	CO3
8	Determination of Stefan – Boltzmann constant.	CO4
9	Determination of emissivity of a grey surface.	CO4
10	Calibration of thermocouples / RTDs at standard reference temperatures.	CO5
Tools:		
	Total Hours	**60**

BLOOM'S	ASSESMENT	ATTENDANCE	END SEMESTER

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TAXONOMY LEVEL	EVALUATION OF LAB OBSERVATION, RECORD [75%]	MODEL LAB EXAM [25%]		EXAMINATION
	38	**12**	**10**	**40**
Remember	05		10	40
Understand	10	06		
Apply				
Analyze	25	06		
Evaluate				
Create				
Total (100 Marks)	**38**	**12**	**10**	**40**

COs/ POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CXXX. 1	3	3			3						3	3	2	2
CXXX. 2	3	3			3						3	3	2	3
CXXX. 3	3	3	3	3	3	3					3	3	2	2
CXXX. 4	3	3	3	3	3	3					3	3	2	2
CXXX. 5	3	3		3	3						3	3	2	2

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

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24ME459	Metrology and Measurements Laboratory	PC	**0**	**0**	**4**	**2**
Pre-requisite Course(s)		**Co-requisite Course(s)**				
Engineering Metrology / Metrology and Measurements (Theory)		**Engineering Metrology / Metrology and Measurements (Theory)**				
Course Objectives						
1	To develop skills in calibration and precise measurement using various measuring instruments and gauges.					

2	To understand and apply measurement techniques for linear, angular, thread, gear, and surface parameters.	
3	To gain hands-on experience with advanced measurement systems like CMM, optical instruments, and machine tool metrology for quality control.	
Course Outcomes Upon completion of the course, students shall have ability to		
C101.1	Apply calibration and use precision instruments for measurement.	[AP]
C101.2	Use measurement techniques to evaluate engineering features.	[AP]
C101.3	Perform machine tool metrology tests to assess accuracy.	[AP]
List of Experiments:		**CO**
1.	Calibration and use of measuring instruments – Vernier caliper, micrometer, Vernier height gauge – using gauge blocks	CO1
2.	Calibration and use of measuring instruments –micrometer, depth micrometer	CO1
3.	Calibration and use of measuring instruments –bore gauge, telescopic gauge.	CO1
4.	Measurement of linear dimensions using Comparators	CO2
5.	Measurement of angles using bevel protractor and sine bar	CO2
6.	Measurement of gear parameters – disc micrometers, gear tooth vernier caliper	CO3
7.	Measurement of screw thread parameters – Screw thread Micrometers and Three wire method '(floating carriage micrometer).	CO4
8.	Non-contact (Optical) measurement using Profile projector system	CO4
9.	Measurement of Surface finish in components manufactured using various processes (turning, milling, grinding, etc.,) using stylus based instruments.	CO5
10.	Machine tool metrology – Level tests using precision level; Testing of straightness of a machine tool guide way using Autocollimator, spindle tests	CO5
	Total Hours	**60**

Bloom's Taxonomy Level	**ASSESMENT**		**Attendance**	**End Semester**
	LAB EXPERIMENTS [75%]	**MODEL LAB EXAM [25%]**		
	38	**12**	**10**	**40**
Remember				
Understand				
Apply	100	100		
Analyze				
Evaluate				
Create				
Attendance				
Total (100 Marks)	**38**	**12**	**10**	**40**

COs/ POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO1 0**	**PO1 1**	**PSO 1**	**PSO 2**	**PSO3**
C101.1		2	2	3		**3**	**3**		1	**2**	**2**	**3**	**3**	
C101.2		2	2	3		**3**	**3**		1	**2**	**2**	**3**	**3**	
C101.3		2	2	3		**3**	**3**		1	**2**	**2**	**3**	**3**	

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SYLLABUS OF SIXTH SEMESTER

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24AM461	Machine Learning for Intelligent Systems	ES	3	0	0	3
Regulation	**Nature of the Course**	**Semester**	**Data Book/Codes/Standards**			
24	THEORY	VI				
Pre-requisite Course(s)		**Co-requisite Course(s)**				

Course Objectives

	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

Course Outcomes

Upon completion of the course, students shall have ability to

C501.1	Explain the philosophy of machine learning, types of learning, and evaluation metrics used in classification and regression problems along with applications of AI in robotics.	[U]
C502.2	Apply clustering and segmentation techniques such as K-means, Mean Shift, Agglomerative clustering, KNN, and PCA for pattern recognition and robotic guidance.	[AP]
C503.3	Analyze fuzzy sets, membership functions, fuzzy rules, and fuzzy logic operations for solving decision-making problems in robotics.	[AP]
C504.4	Develop artificial neural network models including multilayer perceptrons, backpropagation, and neuro-fuzzy systems for intelligent robotic applications.	[AP]
C505.5	Illustrate recurrent neural networks and reinforcement learning concepts including Markov decision process and Q-learning for robotic control problems.	[AP]

Course Contents

Unit – 1	Introduction To Machine Learning	9

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.

Unit – 2	Clustering And Segmentation Methods	9

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.

Unit – 3	Fuzzy Logic	9

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

Unit – 4	Neural Networks	9

Mathematical Models of Neurons, ANN architecture, Learning rules, Multi-layer Perceptrons, Back propagation, Introduction of Neuro-Fuzzy Systems, Architecture of Neuro Fuzzy Networks, Application Case Study of Neural Networks in Robotics.

Unit – 5	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 Hours	45

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Textbooks:	
1	Micheal Negnevitsky, Artificial Intelligence: A Guide to Intelligent Systems, 3rd Edition, Addision Wesley, England, 2011
2	Stuart J. Russell and Peter Norvig, Artificial Intelligence: A Modern Approach, 3rd Edition, Prentice Hall / Pearson Education, New Jersey, 2010. This book is widely used in universities and considered a standard AI textbook.
Reference Books:	
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.
3	Timothy J Ross, "Fuzzy Logic with Engineering Applications", 4th Edition, Chichester, 2011, Sussex Wiley.

Assessment based on Continuous and End Semester Examination						
Bloom's Level	**Continuous Assessment**			**Assignment**	**Attendance**	**End Semester Examination**
	CIA1 (6 Marks)	**CIA2 (6 Marks)**	**Model Exam (8 Marks)**			
Remember				**(10 Marks)**	**(10 Marks)**	**(60 Marks)**
Understand						
Apply						
Analyze						
Evaluate						
Create						
Total (100 Marks)				**10**	**10**	**60**

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject.

COs/ POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PS O1**	**PS O2**	**PS O3**
C501.1	3	2			1							2	1	
C502.2	3	3	2	2	2							3	2	
C503.3	2	3	2	1	1							2	2	
C504.4	3	3	3	2	2							3	3	
C505.5	3	3	3	2	2							3	3	

Course Code	**Course Name**	**Category**	**Hours/Week**			**C**
			L	**T**	**P**	
24AM462	Renewable Energy Technologies	PC	3	0	0	3

Regulation	Nature of the Course	Semester	Data Book/Codes/Standards
24	THEORY	VI	
Pre-requisite Course(s)		**Co-requisite Course(s)**	
Thermodynamics and Thermal Engineering		Heat and Mass Transfer	

Course Objectives

	To know the Indian and global energy scenario.
	To learn the various solar energy technologies and its applications.
	To educate the various wind energy technologies.
	To explore the various bio-energy technologies.
	To study the ocean and geothermal technologies.

Course Outcomes

Upon completion of the course, students shall have ability to

C501.1	Discuss the Indian and global energy scenario.	
C502.2	Describe the various solar energy technologies and its applications.	
C503.3	Explain the various wind energy technologies.	
C504.4	Explore the various bio-energy technologies.	
C505.5	Discuss the ocean and geothermal technologies.	

Course Contents

Unit – 1	**ENERGY SCENARIO**	9

Indian energy scenario in various sectors – domestic, industrial, commercial, agriculture, transportation and others – Present conventional energy status – Present renewable energy status Potential of various renewable energy sources-Global energy status-Per capita energy consumption - Future energy plans.

Unit – 2	**SOLAR ENERGY**	9

Solar radiation – Measurements of solar radiation and sunshine – Solar spectrum - Solar thermal collectors – Flat plate and concentrating collectors – Solar thermal applications – Solar thermal energy storage – Fundamentals of solar photo voltaic conversion – Solar cells – Solar PV Systems – Solar PV applications

Unit – 3	**WIND ENERGY**	9

Wind data and energy estimation – Betz limit - Site selection for windfarms – characteristics - Wind resource assessment - Horizontal axis wind turbine – components - Vertical axis wind turbine – Wind turbine generators and its performance – Hybrid systems – Environmental issues - Applications.

Unit – 4	**BIO-ENERGY**	9

Bio resources – Biomass direct combustion – thermochemical conversion - biochemical conversion mechanical conversion - Biomass gasifier - Types of biomass gasifiers - Cogeneration –- Carbonisation – Pyrolysis - Biogas plants – Digesters –Biodiesel production – Ethanol production - Applications.

Unit – 5	**OCEAN AND GEOTHERMAL ENERGY**	9

Small hydro - Tidal energy – Wave energy – Open and closed OTEC Cycles – Limitations – Geothermal energy – Geothermal energy sources - Types of geothermal power plants – Applications - Environmental impact.

Total Hours	45

Textbooks:

1	Fundamentals and Applications of Renewable Energy | Indian Edition, by Mehmet Kanoglu, Yunus A. Cengel, John M. Cimbala, cGraw Hill; First edition (10 December 2020), ISBN-10 : 9390385636
2	Renewable Energy Sources and Emerging Technologies, by Kothari, Prentice Hall India Learning Private Limited; 2nd edition (1 January 2011), ISBN-10 : 8120344707

Reference Books:

1	Godfrey Boyle, "Renewable Energy, Power for a Sustainable Future", Oxford University Press, U.K., 2012.
2	Rai.G.D., "Non-Conventional Energy Sources", Khanna Publishers, New Delhi, 2014.
3	Sukhatme.S.P., "Solar Energy: Principles of Thermal Collection and Storage", Tata McGraw Hill Publishing Company Ltd., New Delhi, 2009.
4	Tiwari G.N., "Solar Energy – Fundamentals Design, Modelling and applications", Alpha Science Intl Ltd, 2015.
5	Twidell, J.W. & Weir A., "Renewable Energy Resources", EFNSpon Ltd., UK, 2015.

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Assessment based on Continuous and End Semester Examination						
Bloom's Level	**Continuous Assessment**			**Assignment**	**Attendance**	**End Semester Examination**
	CIA1 (6 Marks)	**CIA2 (6 Marks)**	**Model Exam (8 Marks)**			
Remember				(10 Marks)	(10 Marks)	(60 Marks)
Understand	2	2	2			
Apply	4	4	6			
Analyze						
Evaluate						
Create						
Total (100 Marks)	6	6	8	10	10	60

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject.

COs/ POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PS O1**	**PS O2**	**PS O3**
C501.1	3	2			2						2	2	2	
C502.2	3	3	2	3	3						3	3	2	
C503.3	2	3	2	2	3						3	2	2	
C504.4	3	3	3	3	3						3	3	1	
C505.5	3	3	3	3	2						2	3	3	

VERTICAL 1

PROFESSIONAL ELECTIVES

MOBILITY SYSTEMS

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Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24ME501	AUTOMOTIVE MATERIALS, COMPONENTS, DESIGN AND TESTING	ES	3	0	0	3
Regulation	**Nature of the Course**	**Semester**	**Data Book/Codes/Standards**			
24	THEORY	VI				
Pre-requisite Course(s)		**Co-requisite Course(s)**				
Automobile Engineering, Design of Machine elements						

Course Objectives

1.	To study the functional requirements of engine components and suitable materials.
2.	To learn to design of cylinder and piston components.
3.	To learn to design of connecting rod and crank shaft.
4.	To learn to design of flywheel and valve train.
5.	To study the Engine Testing cycles, Emission measurement technologies.

Course Outcomes

Upon completion of the course, students shall have ability to

C601.1	Discuss the requirements of engine components and select suitable materials.	U
C601.2	Apply the concept of design to cylinder and piston components and solve problems.	AN
C601.3	Apply the concept of design to Connecting rod and crank shaft and solve problems.	AN
C601.4	Apply the concept of design to flywheel and valve train and solve problems.	AN
C601.5	Discuss engine teste cycles, dynamometer and emission measurement technologies and instruments	AP

Course Contents

Unit – 1	**FUNCTIONAL REQUIREMENTS OF ENGINE COMPONENTS AND SUITABLE MATERIALS**	9

Functional requirements of engine components – Piston, piston pin, cylinder liner, connecting rod, crank shaft, valves, spring, engine block, cylinder head, and flywheel. Suitable materials for engine components.

Unit – 2	**DESIGN OF CYLINDER AND PISTON COMPONENTS**	9

Design of cylinder, cylinder head, piston, piston rings and piston pin – more details in necessary.

Unit – 3	**DESIGN OF CONNECTING ROD AND CRANK SHAFT**	9

Design of connecting rod – Shank design – small end design – big end design – bolts design. Design of overhang crank shaft under bending and twisting – Crank pin design – Crank web design – Shaft design.

Unit – 4	**DESIGN OF FLYWHEEL AND VALVE TRAIN**	9

Design of valve – inlet valve – exhaust valve - Valve springs – tappet – rocker arm. Determination of mass of flywheel for a given coefficient of fluctuation of speed. Design of flywheel - rim - hub - arm.

Unit – 5	**ENGINE TESTING**	9

Engine test cycles – WLTC – WHSC – WHVC – NRTC – ISO 8178. Dynamometer - Chassis dynamometer - transient dynamometer. Emission measurement technologies and instruments - NOX – Smoke – Particulate matter – CO – CO2 - HC.-Particle counter.

Total Hours	45

Textbooks:

1	Khurmi. R.S. & Gupta. J.K., "A text book of Machine Design", Eurasia Publishing House (Pvt) Ltd, 2001.
2	The Automotive Chassis: Volume 1: Components Design (Mechanical Engineering Series) by Giancarlo Genta and Lorenzo Morello | 24 December 2019.

Reference Books:

1	Hiroshima Yamagata, "The science and technology of materials in automotive engines", Woodhead Publishing Limited, Cambridge, England.

2	Manufacturing Automotive Components from Sustainable Natural Fiber Composites (SpringerBriefs in Materials) by Lobna A. Elseify, Mohamad Midani, et al. | 9 August 2021
3	Advanced Technology for Design and Fabrication of Composite Materials and Structures: Applications to the Automotive, Marine, Aerospace and Applications of Fracture Mechanics) by George C. Sih, Alberto Carpinteri, et al. | 15 December 2010.
4	Mechanical and Materials Engineering of Modern Structure and Component Design (Advanced Structured Materials Book 70) by Andreas Öchsner and Holm Altenbach | 6 June 2015.

Assessment based on Continuous and End Semester Examination						
Bloom's Level	**Continuous Assessment**			**Assignment**	**Attendance**	**End Semester Examination**
	CIA1 (6 Marks)	**CIA2 (6 Marks)**	**Model Exam (8 Marks)**			
Remember				**(10 Marks)**	**(10 Marks)**	**(60 Marks)**
Understand	6	2	2			
Apply		4	6			
Analyze						
Evaluate						
Create						
Total (100 Marks)	6	6	8	**10**	**10**	**60**

CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
BTL mark split up may vary based on the nature of the subject.

COs/ POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PS O3**
C601.1	3	2	3	2	2				*1*			*1*	3	3	2
C601.2	3	2	3	2	2				*1*			*1*	3	3	2
C601.3	3	2	3	2	2				*1*			*1*	3	3	2
C601.4	3	2	3	2	2				*1*			*1*	3	3	2
C601.5	3	2	3	2	2				*1*			*1*	3	3	2

Course Code	**Course Name**	**Category**	**Hours/Week**			**C**
			L	**T**	**P**	
24ME502	**CONVENTIONAL AND FUTURISTIC VEHICLE TECHNOLOGY**	**PE**	**3**	**0**	**0**	**3**
Regulation	**Nature of the Course**	**Semester**	**Data Book/Codes/Standards**			
24	**Theory**	**V**				
Pre-requisite Course(s)		**Co-requisite Course(s)**				
Course Objectives						
1	To study the advanced engine technologies.					
2	To learn various advanced combustion technologies and its benefits.					

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3	To learn the methods of using low carbon fuels and its significance.
4	To learn and understand the hybrid and electric vehicle configurations.
5	To study the application of fuel cell technology in automotives

Course Outcomes

Upon completion of the course, students will be able to

C502.1	Discuss the latest trends in engine technology	AP
C502.2	Discuss the need of advanced combustion technologies and its impact on reducing carbon foot-print on the environment	AP
C502.3	Analyzing the basic characteristics of low carbon fuels, its impact over conventional fuels and in achieving sustainable development goals.	AN
C502.4	Discuss the working and energy flow in various hybrid and electric configurations.	AP
C502.5	Analyzing the need for fuel cell technology in automotive applications.	AN

Course Contents

Unit – 1	**ADVANCED ENGINE TECHNOLOGY**	**CO1**	**9 Hrs**
Gasoline Direct Injection, Common Rail Direct Injection, Variable Compression Ratio Turbocharged Engines, Electric Turbochargers, VVT, Intelligent Cylinder De-activation, After Treatment Technologies, Electric EGR, Current EMS architecture			
Unit – 2	**COMBUSTION TECHNOLOGY**	**CO2**	**9 Hrs**
Spark Ignition combustion, Compression Ignition Combustion, Conventional Dual Fuel Combustion, Low Temperature Combustion Concepts– Controlled Auto Ignition, Homogeneous Charge Compression Ignition, Premixed Charge Compression Ignition, Partially Premixed Compression Ignition, Reactivity Controlled Compression Ignition, Gasoline Direct Injection Compression Ignition.			
Unit – 3	**LOW CARBON FUEL TECHNOLOGY**	**CO3**	**9 Hrs**
Alcohol Fuels, Ammonia Fuel and Combustion, Methane Technology, Dimethyl Ether, Hydrogen Fuel Technology, Challenges, and way forward			
Unit – 4	**HYBRID AND ELECTRIC VEHICLE (BATTERY POWERED)**	**C04**	**9 Hrs**
Conventional Hybrids (Conventional ICE + Battery), Modern Hybrids (RCCI/GDCI Engine + Battery), Pure Electric Vehicle Technology – Challenges and Way forward			
Unit – 5	**FUEL CELL TECHNOLOGY**	**C05**	**9**

			Hrs
Fuel cells for automotive applications - Technology advances in fuel cell vehicle systems – Onboard hydrogen storage - Liquid hydrogen and compressed hydrogen - Metal hydrides, Fuel cell control system - Alkaline fuel cell - Road map to market.			
		Total Hours	**45**
Textbooks:			
1	Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.		
2	Rakesh Kumar Maurya, Characteristics and Control of Low Temperature Combustion Engines. ISBN 978-3-319-68507-6 , SPRINGER		
Reference Books:			
1	Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.		
2	James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003		
3	Rand D.A.J, Woods, R & Dell RM Batteries for Electric vehicles, John Wiley & Sons, 1998		
4	Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.		
5	James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003		

Assessment based on Continuous and End Semester Examination						
BLOOM'S TAXONOMY LEVEL	**CONTINUOUS ASSESSMENT**			**ASSIGNMENT**	**ATTENDANCE**	**END SEMESTER EXAMINATION**
	CIA1 (6 Marks)	**CIA2 (6 Marks)**	**Model Exam (8 Marks)**	**(10 Marks)**	**(10 Marks)**	**(60 Marks)**
Remember						
Understand						
Apply	**6**	**4**	**5**			
Analyze		**2**	**3**			
Evaluate						
Create						
Total (100 Marks)	**6**	**6**	**8**	**10**	**10**	**60**

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject.

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COs/ POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
C502.1	3	2	2	2	2				1		2	3	2	1
C502.2	3	2	2	2	2				1		2	3	2	1
C502.3	3	2	2	2	2				1		2	3	2	1
C502.4	3	2	2	2	2				1		2	3	2	1
C502.5	3	2	2	2	2				1		2	3	2	1

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

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24ME503	Renewable Powered Off Highway Vehicles and Emission Control Technology	PE	3	0	0	3
Regulation	Nature of the Course	Semester	Data Book/Codes/Standards			
	Theory	V				
Pre-requisite Course(s)		Co-requisite Course(s)				

Course Objectives

1	To study the low and zero carbon fuels suitability and methods of use in off-road vehicles.
2	To learn and understand the green energy production methodologies and its use in off-road vehicle categories.
3	To learn various fuel cell types and its suitability in off-highway vehicles applications.
4	To illustrate the impact of in-cylinder technologies on engine out emissions control.
5	To study the existing after-treatment technologies used in off-highway vehicle applications.

Course Outcomes

Upon completion of the course, students will be able to

CXXX.1	Evaluate the availability, suitability, and its role in off-road vehicle categories in reducing the carbon footprint on the environment.	[U]
CXXX.2	Gain the knowledge on various green energy production methods and its impact on meeting energy demand of off-road vehicle applications.	[U]

CXXX.3	Develop the working of fuel cell, various fuel cell types, and its design for off-road vehicle applications.	[U]
CXXX.4	Gain the knowledge on various in-cylinder low temperature combustion technologies and its key role in controlling the engine-out emissions.	[U]
CXXX.5	Develop the working of various existing aftertreatment systems in controlling the engine out emissions.	[U]

Course Contents

Unit – 1	**LOW AND ZERO CARBON FUELS POWERED OFF-HIGHWAY VEHICLES**	**CO1**	**9 Hrs.**
Ethanol, Methanol, Butanol, Biodiesel, CNG, LNG, DME, Polyoxymethylene Dimethyl Ether (PODE), Ammonia and Hydrogen Fuels suitability, methods, and technologies for powering off-road vehicles.			
Unit – 2	**GREEN ENERGY POWERED OFF-HIGHWAY VEHICLES**	**CO2**	**9 Hrs.**
Solar Technology for Green Electricity, Green Electricity for Hydrogen Production, Hydrogen Smart Grid Technologies, Hydrogen to ICE powered vehicles, Hydrogen to Fuel Cell Powered Vehicles.			
Unit – 3	**FUEL CELL POWERED OFF-HIGHWAY VEHICLES**	**CO3**	**9 Hrs.**
Fuel Cell, Types, Applications, Fuel Cell Requirement, Sizing and Design for Off-Highway applications, Merits and Demerits, Pathway to overcome the limitations. Scope of the fuel cell research on Off-road vehicle applications.			
Unit – 4	**IN-CYLINDER TREATMENT TECHNOLOGIES**	**C04**	**9Hrs.**
Low temperature Combustion Modes - Homogeneous Charge Compression Ignition, Premixed Charge Compression Ignition, Reactivity Controlled Compression Ignition, Gasoline Direct Injection Compression Ignition, Water Injection Technologies.			
Unit – 5	**AFTER TREATMENT TECHNOLOGIES**	**C05**	**9Hrs.**
Diesel Oxidation Catalyst, Diesel Particulate Filter, Selective Catalytic Reduction, Ammonia slip / clean up catalyst. CO2 absorption techniques, Waste Heat Recovery and Organic Rankine Cycle.			
	Total Hours		**45**

Textbooks:

1	John Twidell, and Tony Weir. Renewable Energy Sources – 3rd Edition 2015.
2	Rakesh Kumar Maurya, Characteristics and Control of Low Temperature Combustion Engines.

Reference Books:

1	Daniel J Holt. Fuel Cell Powered Vehicles: Automotive Technology of the Future. Society of Automotive Engineers, 2001 - Technology & Engineering.
2	W. Addy Majewski, Magdi K. Khair. Diesel Emissions and Their Control.
3	Toward Zero Carbon: The Chicago Central Area DeCarbonization Plan by Adrian Smith and Gordon Gill | 1 June 2011.

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4	Transportation in a Net Zero World: Transitioning Towards Low Carbon Public Transport (Green Energy and Technology) by Kathryn G. Logan, Astley Hastings, et al. | 7 April 2022.
5	The Political Economy of Low Carbon Transformation: Breaking the habits of capitalism (Routledge Studies in Low Carbon Development) by Harold Wilhite | 21 December 2017.
Web References:	
1	
2	

Assessment based on Continuous and End Semester Examination						
BLOOM'S TAXONOMY LEVEL	**CONTINUOUS ASSESSMENT**			**ASSIGNMENT**	**ATTENDANCE**	**END SEMESTER EXAMINATION**
	CIA1 (6 Marks)	**CIA2 (6 Marks)**	**Model Exam (8 Marks)**	**(10 Marks)**	**(10 Marks)**	**(60 Marks)**
Remember	3	3	4	10	10	60
Understand	3	3	4			
Apply						
Analyze						
Evaluate						
Create						
Total (100 Marks)	6	6	8	10	10	60

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject.

COs/ POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PSO 1**	**PSO 2**	**PSO 3**
CXXX.1	3	3	3	3	3	3	3				3	3	2	1
CXXX.2	3	3	3	3	3	3	3			3	3	3	2	2
CXXX.3	3	3	3	3	3	3	3			3	3	3	2	2

CXXX.4	3	3	3	3	3	3	3				3	3	3	2
CXXX.5	3	3	3	3	3	3	3			3		3	3	3

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

Course Code	Course Name	Category	L	T	P	C
24ME504	VEHICLE HEALTH MONITORING MAINTENANCE AND SAFETY	ES	3	0	0	3
Regulation	Nature of the course	Semester	DataBook/Codes/Standard			
24	Theory	V				
Pre-requisite Course(s)		Co-requisite Course(s)				

Course Objectives:

To enable the students:

To study the powertrain maintenance, fault diagnosis, maintenance of Batteries

To develop vehicle system maintenance and service of clutch, brake.

To study the concepts of vehicle safety and regulations.

To study and understand the simulation of safety concepts.

Course Outcomes

At the end of the course the students would be able to

Understand the knowledge of vehicle health monitoring, maintenance and safety	[U]
Able to process the maintenance of powertrain	[AP]
Ability to understand the maintenance of Vehicle system.	[AP]
Explain and stimulate the awareness of vehicle safety.	[AP]
Simulation of safety concepts.	[AP]

Course Contents

UNIT -1 INTRODUCTION (9)

Need for Maintenance – importance, classification of maintenance work-basic problem diagnosis. Maintenance of vehicle systems – power pack, tyres, safety systems. Scheduled maintenance services – service intervals – On-board diagnostics, Computerized engine analyzer study and practice- OBD and scan tools.

UNIT -2 POWERTRAIN MAINTENANCE (9)

Exhaust emission test of petrol and diesel engine; - Electronic fuel injection and engine management service - fault diagnosis- OBD-III and scan tool, identifying DTC and servicing emission controls, Maintenance of Batteries, Starting System, Charging System and Body Electrical -Fault Diagnosis Using Scan Tools.

UNIT -3 VEHICLE SYSTEM MAINTENANCE (9)

Clutch- adjustment and service, Maintenance and Service of Hydraulic brake, Bleeding of brakes, Checking ABS and components. Maintenance and Service of McPherson strut, coil spring. tyre wear, measurement of read depth and tyre rotation, Computerized wheel balancing & wheel alignment, Maintenance and Service of steering linkage, steering column, Rack and pinion steering .

UNIT -4 VEHICLE SAFETY (9)

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Concepts of vehicle safety -Seat belt, regulations, automatic seat belt tightener system, collapsible steeringcolumn, air bags, electronic system for activating air bags, bumper design for safety, Active Safety - ABS,EBD, CSC, Traction control system, Modern electronic features in vehicles like tyre pressure monitoring, Automatic headlamp ON, Rain sensing wipers.
UNIT -5 SIMULATION OF SAFETY CONCEPTS (9)
Active safety: driving safety, conditional safety, perceptibility safety, operating safety passive safety: exterior safety, interior safety, deformation behavior of vehicle body, speed and acceleration characteristics of passenger compartment on impact. Collision warning system, causes of rear end collision, frontal object detection, rear vehicle object detection system, object detection system with braking system Interactions.

Total Hours :	**45**

TEXT BOOKS :

1.Advanced Automotive Fault Diagnosis Automotive Technology: Vehicle Maintenance and Repair" By Tom Denton 5th Edition,

1. Safety Management System and Documentation Training Programme Handbook by S. V. Paul ISBN: 9788123923444

REFERENCE BOOKS :

1. Ed May, "Automotive Mechanics Volume One" and Two, Mc Graw Hill Publications, Tenth edition, 2018
2. Bosch Automotive Handbook, Tenth Edition, 2018
3. Jack Erjavek, "A systems approach to Automotive Technology", Cengage Learning, 5th Edition, 2012

William H. Crouse and Donald L. Anglin, "Automotive Mechanics", Tata McGraw Hill, 10thEdition 2004

Assessment based on Continuous and End Semester Examination

Bloom's Level	Continuous Assessment			Assignment	Attendance	End Semester Examination
	CIA1 (6 Marks)	CIA2 (6 Marks)	Model Exam (8 Marks)			
Remember				(10 Marks)	(10 Marks)	(60 Marks)
Understand	6	2	2			
Apply		4	6			
Analyze						
Evaluate						
Create						
Total (100 Marks)	**6**	**6**	**8**	**10**	**10**	**60**

● CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.

● The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.

- BTL mark split up may vary based on the nature of the subject.

COs/ POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
C101.1	3	3	3	3	3				3			3	3	3	3
C101.2	3	3	3	3	3				3			3	3	3	3
C101.3	3	3	3	3	3				3			3	3	3	3
C101.4	3	3	3	3	3				3			3	3	3	3
C101.5	3	3	3	3	3				3			3	3	3	3

Assessment based on Continuous and End Semester Examination						
BLOOM'S TAXONOMY LEVEL	CONTINUOUS ASSESSMENT			ASSIGNMENT	ATTENDANCE	END SEMESTER EXAMINATION
	CIA1 (6 Marks)	CIA2 (6 Marks)	Model Exam (8 Marks)	(10 Marks)	(10 Marks)	(60 Marks)
Remember						
Understand						
Apply	6	6	8			
Analyze						
Evaluate						
Create						
Total (100 Marks)	6	6	8	10	10	60

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject.

COs/ POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
C505.1	3	3	2	2	2			1		1	1	3	2	2
C505.2	3	3	2	2	2			1		1	1	3	2	2
C505.3	3	3	2	2	2			1		1	1	3	2	2
C505.4	3	3	2	2	2			1		1	1	3	2	2
C505.5	3	3	2	2	2			1		1	1	3	2	2

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

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Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24ME506	HYBRID AND ELECTRIC VEHICLE TECHNOLOGY	PE	3	0	0	3
Regulation	Nature of the Course	Semester	Data Book/Codes/Standards			
24	Theory	V				
Pre-requisite Course(s)		Co-requisite Course(s)				

Course Objectives

1	To introduce the concept of hybrid and electric drive trains.
2	To elaborate on the types and utilisation of hybrid and electric drive trains.
3	To expose on different types of AC and DC drives for electric vehicles.
4	To learn and utilise different types of energy storage systems
5	To introduce concept of energy management strategies and drive sizing

Course Outcomes

Upon completion of the course, students will be able to

C506.1	Discuss Characterise and configure hybrid drivetrains requirement for a vehicle	AP
C506.2	Design and apply appropriate hybrid and electric drive trains in a vehicle	AP
C506.3	Design and install suitable AC and DC drives for electric vehicles.	AP
C506.4	Discuss arrive at a suitable energy storage system for a hybrid / electric vehicle	AP
C506.5	Apply energy management strategies to ensure better economy and efficiency	AP

Course Contents

Unit – 1	**INTRODUCTION**	**CO1**	**9 Hrs**

Basics of vehicle performance, vehicle power source characterization, transmission characteristics, History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies

Unit – 2	**HYBRID ELECTRIC DRIVE TRAINS**	**CO2**	**9 Hrs**

Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis. Electric Drive-trains: Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis.

Unit – 3	**CONTROL OF AC & DC DRIVES**	**CO3**	**9**

			Hrs
Introduction to electric components used in hybrid and electric vehicles, Configuration, and control - DC Motor drives, Induction Motor drives, Permanent Magnet Motor drive, and Switch Reluctance Motor drives, drive system efficiency			
Unit – 4	**ENERGY STORAGE**	**C04**	**9 Hrs**
Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Energy storage and its analysis - Battery based, Fuel Cell based, and Super Capacitor based, Hybridization of different energy storage devices.			
Unit – 5	**DRIVE SIZING AND ENERGY MANAGEMENT STRATEGIES**	**C05**	**9 Hrs**
Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selection of appropriate energy storage technology, Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles, classification, and comparison of energy management strategies, Implementation issues.			
		Total Hours	**45**
Textbooks:			
1	Iqbal Husain, —Electric and Hybrid Vehicles: Design Fundamentals‖, Third Edition, 2021		
2	James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003		
Reference Books:			
1	Hybrid Electric Vehicle Design and Control: Intelligent Omnidirectional Hybrids (MECHANICAL ENGINEERING) by Yangsheng Xu , Jingyu Yan, et al. | 16 December 2013		

Assessment based on Continuous and End Semester Examination

BLOOM'S TAXONOMY LEVEL	**CONTINUOUS ASSESSMENT**			**ASSIGNMENT**	**ATTENDANCE**	**END SEMESTER EXAMINATION**
	CIA1 (6 Marks)	**CIA2 (6 Marks)**	**Model Exam (8 Marks)**	**(10 Marks)**	**(10 Marks)**	**(60 Marks)**
Remember						
Understand						
Apply	6	6	8			
Analyze						
Evaluate						
Create						
Total (100 Marks)	6	6	8	10	10	60

Course Code	**Course Name**	**Category**	**Hours/Week**			**C**
			L	**T**	**P**	
24ME505	Computer-Aided Engineering and Computational Fluid Dynamics Approach in	**PE**	**3**	**0**	**0**	**3**

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	Future Mobility					
Regulation	**Nature of the Course**	**Semester**	**Data Book/Codes/Standards**			
24	Theory	**V**				
Pre-requisite Course(s)		**Co-requisite Course(s)**				

Course Objectives

1	To study the use of computer in mobility software or mobility.
2	To study the concepts computer aided design and rapid prototyping
3	To introduce the basic concepts of the finite elements methods.
4	To introduce basics and fundamental of the computational fluid dynamics
5	To introduce Turbulence Modelling and various simulation techniques.

Course Outcomes

Upon completion of the course, students will be able to

C505.1	Discuss the basic concept of the CAE /CFD	AP
C505.2	Develop the computer aided design and rapid prototyping.	AP
C505.3	Discuss the basic concept of Finite Element methods.	AP
C505.4	Discuss the concepts of computational fluid dynamics	AP
C505.5	Solving the problem and simulation using computational fluid dynamics.	AP

Course Contents

Unit – 1	**INTRODUCTION TO CAE /CFD**	**CO1**	**9 Hrs**

Introduction to use of computer in Mobility Product Life Cycle, Software for mobility. Introduction to design process and role of computers in the design process, use of modern computational tools used for design and analysis, Concept of modelling and simulation. CFD as a design and research tool, Applications of CFD in mobility engineering.

Unit – 2	**CAD AND RAPID PROTOTYPING**	**CO2**	**9 Hrs**

Curves and Surfaces: Geometric modelling curves and surfaces, Wire frame models, Parametric representations, Parametric curves and surfaces, Solid modelling: Fundamentals of solid modelling, Different solid representation schemes, Boundary representation (B-rep), Constructive solid geometry (CSG). Mechanism design and assembly. CAD/CAM Data Exchange Formats: Types of file formats & their exchange, Graphics standards. CAD Data and Programming Techniques for RP: Transformations, Solid modelling for RP, Surface modelling, STL file generation, Defects in STL files and repairing algorithms, Interface formats

Unit – 3	**INTRODUCTION TO FEA**	**CO3**	**9 Hrs**

Basic Concept of Finite Element Method, Ritz and Rayleigh Ritz methods, Method of weighed residuals, Galerkin method. Governing differential equations of one- and two dimensional problems, One Dimensional Second Order Equations – Discretization – Linear and Higher order Elements – Interpolation and shape functions, Derivation of Shape functions and Stiffness matrices and force vectors-Assembly of Matrices - Solution of static problems and case studies in stress analysis of mechanical components using 2D and 3D elements

Unit – 4	**INTRODUCTION TO CFD**	**C04**	**9 Hrs**

CFD vs. experimentation; continuity, navier-stokes and energy equations; modelling and discretization techniques; basic steps in CFD computation Various simplifications, Dimensionless equations and parameters, Incompressible inviscid flows, Source panel method, and Vortex panel method. Conservation form of the equations, shock fitting and shock capturing, Time marching and space marching. 3-D structured and unstructured grid generation, mesh smoothing and sensitivity checks			
Unit – 5	**PROBLEM SOLVING USING CFD**	**C05**	**9 Hrs**
Turbulence Modelling, different turbulent modelling scheme. Incompressible Viscous Flows:, Applications to internal flows and boundary layer flows. Eddy viscosity and non-eddy viscosity models; Vehicle Aerodynamic Simulation Wind tunnel and on-road simulation of vehicles; Simulation of Ahmed and Windsor bodies; Vorticity based grid-free simulation technique; simulation in climatic and acoustic wind tunnels; velocity vector and pressure contour simulation			
	Total Hours		**45**

Textbooks:	
1	Computational Fluid Dynamics: A Practical Approach by Jiyuan Tu, Guan Heng Yeoh, Chaoqun Liu
2	Applied Computational Fluid Dynamics by S. C. Gupta
Reference Books:	
1	Groover, M. P., CAD/CAM: Computer-Aided Design and Manufacturing, Pearson Education, 2008
2	TirupathiR.Chandrupatla and Ashok D.Belegundu, "Introduction to Finite Elements in Engineering", International Edition, Pearson Education Limited, 2014.
3	Dhanaraj. R and Prabhakaran Nair. K, "Finite Element Analysis", Oxford Publications, 2015
4	Versteeg, H.K., and Malalasekera, W.,"An Introduction to Computational Fluid Dynamics": The finite volume Method, Pearson Education, 2014
5	Ghoshdastidar, P.S., "Computer Simulation of flow and heat transfer", Tata McGraw Hill, 1998

Assessment based on Continuous and End Semester Examination

BLOOM'S TAXONOMY LEVEL	**CONTINUOUS ASSESSMENT**			**ASSIGNMENT**	**ATTENDANCE**	**END SEMESTER EXAMINATION**
	CIA1 (6 Marks)	**CIA2 (6 Marks)**	**Model Exam (8 Marks)**	**(10 Marks)**	**(10 Marks)**	**(60 Marks)**
Remember						
Understand						
Apply	6	6	8			
Analyze						
Evaluate						
Create						
Total (100 Marks)	6	6	8	10	10	60

- IA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.

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- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject.

COs/ POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
C505.1	3	3	2	2	2			1		1	1	3	2	2
C505.2	3	3	2	2	2			1		1	1	3	2	2
C505.3	3	3	2	2	2			1		1	1	3	2	2
C505.4	3	3	2	2	2			1		1	1	3	2	2
C505.5	3	3	2	2	2			1		1	1	3	2	2

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

VERTICAL 2

PROFESSIONAL ELECTIVES

Sensors and Instrumentation

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Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24ME507	SENSORS AND INSTRUMENTATION	ES	3	0	0	3
Regulation	**Nature of the Course**	**Semester**	**Data Book/Codes/Standards**			
24	THEORY	VI				
Pre-requisite Course(s)		**Co-requisite Course(s)**				

Course Objectives

1.	To understand the concepts of measurement technology.
2.	To learn the various sensors used to measure various physical parameters.
3.	To learn the fundamentals of signal conditioning, data acquisition and communication systems used in mechatronics system development.
4.	To learn about the optical, pressure and temperature sensor.
5.	To understand the signal conditioning and DAQ systems.

Course Outcomes

Upon completion of the course, students shall have ability to

C601.1	Apply various calibration techniques and analyze different signal types used in sensors and transducers for measurement applications.	[AP]
C601.2	Demonstrate the working principles and operational characteristics of force, magnetic, heading, pressure, temperature, smart sensors, and transducers in engineering systems.	[AP]
C601.3	Utilize suitable sensors and transducers for solving real-time industrial and engineering application problems.	[AP]
C601.4	Select and justify appropriate sensors for specific engineering and automation applications based on performance characteristics and operating conditions.	[AP]
C601.5	Implement data acquisition systems to acquire, process, and interpret signals obtained from different sensors.	[AP]

Course Contents

Unit – 1	INTRODUCTION	9

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.

Unit – 2	MOTION, PROXIMITY AND RANGING SENSORS	9

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).

Unit – 3	FORCE, MAGNETIC AND HEADING SENSORS	9

Strain Gage, Load Cell, Magnetic Sensors –types, principle, requirement and advantages: Magneto resistive – Hall Effect – Current sensor Heading Sensors – Compass, Gyroscope, Inclinometers.

Unit – 4	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 – 5	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 Hours	45
Textbooks:	
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", Dhanpat Rai & Co, 12th edition New Delhi, 2013.
Reference Books:	
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	Richard Zurawski, "Industrial Communication Technology Handbook" 2nd edition, CRC Press, 2015.

Assessment based on Continuous and End Semester Examination						
Bloom's Level	**Continuous Assessment**			**Assignment**	**Attendance**	**End Semester Examination**
	CIA1 (6 Marks)	**CIA2 (6 Marks)**	**Model Exam (8 Marks)**			
Remember				**(10 Marks)**	**(10 Marks)**	**(60 Marks)**
Understand	6	2	2			
Apply		4	6			
Analyze						
Evaluate						
Create						
Total (100 Marks)	6	6	8	**10**	**10**	**60**

CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.

The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.

BTL mark split up may vary based on the nature of the subject.

COs/ POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PS O3**
C601.1	3	2	1	2	2	1	-	-	-	-	-	1	2	1	3
C601.2	3	2	1	*2*	2	1	-	-	-	-	-	1	2	1	3
C601.3	3	2	1	*1*	2	1	-	-	-	-	-	1	2	1	3
C601.4	3	2	1	*3*	2	1	-	-	-	-	-	1	2	1	3
C601.5	3	2	1	*3*	2	1	-	-	-	-	-	1	2	1	3

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Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24ME580	Electrical Drives and Actuators	PEC	3	0	0	3
Regulation	Nature of the Course	Semester	Data Book/Codes/Standards			
R24	PEC	V	--------			
Pre-requisite Course(s)		Co-requisite Course(s)				
Power Electronics		Electrical Machines				

Course Objectives

1	To understand relays, power semiconductor devices, and the drive characteristics of electrical systems.
2	To acquire knowledge of DC and AC motors along with their drive mechanisms and performance characteristics.
3	To study the principles and applications of special motors, including stepper and servo motors.

Course Outcomes

Upon completion of the course, students shall have ability to

C101.1	Explain the principles and working of relays, drives, and motors.	[U]
C101.2	Interpret the working and characteristics of various drives and motors.	[U]
C101.3	Apply the solid state switching circuits to operate various types of Motors and Drivers	[AP]
C101.4	Explain the performance of motors and drives.	[U]
C101.5	Apply appropriate motors and drives for given applications.	[AP]

Course Contents

Unit – 1	**RELAY AND POWER SEMI-CONDUCTOR DEVICES**	9

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

Unit – 2	**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 – 3	**DC MOTORS AND DRIVES**	9

DC Servomotor - Types of PMDC & BLDC motors - principle of operation- emf and torque equations - characteristics and control – Drives- H bridge - Single and Three Phases – 4 quadrant operation – Applications.

Unit – 4	**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 – 5	**STEPPER AND SERVO MOTOR**	9

Stepper Motor: Classifications- Construction and Principle of Operation – Modes of ExcitationDrive System-Logic Sequencer - Applications. Servo Mechanism – DC Servo motor-AC Servo motor – Applications.

Total Hours	**45**

Textbooks:

1	Bimbhra B.S., "Power Electronics", 7th Edition, Kanna Publishers, New Delhi, 2022
2	Mehta V.K. & Rohit Mehta, "Principles of Electrical Machines", 2nd Edition, S.Chand& Co. Ltd., New Delhi, 2016.

Reference Books:

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", 24th Edition, S.Chand& Co. Ltd., New Delhi, 2024.
3	Singh M.D. &Kanchandhani K.B., "Power Electronics", McGraw Hill, New Delhi, 2007
Web References:	
1	https://mrcet.com/downloads/digital_notes/EEE/31082020/Electrical%20Drives.pdf?utm_source=chatgpt.com
2	https://padeepz.net/mr3392-electrical-drives-and-actuators-pdf/?utm_source=chatgpt.com
3	https://abit.edu.in/wp-content/uploads/2025/08/electricaldrives.pdf?utm_source=chatgpt.com

Assessment based on Continuous and End Semester Examination						
Bloom's Level	**Continuous Assessment**			**Assignment**	**Attendance**	**End Semester Examination**
	CIA1 (6 Marks)	**CIA2 (6 Marks)**	**Model Exam (8 Marks)**			
Remember				**(10 Marks)**	**(10 Marks)**	**(60 Marks)**
Understand	2	2	2			
Apply	4	4	6			
Analyze						
Evaluate						
Create						
Total (100 Marks)	**6**	**6**	**8**	**10**	**10**	**60**

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject.

COs/ POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PSO 1**	**PSO 2**	**PSO3**
C101.1	3	3	2		2						2	3	2	
C101.2	3	3	3	2	2						2	3	2	
C101.3	3	3	3	2	3						2	3	3	
C101.4	3	3	2	2	3						2	3	3	
C101.5	3	2	2		3						3	3	3	2

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Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24ME452	Drone Technology	PE	3	0	0	3

Regulation	Nature of the Course	Semester	Data Book/Codes/Standards
	Analytical	V	

Pre-requisite Course(s)	Co-requisite Course(s)

Course Objectives

1	To understand the basics of drone concepts.
2	To learn and understand the fundaments of design, fabrication and programming of drone.
3	To impart the knowledge of an flying and operation of drone
4	To know about the various applications of drone
5	To understand the safety risks and guidelines of fly safely.

Course Outcomes

Upon completion of the course, students will be able to

CXXX.1	Know about a various type of drone technology, drone fabrication and programming.	[U]
CXXX.2	Execute the suitable operating procedures for functioning a drone.	[U]
CXXX.3	Select appropriate sensors and actuators for Drones.	[U]
CXXX.4	Develop a drone mechanism for specific applications.	[U]
CXXX.5	Create the programs for various drones.	[U]

Course Contents

Unit – 1	**INTRODUCTION TO DRONE TECHNOLOGY**	**CO1**	**9 Hrs.**

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 – 2	**DRONE DESIGN, FABRICATION AND PROGRAMMING**	**CO2**	**9 Hrs.**

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 – 3	**DRONE FLYING AND OPERATION**	**CO3**	**9 Hrs.**

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 – 4	**DRONE COMMERCIAL APPLICATIONS**	**CO4**	**9Hrs.**

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 – 5	**FUTURE DRONES AND SAFETY**	**CO5**	**9Hrs.**

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 Hours	**45**

Textbooks:

1	Daniel Tal and John Altschuld, “Drone Technology in Architecture, Engineering and Construction: A Strategic Guide to Unmanned Aerial Vehicle Operation and Implementation”, 2021 John Wiley & Sons, Inc.
2	Terry Kilby and Belinda Kilby, “Make:Getting Started with Drones “,Maker Media, Inc, 2016.

Reference Books:	
1	John Baichtal, "Building Your Own Drones: A Beginners' Guide to Drones, UAVs, and ROVs", Que Publishing, 2016 Zavrsnik, "Drones and Unmanned Aerial Systems: Legal and Social Implications for Security and Surveillance", Springer, 2018.
Web References:	
1	
2	

Assessment based on Continuous and End Semester Examination						
BLOOM'S TAXONOMY LEVEL	**CONTINUOUS ASSESSMENT**			**ASSIGNMENT**	**ATTENDANCE**	**END SEMESTER EXAMINATION**
	CIA1 (6 Marks)	**CIA2 (6 Marks)**	**Model Exam (8 Marks)**	**(10 Marks)**	**(10 Marks)**	**(60 Marks)**
Remember	3	3	4	10	10	60
Understand	3	3	4			
Apply						
Analyze						
Evaluate						
Create						
Total (100 Marks)	**6**	**6**	**8**	**10**	**10**	**60**

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject.

COs/ POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PSO 1**	**PSO 2**	**PSO 3**
CXXX.1	3	3				3	3	3	3	3	3	2	3	2
CXXX.2	3	3	3	3		3		3	3		3	3	3	2
CXXX.3	3	3	3	3	3	3	3	3	3		3	3	3	2
CXXX.4	3	3	3			3	3	3	3	3	3	3	3	3
CXXX.5	3	3				3	3	3	3	3	3	3	2	3

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

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Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24ME510	ROBOTICS	PE	3	0	0	3
Regulation	**Nature of the Course**	**Semester**	**Data Book/Codes/Standards**			
24	THEORY					
Pre-requisite Course(s)		**Co-requisite Course(s)**				

Course Objectives

	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

Course Outcomes

Upon completion of the course, students shall have ability to

C510.1	Explain the basic components, classification, architecture, workspace, and performance parameters such as accuracy, resolution, and repeatability of robots.	[U]
C510.2	Apply robot kinematics concepts including matrix representation, homogeneous transformation, and forward and inverse kinematics for planar and spatial robotic manipulators.	[AP]
C510.3	Analyze robot dynamics using Lagrange–Euler and Newton–Euler formulations for manipulator motion analysis.	[AN]
C510.4	Illustrate trajectory planning techniques, robot control concepts, and robot programming methods including the Robot Operating System.	[U]
C510.5	Evaluate robot sensors, actuators, power transmission systems, end effectors, and various industrial and service robot applications.	[AP]

Course Contents

Unit – 1	Basics of Robotics	9
Introduction- Basic components of robot-Laws of robotics- classification of robot- robot architecture, work space-accuracy-resolution –repeatability of robot.		
Unit – 2	Robot Kinmeatics	9
Robot kinematics: Introduction- Matrix representation- rigid motion & homogeneous transformation- D-H, forward & inverse kinematics of 2DOF and 3 DOF planar and spatial mechanisms		
Unit – 3	Robot Dynamics	9
Introduction - Manipulator dynamics – Lagrange - Euler formulation- Newton - Euler formulation		
Unit – 4	Trajectory, Path Planning and Programming	9
Trajectory Planning- Joint space and Cartesian space technique, Introduction to robot control, Robot programming and Languages- Introduction to ROS		
Unit – 5	Robot and Robot Applications	9
Sensors and Actuators for Robots, Power transmission systems, Rotary to rotary motion, Rotary to linear motion, Harmonics drives – gear system - belt drives. Robot end effectors & Grippers: Introduction- types & classification- Mechanical gripper- gripper force analysis- other types & special purpose grippers. Robot Applications: pick and place, manufacturing, automotive, medical, space and underwater.		
	Total Hours	45

Textbooks:

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.
Reference Books:	
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	Sathya Ranjan Deb, "Robotics Technology & flexible Automation" Second edition, Tata McGraw-Hill Publication, 2009.

Assessment based on Continuous and End Semester Examination						
Bloom's Level	**Continuous Assessment**			**Assignment**	**Attendance**	**End Semester Examination**
	CIA1 (6 Marks)	**CIA2 (6 Marks)**	**Model Exam (8 Marks)**			
Remember				**(10 Marks)**	**(10 Marks)**	**(60 Marks)**
Understand						
Apply						
Analyze						
Evaluate						
Create						
Total (100 Marks)				**10**	**10**	**60**

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject.

COs/ POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**	**PSO3**
C510.1	3	2			1							1	2	1	1
C510.2	3	3	2	2	2							1	3	2	2
C510.3	3	3	2	2	1							1	2	2	1
C510.4	3	3	2	2	2							1	3	3	1
C510.5	3	3	2	2	2							1	3	3	1

ourse Code	**Course Name**	**Category**	**Hours/Week**			**C**
			L	**T**	**P**	
24ME511	**SMART MOBILITY AND INTELLIGENT VEHICLES**	ES	3	0	0	3
Regulation	**Nature of the Course**	**Semester**	**Data Book/Codes/Standards**			
24	THEORY	VI				
Pre-requisite Course(s)		**Co-requisite Course(s)**				
Course Objectives						
1.	To introduce students to the various technologies and systems used to implement smart mobility and intelligent vehicles.					
2.	To learn Basics of Radar Technology and Systems, Ultrasonic Sonar Systems, LIDAR Sensor Technology and Systems and other sensors for automobile vision system.					
3.	To learn Basic Control System Theory applied to Autonomous Automobiles.					
4.	Apply the basic concepts of wireless communications and wireless data					

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	Networks	
5.	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.	
Course Outcomes **Upon completion of the course, students shall have ability to**		
C601.1	Recognize the concept of cyber-physical control systems and their application to collision avoidance and autonomous vehicles	[U]
C601.2	Select the concept of remote sensing and the types of sensor technology needed to implement remote sensing	[AP]
C601.3	Familiar with the concept of fully autonomous vehicles	[AP]
C601.4	Apply the basic concepts of wireless communications and wireless data networks	[AP]
C601.5	Analyze the concept of the connected vehicle and its role in automated vehicles.	[AP]
Course Contents		
Unit – 1	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 – 2	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 – 3	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 and Autonomy		
Unit – 4	VEHICLE WIRELESS TECHNOLOGY & 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 – 5	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 Hours	45
Textbooks:		
1	"Intelligent Transportation Systems and Connected and Automated Vehicles", 2016, Transportation Research Board.	
2	Radovan Miucic, "Connected Vehicles: Intelligent Transportation Systems", 2019, Springer.	
Reference Books:		
1	Ed May, "Automotive Mechanics Volume One" and Two, Mc Graw Hill Publications, Tenth edition, 2018	
2	Bosch Automotive Handbook, Tenth Edition, 2018	
3	Jack Erjavek, "A systems approach to Automotive Technology", Cengage Learning, 5th	

	Edition, 2012
4	William H. Crouse and Donald L. Anglin, "Automotive Mechanics", Tata McGraw Hill, 10thEdition, 2004

Assessment based on Continuous and End Semester Examination						
Bloom's Level	**Continuous Assessment**			**Assignment**	**Attendance**	**End Semester Examination**
	CIA1 (6 Marks)	**CIA2 (6 Marks)**	**Model Exam (8 Marks)**			
Remember				**(10 Marks)**	**(10 Marks)**	**(60 Marks)**
Understand	6	2	2			
Apply		4	6			
Analyze						
Evaluate						
Create						
Total (100 Marks)	6	6	8	**10**	**10**	**60**

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject.

COs/ POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PS O3**
C601.1	3	3	3	3		3						3	3	3	3
C601.2	3	3	3	3		3						3	3	3	3
C601.3	3	3	3	3		3						3	3	3	3
C601.4	3	3	3	3		3						3	3	3	3
C601.5	3	3	3	3		3						3	3	3	3

Course Code	**Course Name**	**Category**	**Hours/Week**			**C**
			L	**T**	**P**	
24ME512	HAPTICS AND IMMERSIVE TECHNOLOGIES	ES	3	0	0	3
Regulation	**Nature of the Course**	**Semester**	**Data Book/Codes/Standards**			
24	THEORY	VI				
Pre-requisite Course(s)		**Co-requisite Course(s)**				
Course Objectives						
1.	To learn various immersive technologies of VR, AR and MR.					
2.	To learn software related to immersive technologies.					
3.	To learn the concepts of developing AR applications.					
4.	To learn the concepts of developing VR and unreal engine.					
5.	To study the haptic perception and extended reality.					
Course Outcomes **Upon completion of the course, students shall have ability to**						
C601.1	Apply detailed knowledge about immersive technology					[AP]

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C601.2	Gaining the knowledge of different types of Tools and Devices	[AP]
C601.3	Acquiring the knowledge about Unity and Unreal Engine	[AP]
C601.4	Explain the developing application in immersive technologies	[AP]
C601.5	Discuss about haptics in immersive technologies	[AP]
Course Contents		
Unit – 1	INTRODUCTION TO IMMERSIVE TECHNOLOGIES	9
Introduction on Virtual reality – Augmented reality – Mixed reality – Extended reality – VR Devices – AR Devices – Applications		
Unit – 2	SOFTWARE TOOLS	9
Intro to Unity – Unity editor workspace – Intro to C# and visual studio - Programming in Unity – Intro to Unreal Engine – UE4 Editor workspace – Intro to Blueprint programming – Programming in Ue4		
Unit – 3	BUILDING AR APPLICATION WITH UNITY	9
AR SDKs for unity and unreal engine – Working with SDKs for unity – Developing AR application in unity - Building AR application		
Unit – 4	BUILDING VR APPLICATION WITH UNREAL ENGINE	9
VR SDKs for unity and unreal engine – Developing VR application in Ue4 – Building VR application		
Unit – 5	HAPTIC PERCEPTION AND EXTENDED REALITY	9
Extended Reality - Introduction to Haptics – Devices and possibilities – Custom Device development – Device Integration		
	Total Hours	45
Textbooks:		
1	Immersive Multimodal Interactive Presence, by Angelika Peer (Editor), Christos D. Giachritsis (Editor), Springer; 2012th edition (13 April 2014), ISBN-10 : 1447162137	
2	XR Haptics, Implementation & Design Guidelines, by Eric Vezzoli , Chris Ullrich , Gijs den Butter , Rafal Pijewski, March 13, 2022	
Reference Books:		
1	Practical Augmented Reality, by Steve Aukstakalnis, Addison-Wesley Professional; 1st edition (8 September 2016)	
2	Augmented Reality - Theory, Design and Development, by Chetankumar G Shetty.	
3	Strategic Communication and AI, by Simon Moore , Roland Hübscher, Routledge; 1st edition (10 September 2021), ISBN-10 : 0367627795	

Assessment based on Continuous and End Semester Examination						
Bloom's Level	**Continuous Assessment**			**Assignment**	**Attendance**	**End Semester Examination**
	CIA1 (6 Marks)	**CIA2 (6 Marks)**	**Model Exam (8 Marks)**			
Remember				**(10 Marks)**	**(10 Marks)**	**(60 Marks)**
Understand	6	2	2			
Apply		4	6			
Analyze						
Evaluate						
Create						
Total (100 Marks)	6	6	8	**10**	**10**	**60**

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject.

COs/ POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
C601.1	2	2	2		2								2	2	2
C601.2	2	2	2		2								3	2	2
C601.3	2	2	2		2								2	2	2
C601.4	2	2	2		2								3	2	2
C601.5	2	2	2		2								3	2	2

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VERTICAL 3

PROFESSIONAL ELECTIVES

DIGITAL AND GREEN MANUFACTURING

ourse Code	Course Name	Category	Hours/Week			C
			L	T	P	
24ME507	SENSORS AND INSTRUMENTATION	ES	3	0	0	3
Regulation	**Nature of the Course**	**Semester**	**Data Book/Codes/Standards**			
24	THEORY	VI				
Pre-requisite Course(s)		**Co-requisite Course(s)**				

Course Objectives

1.	To understand the concepts of measurement technology.
2.	To learn the various sensors used to measure various physical parameters.
3.	To learn the fundamentals of signal conditioning, data acquisition and communication systems used in mechatronics system development.
4.	To learn about the optical, pressure and temperature sensor.
5.	To understand the signal conditioning and DAQ systems.

Course Outcomes

Upon completion of the course, students shall have ability to

C601.1	Apply various calibration techniques and analyze different signal types used in sensors and transducers for measurement applications.	[AP]
C601.2	Demonstrate the working principles and operational characteristics of force, magnetic, heading, pressure, temperature, smart sensors, and transducers in engineering systems.	[AP]
C601.3	Utilize suitable sensors and transducers for solving real-time industrial and engineering application problems.	[AP]
C601.4	Select and justify appropriate sensors for specific engineering and automation applications based on performance characteristics and operating conditions.	[AP]
C601.5	Implement data acquisition systems to acquire, process, and interpret signals obtained from different sensors.	[AP]

Course Contents

Unit – 1	INTRODUCTION	9

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.

Unit – 2	MOTION, PROXIMITY AND RANGING SENSORS	9

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).

Unit – 3	FORCE, MAGNETIC AND HEADING SENSORS	9

Strain Gage, Load Cell, Magnetic Sensors –types, principle, requirement and advantages: Magneto resistive – Hall Effect – Current sensor Heading Sensors – Compass, Gyroscope, Inclinometers.

Unit – 4	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 – 5	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 Hours	45

Textbooks:

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”, Dhanpat Rai & Co, 12th edition New Delhi, 2013.

Reference Books:

1	C. Sujatha ... Dyer, S.A., Survey of Instrumentation and Measurement, John Wiley & Sons, Canada, 2001.

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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	Richard Zurawski, "Industrial Communication Technology Handbook" 2nd edition, CRC Press, 2015.

Assessment based on Continuous and End Semester Examination						
Bloom's Level	**Continuous Assessment**			**Assignment**	**Attendance**	**End Semester Examination**
	CIA1 (6 Marks)	**CIA2 (6 Marks)**	**Model Exam (8 Marks)**			
Remember				**(10 Marks)**	**(10 Marks)**	**(60 Marks)**
Understand	6	2	2			
Apply		4	6			
Analyze						
Evaluate						
Create						
Total (100 Marks)	6	6	8	**10**	**10**	**60**

CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
BTL mark split up may vary based on the nature of the subject.

COs/ POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PS O3**
C601.1	3	2	1	2	2	1	-	-	-	-	-	1	2	1	3
C601.2	3	2	1	*2*	2	1	-	-	-	-	-	1	2	1	3
C601.3	3	2	1	*1*	2	1	-	-	-	-	-	1	2	1	3
C601.4	3	2	1	*3*	2	1	-	-	-	-	-	1	2	1	3
C601.5	3	2	1	*3*	2	1	-	-	-	-	-	1	2	1	3

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24ME513	Digital Manufacturing and Internet of Things	PC	2	0	2	3

Regulation	Nature of the Course	Semester	Data Book/Codes/Standards
R24		VI	

Pre-requisite Course(s)	Co-requisite Course(s)

Course Objectives

1	To study the various aspects of digital manufacturing.
2	To inculcate the importance of DM in Product Lifecycle Management and Supply chain Management.
3	To formulate of smart manufacturing systems in the digital work environment.
4	To interpret IoT to support the digital manufacturing.
5	To elaborate the significance of digital twin.

Course Outcomes

Upon completion of the course, students will be able to

CXXX.1	Impart knowledge to use various elements in the digital manufacturing.	[U]
CXXX.2	Differentiate the concepts involved in digital product development life cycle process and supply chain management in digital environment.	[U]
CXXX.3	Select the proper procedure of validating practical work through digital validation in Factories.	[U]
CXXX.4	Implementation the concepts of IoT and its role in digital manufacturing.	[U]
CXXX.5	Analyze and optimize various practical manufacturing process through digital twin.	[U]

Course Contents

Unit – 1	**INTRODUCTION**	**CO1**	**6 Hrs.**

Introduction – Need – Overview of Digital Manufacturing and the Past – Aspects of Digital Manufacturing: Product life cycle, Smart factory, and value chain management – Practical Benefits of Digital Manufacturing – The Future of Digital Manufacturing.

PRACTICAL:

1. Measure the Distance Using Ultrasonic Sensor and Make Led Blink Using Arduino.

Unit – 2	**DIGITAL LIFE CYCLE & SUPPLY CHAIN MANAGEMENT**	**CO2**	**6 Hrs.**

Collaborative Product Development, Mapping Requirements to specifications – Part Numbering, Engineering Vaulting, and Product reuse – Engineering Change Management, Bill of Material and Process Consistency – Digital Mock up and Prototype development – Virtual testing and collateral. Overview of Digital Supply Chain - Scope& Challenges in Digital SC - Effective Digital Transformation - Future Practices in SCM.

PRACTICAL:

2. Detect the Vibration of an Object Using Arduino.

Unit – 3	**SMART FACTORY**	**CO3**	**6 Hrs.**

Smart Factory – Levels of Smart Factories – Benefits – Technologies used in Smart Factory – Smart Factory in IoT- Key Principles of a Smart Factory – Creating a Smart Factory – Smart Factories and Cybersecurity

PRACTICAL:

1. Sense a Finger When it is Placed on Board Using Arduino

Unit – 4	**INDUSTRY 4.0**	**CO4**	**6 Hrs.**

Introduction – Industry 4.0 –Internet of Things – Industrial Internet of Things – Framework: Connectivity devices and services – Intelligent networks of manufacturing – Cloud computing – Data analytics –Cyber physical systems –Machine to Machine communication – Case Studies.

PRACTICAL:

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2. Switch Light On and Off Based on the Input of User Using Raspberry Pi			
Unit – 5	**STUDY OF DIGITAL TWIN**	**CO5**	**6 Hrs.**
Basic Concepts – Features and Implementation – Digital Twin: Digital Thread and Digital Shadow- Building Blocks – Types – Characteristics of a Good Digital Twin Platform – Benefits, Impact & Challenges – Future of Digital Twins.			
PRACTICAL: 2. Connect with the Available Wi-Fi Using Arduino			
		Total Theory Hours	**30Hrs.**
		Total Practical Hours	**30Hrs.**

Textbooks:	
1	Zude Zhou, Shane (Shengquan) Xie and Dejun Chen, Fundamentals of Digital Manufacturing Science, Springer-Verlag London Limited, 2012.
2	Alasdair Gilchrist, "Industry 4.0: The Industrial Internet of Things", A press, 2016.
Reference Books:	
1	Lihui Wang and Andrew YehChing Nee, Collaborative Design and Planning for Digital Manufacturing, Springer-Verlag London Limited, 2009..
2	Andrew Yeh Chris Nee, Fei Tao, and Meng Zhang, "Digital Twin Driven Smart Manufacturing", Elsevier Science., United States, 2019.
3	Alp Ustundag and Emre Cevikcan, "Industry 4.0: Managing The Digital Transformation", Springer Series in Advanced Manufacturing., Switzerland, 2017
4	Ronald R. Yager and Jordan Pascual Espada, "New Advances in the Internet of Things", Springer., Switzerland, 2018.
5	Ronald R. Yager and Jordan Pascual Espada, "New Advances in the Internet of Things", Springer., Switzerland, 2018.
Web References:	
1	

BLOOM'S TAXONOMY LEVEL	**ASSESMENT-1**			**ASSESMENT-2**		**ASSIGNMENT**	**ATTENDANCE**	**END SEMESTER EXAMINATION**
	CIA1	**CIA2**	**MODEL**	**LAB EXPERIMENTS**	**MODEL LAB EXAM**			
	6	**6**	**8**	**10**	**10**	**10**	**10**	**40**
Remember							10	40
Understand	3	3	4	5	5	10		
Apply	3	3	4	5	5			
Analyze								
Evaluate								
Create								
Total(100Marks)	**6**	**6**	**8**	**10**	**10**	**10**	**10**	**40**

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and

Assignment III marks converted to 10 marks.

- Experiment wise laboratory completion 10 marks and Model lab exam will be conducted for 100 marks and the same will be converted to 10 marks.
- BTL mark split up may vary based on the nature of the subject.

COs/ POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CXXX.1	3	3	3	3	3	3	3				3	3	3	1
CXXX.2	3	3	3	3	3	3		3	3	3	3	3	2	3
CXXX.3	3	3	3	3	3	3	3	3	3		3	3	3	2
CXXX.4	3	3	3	3	3	3	3	3	3	3	3	3	3	2
CXXX.5	3	3	3	3	3	3	3	3	3	3	3	3	3	2

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

rse Code	Course Name	Category	Hours/Week			C
			L	T	P	
24ME514	LEAN MANUFACTURING	ES	3	0	0	3
Regulation	**Nature of the Course**	**Semester**	**Data Book/Codes/Standards**			
24	THEORY	VI				
Pre-requisite Course(s)		**Co-requisite Course(s)**				
Course Objectives						
1.	To introduce the basics of 6 SIGMA					
2.	To learning about the lean manufacturing tools.					
3.	To study about the deeper understanding methodologies of Lean manufacturing.					
4.	To study the lean concepts and its elements.					
5.	To learn implementation and challenges of lean manufacturing.					
Course Outcomes						
Upon completion of the course, students shall have ability to						
C601.1	Discuss the fundamentals and principles of Six Sigma methodology.					AP
C601.2	Elaborate on the principles and application of lean manufacturing tools.					AP
C601.3	Illustrate the methodologies for achieving a deeper understanding of Lean manufacturing.					AP
C601.4	Discuss lean concepts and its essential elements for process improvement.					AP
C601.5	Describe the implementation strategies and challenges associated with lean manufacturing.					AP
Course Contents						
Unit – 1	**BASICS OF 6 SIGMA**					9
Introduction to 6 Sigma, basic tools of six sigma like problem solving approach, standard deviation, normal distribution, various sigma levels with some examples, value for the enterprise, Variation, and sources of variation, Mean and moving the mean, Various quality costs, cost of poor quality.						
Unit – 2	**INTRODUCTION TO LEAN MANUFACTURING TOOLS**					9
Process Capability Indices, Cause and Effect diagram, Control Charts, Introduction to FMEA, APQP, PPAP. 3 foundational 6 Sigma methodologies: DMAIC, DMEDI, and Process Management DMEDI for process creation, DMAIC for process improvement and PDCA for sustaining improvements.						
Unit – 3	**DEEPER UNDERSTADING METHODOLOGIES**					9
What is a process, Why Process management, Keys to process management, Difference between process management and 6 Sigma, Introduction to Deming cycle, PDCA, DMAIC and continuous improvement, DMEDI for creation process, DMAIC Vs DMEDI with examples, Introduction to Toyota Production System, Six Sigma and Production System integration.						
Unit – 4	**LEAN ELEMENTS**					9

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Introduction to Lean Concepts like In-Built Quality, Concept of Right Part at the Right Time, Lead Time reduction, Optimum utilization of Capital, Optimum utilization of People. Understanding the Zero-defect concept and Metrics, Focus on Human Resources, Quality, Delivery, Cost. Building Zero defect capabilities, Cultural and Organizational aspects.		
Unit – 5	**IMPLEMENTATION AND CHALLENGES**	9
Implementing Checks and Balances in the process, Robust Information Systems, Dashboard, follow up and robust corrective and preventive mechanism. Concept of Audits, and continuous improvement from gap analysis, risk assessments etc.		
	Total Hours	45
Textbooks:		
1	Quality Planning and Analysis- JM Juran& FM Gryna. Tata Mc Graw Hill	
2	Lean Manufacturing: Principles to Practice by Akhilesh N. Singh, Bibliophile SouthAsia	
Reference Books:		
1	Quality Council of India https://qcin.org/ & its library. https://qcin.org/nbqp/knowledge_bank/	
2	International Society of Six Sigma Professionals: https://isssp.org/about-us/	
3	NPTEL / SWAYAM: https://nptel.ac.in/courses/110105123 : Six Sigma, Prof. Jitesh J Thakkar, IIT Kharagpur, Certification course. (Self- Learning).	

Assessment based on Continuous and End Semester Examination						
Bloom's Level	**Continuous Assessment**			**Assignment**	**Attendance**	**End Semester Examination**
	CIA1 (6 Marks)	**CIA2 (6 Marks)**	**Model Exam (8 Marks)**			
Remember				**(10 Marks)**	**(10 Marks)**	**(60 Marks)**
Understand	6	2	2			
Apply		4	6			
Analyze						
Evaluate						
Create						
Total (100 Marks)	6	6	8	**10**	**10**	**60**

CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
BTL mark split up may vary based on the nature of the subject.

COs/ POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PS O3**
C601.1	1	1	2	1	1				1		3	1	1	2	1
C601.2	1	1	2	1	1				1		3	1	1	2	1
C601.3	1	1	2	1	1				1		3	1	1	2	1
C601.4	1	1	2	1	1				1		3	1	1	2	1
C601.5	1	1	2	1	1				1		3	1	1	2	1

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24ME515	Modern Robotics	PEC	2	0	2	3
Regulation	Nature of the Course	Semester	Data Book/Codes/Standards			
R24			--------			

Pre-requisite Course(s)	Co-requisite Course(s)
Theory of Machines	Mechatronics and Control Systems

Course Objectives

1	To understand the fundamentals of robotics, including history, robot anatomy, kinematics, and simulation techniques.
2	To study robot grasping, manipulation, and mobile robot operations for various robotic applications.
3	To explore the applications of industrial, service, and domestic robots in modern engineering systems.

Course Outcomes

Upon completion of the course, students shall have ability to

C101.1	Discuss the definition, history of robotics and robot anatomy.	[U]
C101.2	Develop the simulation of robot kinematics	[AP]
C101.3	Describe the grasping and manipulation of robots.	[U]
C101.4	Explain about mobile robot and manipulation.	[U]
C101.5	Discuss the applications of industrial, service, domestic robots.	[U]

Course Contents

Unit – 1	**INTRODUCTION**	9

Robot: Definition, History of Robotics, Robot Anatomy, Co-ordinate systems, types and classification, Configuration space and degrees of freedom of rigid bodies and robots, Configuration space topology and representation; configuration and velocity constraints; task space and workspace, Rigid-body motions, rotation matrices, angular velocities, and exponential coordinates of rotation, Homogeneous transformation matrices.

Unit – 2	**SIMULATION OF ROBOT KINEMATICS**	9

Robot kinematics, Forward and inverse kinematics (two three four degrees of freedom), Forward and inverse kinematics of velocity, Homogeneous transformation matrices, translation and rotation matrices Dennavit and Hartenberg (D-H) transformation, Dynamics of Open Chains, Trajectory Generation, motion planning, robot control: First- and second-order linear error dynamics, stability of a feedback control system.

Unit – 3	**GRASPING AND MANIPULATION OF ROBOTS**	**9**

Kinematics of contact, contact types (rolling, sliding, and breaking), graphical methods for representing kinematic constraints in the plane, and form-closure grasping, Coulomb friction, friction cones, graphical methods for representing forces and torques in the plane, End effectors, grippers, types of gripper, gripper force analysis, and examples of manipulation and grasping.

Unit – 4	**MOBILE ROBOTS**	9

Mobile robot, Wheeled Mobile Robots: Kinematic models of omnidirectional and non-holonomic wheeled mobile robots, Controllability, motion planning, feedback control of non-holonomic wheeled mobile robots; odometry for wheeled mobile robots; and mobile manipulation. Reference Trajectory generation, feed forward control.

Unit – 5	**APPLICATIONS OF ROBOTS**	9

Application of robotic: industrial robots, Service robots, domestic and house hold robots, Medical robots, military robots, agricultural robots, space robots, Aerial robotics Role of robots in inspection, assembly, material handling, underwater, space and healthcare.

Total Hours	**45**

Textbooks:

1	Modern Robotics: Mechanics, Planning, and Control, by Kevin M. Lynch , Frank C. Park , Cambridge University Press; 1st edition (25 May 2017), ISBN-10 : 110715
2	Modern Robotics: Mechanics, Systems and Control, by Julian Evans, Larsen and Keller Education (27 June 2019), ISBN-10 : 1641720751

Reference Books:

1	Modern Robotics: Designs, Systems and Control, by Jared Kroff, Willford Press (18 June 2019)
2	Advanced Technologies in Modern Robotic Applications, by ChenguangYang , Hongbin Ma , Mengyin Fu, Springer; Softcover reprint of the original 1st ed. 2016 edition (30 May 2018)

Web References:

1	

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Assessment based on Continuous and End Semester Examination						
Bloom's Level	**Continuous Assessment**			**Assignment**	**Attendance**	**End Semester Examination**
	CIA1 (6 Marks)	**CIA2 (6 Marks)**	**Model Exam (8 Marks)**			
Remember				**(10 Marks)**	**(10 Marks)**	**(60 Marks)**
Understand	2	2	2			
Apply	4	4	6			
Analyze						
Evaluate						
Create						
Total (100 Marks)	**6**	**6**	**8**	**10**	**10**	**60**

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject.

COs/ POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PSO 1**	**PSO 2**	**PSO3**
C101.1	3	2	3	2										
C101.2	3	2	3	2										
C101.3	3	2	3	2										
C101.4	3	2	3	2										
C101.5	3	2	3	2										

Course Code	**Course Name**	**Category**	**Hours/Week**			**C**
			L	**T**	**P**	
24ME516	**Green Supply Chain Management**	PEC	**3**	**0**	**0**	**3**
Regulation	**Nature of the Course**	**Semester**	**Data Book/Codes/Standards**			
R24	PEC	**VI**	**--------**			
Pre-requisite Course(s)		**Co-requisite Course(s)**				
Supply Chain Management		Environmental Management				
Course Objectives						
1	To understand standards, legislation, and modern as well as lead-free electronic manufacturing techniques.					
2	To learn electronic assembly processes, recycling methods, and the importance of e-waste management.					
3	To apply reliability, product life cycle tools, and green manufacturing practices in real-world applications.					
Course Outcomes Upon completion of the course, students shall have ability to						
C101.1	Enhance concise awareness of standards and legislation in modern electronic manufacturing for a green environment.					[U]

C101.2	Explain conventional electronic processing and lead-free manufacturing techniques.	[U]
C101.3	Understand the assembly process and the importance of recycling electronics.	[U]
C101.4	Apply reliability analysis and product life cycle estimation tools in electronic manufacturing.	[AP]
C101.5	Perform green electronic manufacturing procedures in practical scenarios.	[AP]

Course Contents

Unit – 1	**INTRODUCTION TO GREEN ELECTRONICS**	9

Environmental concerns of the modern society- Overview of electronics industry and their relevant regulations in China, European Union and other key countries- global and regional strategy and policy on green electronics industry. Restriction of Hazardous substances (RoHS) - Waste Electrical and electronic equipment (WEEE - Energy using Product (EuP) and Registration - Evaluation, Authorization and Restriction of Chemical substances (REACH).

Unit – 2	**GREEN ELECTRONICS MATERIALS AND PRODUCTS**	9

Basics of IC manufacturing and its process – Electronics with Lead (Pb) -free solder pastes, conductive adhesives, Introduction to green electronic materials and products - halogen-free substrates and components. Substitution of non-recyclable thermosetting polymer based composites with recyclable materials X-Ray Fluorescence (XRF) for identifying hazardous substances in electronic products

Unit – 3	**GREEN ELECTRONICS ASSEMBLY AND RECYCLING**	**9**

Various processes in assembling electronics components - the life-cycle environmental impacts of the materials used in the processes - substrate interconnects. Components and process equipments - Technology and management on e-waste recycle system construction, global collaboration, and product disassembles technology.

Unit – 4	**PRODUCT DESIGN AND SUSTAINABLE ECO-DESIGN**	9

Stages of product development process in green design: Materials- Manufacturing - Packaging and use - End of Life and disposal - Design for recycling - Life Cycle Assessment (LCA), and Eco-design tools - Environmental management systems, and International standards - Eco-design in electronics industry.

Unit – 5	**CASE STUDIES**	9

Reliability of green electronics systems , Reuse and recycle of End-of-Life(EOL) electrical and electronic equipment for effective waste management – Introduction of Green Supply Chain, and Modeling green products from Supply Chain point of view - A life-cycle assessment for eco-design of Cathode Ray Tube Recycling.

Total Hours	**45**

Textbooks:

1	Green Supply Chain Management, by Charisios Achillas , Dionysis D. Bochtis , Dimitrios Aidonis, Routledge; 1st edition (16 November 2018), ISBN-10 : 1138644617
2	Sammy G. Shina, Green Electronics Design and Manufacturing, McGraw Hill., 2008.

Reference Books:

1	Yuhang yang and Maode Ma, Green Communications and Networks, Springer Publication., 2014
2	Charles A. Harper, Electronic Materials and Processes Hand book, McGraw-Hill, 2010.

Web References:

1	https://en.wikipedia.org/wiki/RoHS?utm_source=chatgpt.com
2	https://en.wikipedia.org/wiki/China_RoHS?utm_source=chatgpt.com

Assessment based on Continuous and End Semester Examination

Bloom's Level	**Continuous Assessment**			**Assignment**	**Attendance**	**End Semester Examination**
	CIA1 (6 Marks)	**CIA2 (6 Marks)**	**Model Exam (8 Marks)**			
Remember				**(10 Marks)**	**(10 Marks)**	**(60 Marks)**
Understand	2	2	2			
Apply	4	4	6			
Analyze						
Evaluate						
Create						
Total (100 Marks)	**6**	**6**	**8**	**10**	**10**	**60**

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- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject.

COs/ POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PSO 1	PSO 2	PSO3
C101.1	3	3	2			3	3		3		2	3	2	2
C101.2	3	3	3	2	3	3			2		2	3	3	2
C101.3	3	3	3	3	3	3	2	2	2	2	2	3	3	2
C101.4	3	3	3	3	3	3	2	2	2	3	3	3	3	2
C101.5	2	3	3	3	3	3	2	2	2	3	3	3	2	3

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24ME517	3D printing	PE -3	3	0	0	3
Regulation	**Nature of the Course**	**Semester**	**Data Book/Codes/Standards**			
24	Theory	V				
Pre-requisite Course(s)		**Co-requisite Course(s)**				

Course Objectives

1	To introduce the development of Additive Manufacturing (AM), various business opportunities and applications
2	To familiarize various software tools, processes and techniques to create physical objects that satisfy product development / prototyping requirements, using AM.
3	To be acquainted with vat polymerization and direct energy deposition processes
4	To be familiar with powder bed fusion and material extrusion processes.
5	To gain knowledge on applications of binder jetting, material jetting and sheet lamination processes

Course Outcomes

Upon completion of the course, students will be able to

C517.1	Understand the development of AM technology and how AM technology propagated into various businesses and developing opportunities	U
C517.2	Apply knowledge on process of transforming a concept into the final product in AM technology.	AP
C517.3	Apply the vat polymerization and direct energy deposition processes and its applications.	AP
C517.4	Apply knowledge on process and applications of powder bed fusion and material extrusion	AP
C517.5	Analyze the advantages, limitations, applications of binder jetting, material jetting and sheet lamination processes.	AN

Course Contents

Unit – 1	INTRODUCTION	**CO1**	**9 Hrs**

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. Business Opportunities and

Future Directions – Case studies: Automobile, Aerospace, Healthcare			
Unit – 2	DESIGN FOR ADDITIVE MANUFACTURING (DFAM)	**CO2**	**9 Hrs**
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 – 3	VAT POLYMERIZATION AND DIRECTED ENERGY DEPOSITION	**CO3**	**9 Hrs**
Photo polymerization: Stereolithography 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 – 4	POWDER BED FUSION AND MATERIAL EXTRUSION	**C04**	**9 Hrs**
Powder Bed Fusion: Selective Laser Sintering (SLS): Process - Powder Fusion Mechanism - Materials and Application. Selective Laser Melting (SLM), Electron Beam Melting (EBM): Materials - Process - Advantages and Applications. Material Extrusion: Fused Deposition Modeling (FDM)- Process-Materials -Applications and Limitations.			
Unit – 5	OTHER ADDITIVE MANUFACTURING PROCESSES	**C05**	**9 Hrs**
Binder Jetting: Three-Dimensional Printing - Materials - Process - Benefits- Limitations - Applications. Material Jetting: Multijet Modeling- Materials - Process - Benefits - Applications. Sheet Lamination: Laminated Object Manufacturing (LOM)- Basic Principle- Mechanism: Gluing or Adhesive Bonding - Thermal Bonding- Materials- Application and Limitation.			
		Total Hours	**45**
Textbooks:			
1	Ian Gibson, David Rosen, Brent Stucker, Mahyar Khorasani "Additive manufacturing technologies". 3 rd edition Springer Cham, Switzerland. (2021). ISBN: 978-3-030-56126-0		
2	Andreas Gebhardt and Jan-Steffen Hötter "Additive Manufacturing: 3D Printing for Prototyping and Manufacturing", Hanser publications, United States, 2015, ISBN: 978-1-56990-582-1.		
Reference Books:			
1	Andreas Gebhardt, "Understanding Additive Manufacturing: Rapid Prototyping, Rapid Manufacturing", Hanser Gardner Publication, Cincinnati., Ohio, 2011, ISBN :9783446425521		
2	Milan Brandt, "Laser Additive Manufacturing: Materials, Design, Technologies, and Applications", Woodhead Publishing., United Kingdom, 2016, ISBN: 9780081004333		
3	Amit Bandyopadhyay and Susmita Bose, "Additive Manufacturing", 1st Edition, CRC Press., United States, 2015, ISBN-13: 978-1482223590.		
4	Kamrani A.K. and Nasr E.A., "Rapid Prototyping: Theory and practice", Springer., United States ,2006, ISBN: 978-1-4614-9842-1.		
5	Liou, L.W. and Liou, F.W., "Rapid Prototyping and Engineering applications: A tool box for prototype development", CRC Press., United States, 2011, ISBN: 9780849334092.		

Assessment based on Continuous and End Semester Examination						
BLOOM'S TAXONOMY LEVEL	**CONTINUOUS ASSESSMENT**			**ASSIGNMENT**	**ATTENDANCE**	**END SEMESTER EXAMINATION**
	CIA1 (6 Marks)	**CIA2 (6 Marks)**	**Model Exam (8 Marks)**	**(10 Marks)**	**(10 Marks)**	**(60 Marks)**
Remember						
Understand	3		2			
Apply	3	6	6			
Analyze						
Evaluate						
Create						
Total (100 Marks)	**6**	**6**	**8**	**10**	**10**	**60**

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be

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subsequently converted to 6, 6 and 8 marks respectively.

- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject.

COs/ POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
C517.1	3	2	1	1	2					2	2	3	2	2
C517.2	3	3	3	2	3					2	2	3	2	2
C517.3	3	2	2	3	2					2	2	3	2	2
C517.4	3	3	2	3	3					2	2	3	2	2
C517.5	2	2	2	2	2					2	2	3	2	2

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

Code	Course Name		Category	Hours/Week			C
				L	T	P	
24ME518	ADDITIVE MANUFACTURING		ES	3	0	0	3
Regulation	**Nature of the Course**		**Semester**	**Data Book/Codes/Standards**			
24	THEORY		VI				
Pre-requisite Course(s)			**Co-requisite Course(s)**				

	Course Objectives	
1.	To introduce the development of Additive Manufacturing (AM), various business opportunities and applications.	
2.	To familiarize various software tools, processes and techniques to create physical objects that satisfy product development / prototyping requirements, using AM.	
3.	To be acquainted with vat polymerization and direct energy deposition processes.	
4.	To be familiar with powder bed fusion and material extrusion processes.	
5.	To gain knowledge on applications of binder jetting, material jetting and sheet lamination processes.	
	Course Outcomes **Upon completion of the course, students shall have ability to**	
C601.1	Understand the basic concepts of Additive manufacturing.	U
C601.2	Apply the knowledge of additive manufacturing process to transforming a concept into the final product.	AP
C601.3	Apply the vat polymerization and direct energy deposition processes and its applications.	AP
C601.4	Analyze the applications of powder bed fusion and material extrusion.	AN
C601.5	Apply the advantages, limitations, applications of binder jetting, material jetting and sheet lamination processes.	AP
	Course Contents	
Unit – 1	**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. Business Opportunities and Future Directions – Case studies: Automobile, Aerospace, Healthcare.	
Unit – 2	**DESIGN FOR ADDITIVE MANUFACTURING**	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 – 3	**VAT POLYMERIZATION AND DIRECTED ENERGY DEPOSITION**	9
	Photo polymerization: Stereolithography 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 – 4	**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), Electron Beam Melting (EBM): Materials – Process – Advantages and Applications. Material Extrusion: Fused Deposition Modeling (FDM)- Process-Materials -Applications and Limitations.	
Unit – 5	**OTHER ADDITIVE MANUFACTURING PROCESSES**	9
	Binder Jetting: Three-Dimensional Printing – Materials – Process – Benefits- Limitations – Applications. Material Jetting: Multijet Modeling- Materials – Process – Benefits – Applications. Sheet Lamination: Laminated Object Manufacturing (LOM)- Basic Principle- Mechanism: Gluing or Adhesive Bonding – Thermal Bonding- Materials- Application and Limitation.	
	Total Hours	45
	Textbooks:	
1	Ian Gibson, David Rosen, Brent Stucker, Mahyar Khorasani "Additive manufacturing technologies". 3rd edition Springer Cham, Switzerland. (2021). ISBN: 978-3-030-56126-0	
2	Andreas Gebhardt and Jan-Steffen Hötter "Additive Manufacturing: 3D Printing for Prototyping and Manufacturing", Hanser publications, United States, 2015, ISBN: 978-1-56990-582-1.	
	Reference Books:	
1	Andreas Gebhardt, "Understanding Additive Manufacturing: Rapid Prototyping, Rapid Manufacturing", Hanser Gardner Publication, Cincinnati., Ohio, 2011, ISBN :9783446425521.	
2	Milan Brandt, "Laser Additive Manufacturing: Materials, Design, Technologies, and Applications", Woodhead Publishing., United Kingdom, 2016, ISBN: 9780081004333.	
3	Amit Bandyopadhyay and Susmita Bose, "Additive Manufacturing", 1st Edition, CRC Press., United States, 2015, ISBN-13: 978-1482223590.	
4	Kamrani A.K. and Nasr E.A., "Rapid Prototyping: Theory and practice", Springer., United States ,2006, ISBN: 978-1-4614-9842-1.	

Assessment based on Continuous and End Semester Examination						
Bloom's Level	**Continuous Assessment**			**Assignment**	**Attendance**	**End Semester Examination**
	CIA1 (6 Marks)	**CIA2 (6 Marks)**	**Model Exam (8 Marks)**			
Remember				**(10 Marks)**	**(10 Marks)**	**(60 Marks)**
Understand	6	2	2			
Apply		4	6			
Analyze						
Evaluate						
Create						
Total (100 Marks)	6	6	8	**10**	**10**	**60**

CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.

The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.

BTL mark split up may vary based on the nature of the subject.

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COs/ POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
C601.1	2	1	2	2						2	2		2		
C601.2	2	2	2	2						2	2	2	2		
C601.3	3	2	2	2						2	2	2	2		
C601.4	2	2	2	2						2	2	2	2		
C601.5	3	2	2	2						2	2	2	2		

VERTICAL 4

PROFESSIONAL ELECTIVES

Industry 4.0

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Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24ME519	Intelligent Machining	PE	3	0	0	3
Regulation	**Nature of the Course**	**Semester**	**Data Book/Codes/Standards**			
24	THEORY					
Pre-requisite Course(s)		**Co-requisite Course(s)**				

Course Objectives

	To understand the basic concepts of artificial intelligence and machine intelligence.
	To understand the basic concepts of artificial intelligence and machine intelligence.
	To learn machine learning techniques used in intelligent systems.

Course Outcomes

Upon completion of the course, students shall have ability to

C519.1	Explain the basic concepts of artificial intelligence, intelligent agents and machine intelligence applications in mechanical engineering.	[U]
C519.2	Apply machine learning techniques such as classification and regression for solving engineering problems.	[AP]
C519.3	Apply machine learning techniques such as classification and regression for solving engineering problems.	[AN]
C519.4	Explain fuzzy logic concepts and their applications in intelligent control systems.	[U]
C519.5	Evaluate reinforcement learning methods and machine intelligence applications in robotics and smart manufacturing.	[AP]

Course Contents

Unit – 1	Introduction to Artificial Intelligence	9
Introduction to Artificial Intelligence – Intelligent agents – Types of intelligent agents – Problem solving and search strategies – Knowledge representation – Applications of machine intelligence in robotics and mechanical engineering systems.		
Unit – 2	Machine Learning Fundamentals	9
Introduction to machine learning – Supervised learning – Unsupervised learning – Classification and regression – Decision trees – Model evaluation and performance metrics – Applications in predictive maintenance and condition monitoring.		
Unit – 3	Artificial Neural Networks	9
Biological neuron model – Artificial neuron – Perceptron model – Multi-layer perceptron – Learning rules – Backpropagation algorithm – Applications of neural networks in robotics and intelligent systems.		
Unit – 4	Fuzzy Logic and Intelligent Control	9
Classical sets and fuzzy sets – Membership functions – Fuzzy rule base – Fuzzy inference systems – Fuzzification and defuzzification – Fuzzy controllers – Applications in robotic and industrial control systems.		
Unit – 5	Reinforcement Learning and Intelligent Applications	9
Reinforcement learning – Markov decision process – Learning agents – Q-learning concept – Intelligent robotics – Machine vision – Smart manufacturing applications.		
	Total Hours	45

Textbooks:

1	Artificial Intelligence: A Guide to Intelligent Systems, Michael Negnevitsky, 3rd Edition, Pearson Education / Addison-Wesley, England, 2011
2	Artificial Intelligence: A Modern Approach, Stuart J. Russell and Peter Norvig, 3rd Edition, Pearson Education, New Jersey, 2010

Reference Books:

1	Machine Learning, Tom M. Mitchell, McGraw-Hill Education, New York, 1997
2	Pattern Recognition and Machine Learning, Christopher M. Bishop, Springer, New York, 2006
3	Introduction to Machine Learning, Ethem Alpaydin, MIT Press, Cambridge, 2014.

Assessment based on Continuous and End Semester Examination						
Bloom's Level	Continuous Assessment			Assignment	Attendance	End Semester Examination
	CIA1 (6 Marks)	CIA2 (6 Marks)	Model Exam (8 Marks)			
Remember				(10 Marks)	(10 Marks)	(60 Marks)
Understand						
Apply						
Analyze						
Evaluate						
Create						
Total (100 Marks)				**10**	**10**	**60**

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject.

COs/ POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
C519.1	3	2										1	2	1	1
C519.2	3	3	2	2								1	3	2	2
C519.3	3	3	2	2								1	2	2	1
C519.4	2	2	2	2								1	3	3	1
C519.5	3	3	2	2								1	3	3	1

Code	Course Name	Category	Hours/Week			C
			L	T	P	
24ME520	MACHINE DIAGNOSTICS AND CONDITION MONITORING	ES	3	0	0	3
Regulation	**Nature of the Course**	**Semester**	**Data Book/Codes/Standards**			
24	THEORY	VI				
Pre-requisite Course(s)		**Co-requisite Course(s)**				

Course Objectives

1.	Provide an overview of the fundamental principles of maintenance and condition monitoring techniques.
2.	Acquire knowledge of data acquisition and signal processing techniques.
3.	Explain about diagnosis of machinery faults and methods to correct faults
4.	Describe oil analysis and other NDT techniques
5.	To learn condition based technique to analyze decision tree .

Course Outcomes

Upon completion of the course, students shall have ability to

C601.1	Apply maintenance and condition monitoring techniques to machineries and industries	[AP]
C601.2	Implement data acquisition and signal processing techniques to all mechanical components and plants	[AP]
C601.3	Diagnose Machinery faults and apply methods to correct faults	[AP]
C601.4	Predict machinery faults and using oil analysis and other NDT techniques	[AP]

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C601.5	Diagonose the decision tree in machine tool condition monitoring.	[AP]
Course Contents		
Unit – 1	BASIC CONCEPTS	9
Machinery failures, basic maintenance strategies, factors influencing maintenance strategies, machine condition monitoring, transducer selection and location, PC interfacing and virtual instrumentation. Vibration signatures of faults in rotating and reciprocating machines; detection and diagnosis of faults.		
Unit – 2	INSTRUMENTATION AND SIGNAL PROCESSING	9
Types of sensors in condition monitoring: vibration, acoustics and noise, acoustic emission, temperature, ultrasonic and infra-red sensors – Signal processing: basic signal and systems concepts, time domain analysis, frequency domain analysis, time-frequency analysis, wavelets and wavelet packets.		
Unit – 3	MACHINERY FAULT DIAGNOSIS USING VIBRATION ANALYSIS	9
Unbalance, bent shaft, Eccentricity, Misalignment, looseness, Belt drive problems, gear defects, bearing defects, Electrical faults, Cavitation Shaft cracks, Rotor rubs, Resonance, Hydraulic and aerodynamic forces. Introduction, Balancing Alignment, Resonance vibration control with dynamic absorbers		
Unit – 4	OIL AND PRACTICAL ANALYSIS AND OTHER PREDICTIVE MAINTENANCE TECHNIQUES:	9
Introduction, oil fundamentals, oil analysis sampling methods, lubricant properties, contaminants in lubricants, practical analysis techniques. Ultrasound, Infrared thermography applications of IR thermography, ISO 2372 standards for vibrations.		
Unit – 5	PATTERN RECOGNITION	9
Feature extraction and feature selection methods, feature reduction using PCA – discriminant functions and decision boundaries, decision trees, maximum likelihood and nearest neighbour classification – Bayesian theory, neural networks, fuzzy logic and support vector machines (SVM) in classification. Application and case studies of condition monitoring: Bearings, gear boxes, engines, structural health monitoring, machine tool condition monitoring etc.		
	Total Hours	45
Textbooks:		
1	Machinery vibration Analysis & Predictive Maintenance by Paresh Girdhar, Elsevier publishers.	
2	Mechanical Fault diagnosis and condition monitoring by R. A .Collacott.	
3	Balageas D., Fritzen C P. & Guemes A. – 'Structural Health Monitoring' – Published by ISTE Ltd., – 2006	
Reference Books:		
1	Collacot – 'Mechanical Fault Diagnosis and Condition Monitoring'- Chapman – Hall – 1987	
2	First course on condition monitoring in the process industries, by M.J.Neale, Nov 1979, Manchester.	
3	Norton M. and Karczub D. – 'Fundamentals of Noise and Vibration Analysis for Engineers' – Cambridge University Press – 2003 – 2nd Edition.	

Assessment based on Continuous and End Semester Examination						
Bloom's Level	**Continuous Assessment**			**Assignment**	**Attendance**	**End Semester Examination**
	CIA1 (6 Marks)	**CIA2 (6 Marks)**	**Model Exam (8 Marks)**			
Remember				**(10 Marks)**	**(10 Marks)**	**(60 Marks)**
Understand	6	2	2			
Apply		4	6			
Analyze						
Evaluate						

Create						
Total (100 Marks)	6	6	8	**10**	**10**	**60**

CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.

The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.

BTL mark split up may vary based on the nature of the subject.

COs/ POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
C601.1	2	2	2		2								2	2	2
C601.2	2	2	2		2								3	2	2
C601.3	2	2	2		2								2	2	2
C601.4	2	2	2		2								3	2	2
C601.5	2	2	2		2								3	2	2

Course Code	**Course Name**	**Category**	**Hours/Week**			**C**
			L	**T**	**P**	
24ME521	**Artificial Intelligence Applications in Mechanical Engineering**	**PCC**	**3**	**0**	**0**	**3**
Regulation	**Nature of the Course**	**Semester**	**Data Book/Codes/Standards**			
R24	**PCC**	**V**	**--------**			
Pre-requisite Course(s)		**Co-requisite Course(s)**				
Engineering Measurements		Manufacturing Technology				

Course Objectives

1	To develop knowledge of measurement principles, instruments, and techniques for evaluating engineering dimensions and surface characteristics.
2	To apply concepts of tolerancing, limits & fits, and uncertainty analysis in inspection and quality control.
3	To understand and utilize advanced metrology systems for modern manufacturing and precision measurement.

Course Outcomes

Upon completion of the course, students shall have ability to

C101.1	Discuss measurement concepts for application in various metrological instruments.	[U]
C101.2	Apply principles of linear and angular measuring instruments for assembly and transmission elements.	[AP]
C101.3	Apply tolerance symbols and perform tolerance analysis in industrial applications.	[AP]
C101.4	Apply principles and methods of form and surface metrology.	[AP]
C101.5	Apply advanced measurement techniques for quality control in manufacturing industries.	[AP]

Course Contents

Unit – 1	**BASICS OF METROLOGY**	9

Measurement – Need, Process, Role in quality control; Factors affecting measurement - SWIPE; Errors in Measurements – Types – Control – Measurement uncertainty – Types, Estimation, Problems on Estimation of Uncertainty, Statistical analysis of measurement data, Measurement system analysis, Calibration of measuring instruments, Principle of air gauging- ISO standards.

Unit – 2	**MEASUREMENT OF LINEAR, ANGULAR DIMENSIONS**	9

Linear Measuring Instruments – Vernier caliper, Micrometer, Vernier height gauge, Depth Micrometer, Bore gauge, Telescoping gauge; Gauge blocks – Use and precautions, Comparators – Working and advantages; Opto-mechanical measurements using measuring microscope and Profile projector - Angular measuring instruments – Bevel protractor, Clinometer, Angle gauges, Precision level, Sine bar, Autocollimator, Angle dekkor, Alignment telescope.

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Unit – 3	**TOLERANCE ANALYSIS**	**9**
Tolerancing– Interchangeability, Selective assembly, Tolerance representation, Terminology, Limits and Fits, Problems (using tables IS919); Design of Limit gauges, Problems. Tolerance analysis in manufacturing, Process capability, tolerance stackup, tolerance charting.		
Unit – 4	**METROLOGY OF SURFACES**	9
Fundamentals of GD & T- Conventional vs Geometric tolerance, Datums, Inspection of geometric deviations like straightness, flatness, roundness deviations; Simple problems – Measurement of Surface finish – Functionality of surfaces, Parameters, Comparative, Stylus based and Optical Measurement techniques, Filters, Introduction to 3D surface metrology- Parameters.		
Unit – 5	**ADVANCES IN METROLOGY**	9
Lasers in metrology - Advantages of lasers – Laser scan micrometers; Laser interferometers – Applications – Straightness, Alignment; Ball bar tests, Computer Aided Metrology - Basic concept of CMM – Types of CMM – Constructional features – Probes – Accessories – Software – Applications – Multisensor CMMs. Machine Vision - Basic concepts of Machine Vision System – Elements – Applications - On-line and in-process monitoring in production - Computed tomography – White light Scanners.		
	Total Hours	**45**
Textbooks:		
1	Gupta, I.C., Engineering Metrology, 7th Edition, Dhanpat Rai Publications, 2020.	
2	Jain, R.K., Engineering Metrology, 22nd Edition, Khanna Publishers, 2009.	
Reference Books:		
1	Raghavendra N.V. and Krishnamurthy. L., Engineering Metrology and Measurements, Oxford University Press, 2013.	
2	Venkateshan, S. P., "Mechanical Measurements", Second edition, John Wiley &Sons, 2015.	
Web References:		
1	https://www.mitutoyo.com/education	
2	https://hexagonmi.com/en/learn	

Assessment based on Continuous and End Semester Examination						
Bloom's Level	**Continuous Assessment**			**Assignment**	**Attendance**	**End Semester Examination**
	CIA1 (6 Marks)	**CIA2 (6 Marks)**	**Model Exam (8 Marks)**			
Remember				**(10 Marks)**	**(10 Marks)**	**(60 Marks)**
Understand	2	2	2			
Apply	4	4	6			
Analyze						
Evaluate						
Create						
Total (100 Marks)	**6**	**6**	**8**	**10**	**10**	**60**

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject.

COs/ POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PSO 1	PSO 2	PSO3
C101.1	3	2	2									3	3	
C101.2	2	3	2	2								3	3	
C101.3	2	2	3	2	2	2						3	3	2
C101.4	2	2	2	3	2							3	3	2
C101.5	2	2	2	2	3	3	3	3	3	2	3	2	3	3

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24ME522	Soft Robotics	PC	3	0	0	3
Regulation	Nature of the Course	Semester	Data Book/Codes/Standards			
R24		VI				
Pre-requisite Course(s)		Co-requisite Course(s)				

Course Objectives

1	To introduce the fundamental concepts, scope, and applications of soft robotics. .
2	To explore materials and fabrication techniques suitable for soft robotic systems.
3	To understand actuation principles, sensing technologies, and control strategies in soft robotics.
4	To develop skills in modeling, simulation, and design methodologies for soft robotic structures.
5	To analyze real-world applications, challenges, and future directions of soft robotics in healthcare, industry, and exploration.

Course Outcomes

Upon completion of the course, students will be able to

CXXX.1	Define and explain the scope and importance of soft robotics compared to traditional robotics.	[U]
CXXX.2	Identify and evaluate suitable materials and fabrication methods for soft robotic components.	[U]
CXXX.3	Demonstrate practical knowledge of actuation mechanisms and control systems in soft robotics.	[U]
CXXX.4	Apply modeling and simulation tools to design and analyze soft robotic prototypes.	[U]
CXXX.5	Assess applications, ethical considerations, and future research directions in soft robotics.	[U]

Course Contents

Unit – 1	**Introduction to Soft Robotics**	**CO1**	**6 Hrs.**

Definition and scope of soft robotics - Differences between soft and traditional robotics - Historical development and emerging trends - Importance in human-robot interaction and delicate task environments - Case studies: medical devices, wearable robotics, food handling.

PRACTICAL:

Build a simple soft gripper using a balloon and silicone tubing to demonstrate how soft robotics can safely handle delicate objects like fruits.

Unit – 2	**Materials and Fabrication Techniques**	**CO2**	**6 Hrs.**

Softmaterials: elastomers, hydrogels, bio-compatible polymers - Smart materials: shape-memory alloys, electroactive polymers - Fabrication methods: 3D printing, molding, casting, additive manufacturing -

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Challenges in durability, scalability, and biocompatibility - Laboratory demonstrations of material properties.			
PRACTICAL: Fabricate a small elastomer sample using silicone casting, then test its stretchability and recovery to understand material properties.			
Unit – 3	**Actuation and Control Systems**	**CO3**	**6 Hrs.**
Actuation principles: pneumatic, hydraulic, tendon-driven, shape-changing - Bio-inspired actuation (muscle-like systems, octopus arms) - Sensors for soft robotics: stretchable sensors, tactile sensing, embedded electronics - Control strategies: model-based vs. data-driven approaches - Integration of AI and machine learning in soft robotic control.			
PRACTICAL: Create a pneumatic actuator by connecting a syringe to a silicone chamber, then observe how air pressure drives movement and test basic control with varying input.			
Unit – 4	**Modeling, Simulation, and Design**	**CO4**	**6 Hrs.**
Mathematical modeling of soft structures (continuum mechanics basics) - Finite element analysis (FEA) for soft materials - Simulation tools for soft robotic design - Design methodologies: bio-inspired design, modular design approaches - Case studies of successful prototypes			
PRACTICAL: Use a basic finite element analysis (FEA) software to simulate deformation of a soft beam under load, comparing results with a physical silicone strip experiment.			
Unit – 5	**Applications, Challenges, and Future Directions**	**CO5**	**6 Hrs.**
Healthcare: prosthetics, surgical tools, rehabilitation devices - Industrial: food processing, packaging, agriculture - Exploration: underwater robotics, space robotics - Ethical and safety considerations in human-robot interaction - Future research directions: hybrid robots, sustainability, AI integration.			
PRACTICAL: Prototype a soft wearable wrist support using elastomer bands and sensors, then evaluate comfort, flexibility, and potential healthcare applications.			
	Total Theory Hours		**30Hrs.**
	Total Practical Hours		**30Hrs.**
Textbooks:			
1	Modern Robotics: Mechanics, Planning, and Control, by Kevin M. Lynch , Frank C. Park , Cambridge University Press; 1st edition (25 May 2017), ISBN-10 : 110715.		
2	Modern Robotics: Mechanics, Systems and Control, by Julian Evans, Larsen and Keller Education (27 June 2019), ISBN-10 : 1641720751.		
Reference Books:			

1	Lihui Wang and Andrew YehChing Nee, Collaborative Design and Planning for Digital Manufacturing, Springer-Verlag London Limited, 2009..
2	Andrew Yeh Chris Nee, Fei Tao, and Meng Zhang, "Digital Twin Driven Smart Manufacturing", Elsevier Science., United States, 2019.
3	Alp Ustundag and Emre Cevikcan, "Industry 4.0: Managing The Digital Transformation", Springer Series in Advanced Manufacturing., Switzerland, 2017
4	Ronald R. Yager and Jordan Pascual Espada, "New Advances in the Internet of Things", Springer., Switzerland, 2018.
5	Ronald R. Yager and Jordan Pascual Espada, "New Advances in the Internet of Things", Springer., Switzerland, 2018.
Web References:	
1	

BLOOM'S TAXONOMY LEVEL	ASSESMENT-1			ASSESMENT-2		ASSIGNMENT	ATTENDANCE	END SEMESTER EXAMINATION
	CIA1	CIA2	MODEL	LAB EXPERIMENTS	MODEL LAB EXAM			
	6	6	8	10	10	10	10	40
Remember							10	40
Understand	3	3	4	5	5			
Apply								
Analyze	3	3	4	5	5	10		
Evaluate								
Create								
Total(100Marks)	6	6	8	10	10	10	10	40

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 marks.
- Experiment wise laboratory completion 10 marks and Model lab exam will be conducted for 100 marks and the same will be converted to 10 marks.
- BTL mark split up may vary based on the nature of the subject.

COs/ POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CXXX.1	3	3	3	3	3	3					3	3	2	3

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CXXX.2	3	3	3	3	3	3			3		3	3	3	2
CXXX.3	3	3	3	3	3	3	3	3	3		3	3	2	2
CXXX.4	3	3	3	3	3	3		3	3	3	3	2	2	2
CXXX.5	3	3	3	3	3	3	3	3	3	3	3	3	2	2

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

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24ME523	ADVANCED MACHINING AND AUTOMATION	ES	3	0	0	3
Regulation	**Nature of the Course**	**Semester**	**Data Book/Codes/Standards**			
24	THEORY	VI				
Pre-requisite Course(s)		**Co-requisite Course(s)**				

Course Objectives

1.	To Apply the principle of automation and various equipment and systems that are used in the industry.
2.	To recognize the use of automated systems in Manufacturing & Monitoring.
3.	To get detailed study of flexible manufacturing systems.
4.	To categorize the Material handling and Data capture technologies used in the automated systems.
5.	To categorize the Material handling and Data capture technologies used in the automated systems.

Course Outcomes

Upon completion of the course, students shall have ability to

C601.1	To Study the principle of automation and systems that are used in the industry.	[U]
C601.2	To discuss the idea of Manufacturing & Monitoring systems utilize for automation.	[AP]
C601.3	To summarize the concepts and the importance of FMS in the automated systems.	[U]
C601.4	To interpret the importance of the various Automatic material handling devices and automatic identification Methods.	[AP]
C601.5	To illustrate modern concepts for Automation in Manufacturing Systems.	[AP]

Course Contents

Unit – 1	INTRODUCTION TO AUTOMATION	9

Automation in Production Systems- Computerized Manufacturing Support Systems, Automation Principles and Strategies, Basic elements of an Automated Systems, Advanced automation functions, Level - Process Industries and Discrete Manufacturing Industries, Importance of automation in the manufacturing industry and its Applications – Design of an automated system - Building blocks of an automated system, working principle and examples - Fabrication or selection of various components of an automated system, Sensors used in an automated system , construction and principle of operation.

Unit – 2	AUTOMATED MANUFACTURING AND MONITORING SYSTEM	9

Introduction to Manufacturing Systems – Components – Classification - Single Station Manufacturing Cells - Cellular Manufacturing – Manual assembly lines - Transfer Lines - Automated Assembly Systems - Production Monitoring System-Introduction – types - process control & strategies - Linear & Circular Interpolation Program Simulation & Execution- Milling in Sinumeric Controller – Inspection – types - Automated Inspection - Quantitative Analysis of Inspection - case-studies

Unit – 3	FLEXIBLE MANUFACTURING SYSTEM	9

Introduction to FMS, Objective, need, Components and types of FMS, Applications, Benefits and limitations, planning and implementation issues, Quantitative Analysis of Flexible Manufacturing Systems, Simple example of FMS planning for Automobile plant, Different FMS software's, General structure and Requirements for FMS Software, Functional descriptions and operational overview advantages, FMS application in machining, sheet metal fabrication		
Unit – 4	INDUSTRIAL ROBOTICS AND MATERIAL HANDLING SYSTEM	9
Introduction, Robot Anatomy and Related Attributes, Robot Control Systems, End Effectors, Sensors in Robotics, Industrial Robot Applications, Robot Programming overview, Engineering Analysis of Industrial Robots. Automated Storage Systems – types - Automated Storage/Retrieval Systems (AS/RS), Material transport system – types - Automated guided vehicles (AGVs), Automatic Identification Methods - Barcode Technology, Radio Frequency Identification (RFID), Magnetic Stripes, Optical character recognition (OCR) - case-studies.		

Unit – 5	INTELLIGENT MANUFACTURING SYSTEMS	9
Artificial Intelligence based systems, role of artificial intelligence in Industry Automation, Benefits, Applications, Evolution of process automation, Robotic Process Automation (RPA) - Challenges, benefits of RPA – RPA in supply chain, Industry 4.0 – building blocks - IoT in Manufacturing - Smart Manufacturing – Concepts, applications, benefits & challenges, Product Lifecycle Management (PLM), Case studies.		
	Total Hours	45
Textbooks:		
1	Mikell P. Groover, "Automation Production systems and Computer Integrated manufacturing", Fourth edition, prentice hall of India, New Delhi, 2016.	
2	G. Boothroyd – "Assembly Automation and Product Design", Second Edition, Taylor & Francis, First Indian Edition – 2010.	
Reference Books:		
1	David J. Parrish, "Flexible Manufacturing", Butterworth-Heinemann, Newton, MA, USA, 1990.	
2	Russel,S., and Norvig,P., (2015), Artificial Intelligence: A Modern Approach, 3rd Edition, Prentice Hall	
3	Vijay Madisetti and ArshdeepBahga, "Internet of Things (A Hands-on-Approach)", 1st Edition, VPT, 2014.	
4	Regtien, P. P. L., Sensors for mechatronics, Elesevier, USA, 2012.	

Assessment based on Continuous and End Semester Examination

Bloom's Level	Continuous Assessment			Assignment	Attendance	End Semester Examination
	CIA1 (6 Marks)	CIA2 (6 Marks)	Model Exam (8 Marks)			
Remember				(10 Marks)	(10 Marks)	(60 Marks)
Understand	6	2	2			
Apply		4	6			
Analyze						
Evaluate						
Create						
Total (100 Marks)	6	6	8	**10**	**10**	**60**

CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.

The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.

BTL mark split up may vary based on the nature of the subject.

COs/ POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
C601.1	-	3	-	-	2	-	-	-	-	-	-	-	2	-	-
C601.2	-	*3*	-	-	-	-	-	-	-	-	-	-	*3*	-	-

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C601.3	-	-	3	-	2	-	-	-	-	-	-	-	*1*	-	-
C601.4	-	-	3	-	2	-	-	-	-	-	-	-	*2*	-	-
C601.5	-	-	3	-	3	-	-	-	-	-	-	-	-	*2*	-

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24ME524	INTELLIGENT MACHINES	ES	3	0	0	3
Regulation	**Nature of the Course**	**Semester**	**Data Book/Codes/Standards**			
24	THEORY	VI				
Pre-requisite Course(s)		**Co-requisite Course(s)**				

Course Objectives

1.	Building the fundamentals of Machine Learning.
2.	Imparting Statistical and linear algebra skills for Machine learning.
3.	Developing neural network models for engineering applications.
4.	Gaining practical experience in programming tools for Machine Learning.
5.	Empowering students with tools and techniques used in Machine learning.

Course Outcomes

Upon completion of the course, students shall have ability to

C601.1	Identify the importance and applications of machine learning	[U]
C601.2	Apply linear algebra methods to model engineering data	[AP]
C601.3	Understand various supervised and unsupervised ML algorithms	[U]
C601.4	Apply dimension reduction technique to reduce the dimensions of the data.	[AP]
C601.5	Design and implement various machine learning algorithms for real-world applications.	[AP]

Course Contents

Unit – 1	FUNDAMENTALS OF MACHINE LEARNING	9

Review linear algebra, vector spaces, Linear transformations, Eigen values and vectors, random variables, and probability distributions. Introduction to signal processing – Time, Frequency, TimeFrequency domain analysis. Regression – Simple and regularized Linear Regression, Gradient descent, Multiple linear regression in multiple variables –Linear models for classification, Discriminant functions, Logistic regression

Unit – 2	MACHINE LEARNING SKILLS	9

Introduction: Basic motivation, examples of machine learning applications Unsupervised, Supervised, Reinforcement, Hybrid models, Handling datasets, Performance metrics

Unit – 3	NEURAL NETWORK	9

Dimensionality reduction - Principal Component Analysis, Singular Value decomposition, Fundamentals of Deep Learning and Reinforcement Learning

Unit – 4	NETWORK PROGRAMMING	9

Classification - Decision Tree, Support Vector Machine, Naïve Bayes, Neural networks model representation-Feed-forward network functions, Network training, Back-propagation algorithm. S5 Clustering, Mixture densities, K-Means clustering, Expectation maximization, Spectral clustering

Unit – 5	TECHNIQUES IN MACHINE LEARNING	9

Application of machine learning in mechanical design, case studies in dynamics, fault analysis, system control, modeling, etc.

	Total Hours	45
Textbooks:		
1	T. Hastie, R. Tibshirani, J. Friedman. The Elements of Statistical Learning, 2e, 2008.	
2	Christopher Bishop. Pattern Recognition and Machine Learning.	
Reference Books:		
1	E. Alpaydin, Introduction to Machine Learning, 3rd Edition, Prentice Hall (India) 2015.	
2	R. O. Duda, P. E. Hart, and D. G. Stork, Pattern Classification, 2nd Edn., Wiley India, 2007.	
3	C. M. Bishop, Pattern Recognition and Machine Learning (Information Science and Statistics), Springer, 2006.	
4	S. O. Haykin, Neural Networks, and Learning Machines, 3rd Edition, Pearson Education (India), 2016	

Assessment based on Continuous and End Semester Examination						
Bloom's Level	**Continuous Assessment**			**Assignment**	**Attendance**	**End Semester Examination**
	CIA1 (6 Marks)	**CIA2 (6 Marks)**	**Model Exam (8 Marks)**			
Remember				**(10 Marks)**	**(10 Marks)**	**(60 Marks)**
Understand	6	2	2			
Apply		4	6			
Analyze						
Evaluate						
Create						
Total (100 Marks)	6	6	8	**10**	**10**	**60**

CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.

The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.

BTL mark split up may vary based on the nature of the subject.

COs/ POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**	**PSO3**
C601.1	3	2	2	2						2	2		2		
C601.2	3	2	2	2						2	2	2	2		
C601.3	3	2	2	2						2	2	2	2		
C601.4	3	2	2	2	3					2	2	2	2		
C601.5	3	2	2	2	3					2	2	2	2		

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VERTICAL 5

PROFESSIONAL ELECTIVES

DIVERSIFIED COURSES GROUP

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24ME525	AUTOMOBILE ENGINEERING	PE	3	0	0	3
Regulation	**Nature of the Course**	**Semester**	**Data Book/Codes/Standards**			
24	THEORY					
Pre-requisite Course(s)		**Co-requisite Course(s)**				

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

Course Outcomes

Upon completion of the course, students shall have ability to

C525.1	Understand the various parts of the automobile and their functions and materials.	[U]
C525.2	Discuss the engine auxiliary systems and engine emission control.	[AP]
C525.3	Understand the working of different types of transmission systems.	[U]
C525.4	Understand the Steering, Brakes and Suspension Systems	[U]
C525.5	Discuss possible alternate sources of energy for IC Engines.	[AP]

Course Contents

Unit – 1	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 – 2	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 – 3	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 – 4	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 – 5	ALTERNATIVE ENERGY SOURCES	9

Use of Natural Gas, Liquefied Petroleum Gas, Bio-diesel, Bio-ethanol, Gasohol and Hydrogen in Automobiles- Engine modifications required –Performance, Combustion and Emission Characteristics of SI and CI engines with these alternate fuels - Electric and Hybrid Vehicles, Fuel Cell Note: Practical Training in dismantling and assembling of Engine parts and Transmission Systems should be given to the students.

Total Hours	45

Textbooks:

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.

Reference Books:

1	Ganesan V. "Internal Combustion Engines", Third Edition, Tata McGraw-Hill, 2012.
2	Joseph Heitner, "Automotive Mechanics," Second Edition, East-West Press, 1999.
3	Heinz Heisler, "Advanced Engine Technology," SAE International Publications USA, 1998.

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Assessment based on Continuous and End Semester Examination						
Bloom's Level	Continuous Assessment			Assignment	Attendance	End Semester Examination
	CIA1 (6 Marks)	CIA2 (6 Marks)	Model Exam (8 Marks)			
Remember				(10 Marks)	(10 Marks)	(60 Marks)
Understand						
Apply						
Analyze						
Evaluate						
Create						
Total (100 Marks)				**10**	**10**	**60**

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject.

COs/ POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
C525.1	3	3						1	1			3	3		3
C525.2	3	3	1	2				1	1	2		3	2	2	
C525.3	3	3						1	1			3	2		3
C525.4	3	3	1	2				1	1	2		3	2	2	3
C525.5	3	3	1	2				1	1	2		3	2	2	

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24ME526	COMPOSITE MATERIALS AND MECHANICS	PE	3	0	0	3
Regulation	**Nature of the Course**	**Semester**	**Data Book/Codes/Standards**			
24	THEORY					
Pre-requisite Course(s)		**Co-requisite Course(s)**				
Course Objectives						
	To study the fundamentals of composite material strength and its mechanical behavior					
	To study the analysis of fiber reinforced Laminate design for different combinations of plies with different orientations of the fiber.					
	To study Thermo-mechanical behavior and study of residual stresses in Laminates during processing.					
	To Implementation of Classical Laminate Theory (CLT) to study and analysis for residual stresses in an isotropic layered structure such as electronic chips.					
	To study the fundamentals of composite material strength and its mechanical					

Course Outcomes

Upon completion of the course, students shall have ability to

C526.1	Explain the characteristics of composite materials, fibers, matrices, lamina constitutive equations, and composite manufacturing processes.	[U]
C526.2	Apply laminate constitutive equations to analyze stress–strain relations and structural properties of laminated composite plates.	[AP]
C526.3	Apply lamina strength using various failure theories such as Maximum stress, Tsai–Hill, and Tsai–Wu criteria.	[AP]
C526.4	Apply thermal effects on laminated composites using modified constitutive equations and coefficients of thermal expansion.	[AP]
C526.5	Apply the behavior of laminated flat plates under static bending, buckling, and vibration conditions.	[AP]

Course Contents

Unit – 1	INTRODUCTION, LAMINA CONSTITUTIVE EQUATIONS & MANUFACTURING	9

Definition –Need – General Characteristics, Applications. Fibers – Glass, Carbon, Ceramicand Aramid fibers. Matrices – Polymer, Graphite, Ceramic and Metal Matrices – Characteristics of fibers and matrices. Lamina Constitutive Equations: Lamina Assumptions – Macroscopic Viewpoint. Generalized Hooke's Law. Reduction to Homogeneous Orthotropic Lamina – Isotropic limit case, Orthotropic Stiffness matrix (Qij), Typical Commercial material properties, Rule of Mixtures. Generally Orthotropic Lamina –Transformation Matrix, Transformed Stiffness. Manufacturing:Bag Moulding Compression Moulding – Pultrusion – Filament Winding – Other Manufacturing Processes

Unit – 2	FLAT PLATE LAMINATE CONSTITUTE EQUATIONS	9

Definition of stress and Moment Resultants. Strain Displacement relations. Basic Assumptions of Laminated anisotropic plates. Laminate Constitutive Equations – Coupling Interactions, Balanced Laminates, Symmetric Laminates, Angle Ply Laminates, Cross Ply Laminates. Laminate Structural Moduli. Evaluation of Lamina Properties from Laminate Tests. Quasi-Isotropic Laminates. Determination of Lamina stresses within Laminates.

Unit – 3	LAMINA STRENGTH ANALYSIS	9

Introduction - Maximum Stress and Strain Criteria. Von-Misses Yield criterion for Isotropic Materials. Generalized Hill's Criterion for Anisotropic materials. Tsai-Hill's Failure Criterion for Composites. Tensor Polynomial (Tsai-Wu) Failure criterion. Prediction of laminate Failure

Unit – 4	THERMAL ANALYSIS	9

Assumption of Constant C.T. E's. Modification of Hooke's Law. Modification of Laminate Constitutive Equations. Orthotropic Lamina C.T. E's. C.T. E's for special Laminate Configurations –Unidirectional, Off-axis, Symmetric Balanced Laminates, Zero C.T.E laminates, Thermally Quasi-Isotropic Laminates

Unit – 5	ANALYSIS OF LAMINATED FLAT PLATES	9

Equilibrium Equations of Motion. Energy Formulations. Static Bending Analysis. Buckling Analysis. Free Vibrations – Natural Frequencies

Total Hours	45

Textbooks:

1	Gibson, R.F., "Principles of Composite Material Mechanics", Second Edition, McGraw-Hill, CRC press in progress, 1994, -.
2	Hyer, M.W., "Stress Analysis of Fiber – Reinforced Composite Materials", McGraw Hill, 1998

Reference Books:

1	Agarwal, B.D., and Broutman L.J., "Analysis and Performance of Fiber Composites", John Wiley and Sons, New York, 1990.
2	Halpin, J.C., "Primer on Composite Materials, Analysis", Technomic Publishing Co., 1984.
3	Issac M. Daniel and Ori Ishai, "Engineering Mechanics of Composite Materials", Oxford University Press-2006, First Indian Edition - 2007

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Assessment based on Continuous and End Semester Examination						
Bloom's Level	Continuous Assessment			Assignment	Attendance	End Semester Examination
	CIA1 (6 Marks)	CIA2 (6 Marks)	Model Exam (8 Marks)			
Remember				(10 Marks)	(10 Marks)	(60 Marks)
Understand						
Apply						
Analyze						
Evaluate						
Create						
Total (100 Marks)				**10**	**10**	**60**

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject.

COs/ POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
C526.1	3	2										1	2	1	
C526.2	3	3	2	2								1	3	2	
C526.3	3	3	2	2								1	2	2	
C526.4	2	3	2	1								1	3	2	
C526.5	3	3	2	2								1	3	3	

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24ME527	**Design for Manufacturing**	**PEC**	**3**	**0**	**0**	**3**
Regulation	**Nature of the Course**	**Semester**	**Data Book/Codes/Standards**			
R24	**PEC**	**VI**	**--------**			
Pre-requisite Course(s)		**Co-requisite Course(s)**				
Manufacturing Processes		Machine Design				
Course Objectives						
1	Understand economic process selection and general design principles for manufacturability, including design considerations for casting.					
2	Apply design principles for forming, machining, and welding to develop engineered products.					
3	Incorporate assembly design considerations for effective and manufacturable product development.					
Course Outcomes **Upon completion of the course, students shall have ability to**						
C101.1	Discuss the economic process selection and general design principles for manufacturability in product development, and apply casting design considerations to cast components.					[U]
C101.2	Apply forming design principles for extruded, stamped, and forged components.					[AP]

C101.3	Apply machining design considerations for various turned, drilled, milled, planed, shaped, slotted, and ground parts.	[AP]
C101.4	Apply welding design principles for cost-effective, strong, and distortion-minimized components.	[AP]
C101.5	Apply assembly design principles to minimize parts and optimize fasteners, joints, and automatic assembly.	[AP]

Course Contents		
Unit – 1	**INTRODUCTION AND CASTING**	**9**
Introduction - Economics of process selection - General design principles for manufacturability; Design considerations for: Sand cast – Die cast – Permanent mold cast parts.		
Unit – 2	**FORMING**	**9**
Design considerations for: Metal extruded parts – Impact/Cold extruded parts – Stamped parts –Forged parts.		
Unit – 3	**MACHINING**	**9**
Design considerations for: Turned parts – Drilled parts – Milled, planed, shaped and slotted parts– Ground parts.		
Unit – 4	**WELDING**	**9**
Arc welding – Design considerations for: Cost reduction – Minimizing distortion – Weld strength – Weldment & heat treatment. Resistance welding – Design considerations for: Spot – Seam – Projection – Flash & Upset weldment.		
Unit – 5	**ASSEMBLY**	**9**
Design for assembly – General assembly recommendations – Minimizing the no. of parts – Design considerations for: Rivets – Screw fasteners – Gasket & Seals – Press fits – Snap fits – Automatic assembly.		
	Total Hours	**45**

Textbooks:	
1	James G. Bralla, "Handbook of Product Design for Manufacture", 2nd Edition, McGraw Hill, 1999
2	O. Molloy, E.A. Warman, S. Tilley, Design for Manufacturing and Assembly: Concepts, Architectures and Implementation, Springer, 2012
Reference Books:	
1	CorradoPoli, Design for Manufacturing: A Structured Approach, Elsevier, 2001.
2	Erik Tempelman, Hugh Shercliff, Bruno Ninaber van Eyben, Manufacturing and Design: Understanding the Principles of How Things Are Made, Elsevier, 2014.
Web References:	
1	https://aplustopper.com/cme391-design-for-manufacturing%E2%80%91syllabus/
2	https://en.wikipedia.org/wiki/Design_for_manufacturability?utm_source=chatgpt.com

Assessment based on Continuous and End Semester Examination						
Bloom's Level	**Continuous Assessment**			**Assignment**	**Attendance**	**End Semester Examination**
	CIA1 (6 Marks)	**CIA2 (6 Marks)**	**Model Exam (8 Marks)**			
Remember				**(10 Marks)**	**(10 Marks)**	**(60 Marks)**
Understand	2	2	2			
Apply	4	4	6			
Analyze						
Evaluate						
Create						
Total (100 Marks)	**6**	**6**	**8**	**10**	**10**	**60**

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.

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- BTL mark split up may vary based on the nature of the subject.

COs/ POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PSO 1	PSO 2	PSO3
C101.1	3	3	3	2	2			2	2	2	2	3	3	
C101.2	3	3	3	2	2			2	2	2	2	3	3	
C101.3	3	3	3	2	3			2	2	2	2	3	3	
C101.4	3	3	3	2	2			2	2	2	2	3	3	
C101.5	3	3	3	2	3			2	2	2	2	3	3	

rse Code	Course Name	Category	Hours/Week			C
			L	T	P	
24ME528	CASTING AND WELDING PROCESSES	ES	3	0	0	3
Regulation	**Nature of the Course**	**Semester**	**Data Book/Codes/Standards**			
24	THEORY	VI				
Pre-requisite Course(s)		**Co-requisite Course(s)**				

Course Objectives

1.	To study the ferrous casting metallurgy and its applications.
2.	To study the nonferrous casting metallurgy and its applications.
3.	To study the ferrous welding metallurgy and its applications.
4.	To study the welding metallurgy of alloy steels and nonferrous metals and its applications
5.	To Identifying the causes and remedies of various welding defects; applying welding standards and codes.

Course Outcomes

Upon completion of the course, students shall have ability to

C601.1	To have the knowledge of the fundamental techniques to manufacture an engineering component.	AP
C601.2	To study the metallurgical concepts and applications of casting process.	AP
C601.3	Analyse the ferrous welding metallurgy with its application.	AP
C601.4	To be able to manufacture engineering components through foundry, metal forming and welding processes.	AP
C601.5	To understand different welding processes, design of welding joint, defects and weldability of different materials.	AP

Course Contents

Unit – 1	**FERROUS CAST ALLOYS**	9

Solidification of pure metals and alloys and eutectics -Nucleation – Growth Process, Critical nucleus size Super cooling- Niyama Criterion -G/R ratio- Cell- Dendritic – Random dendritic structure-Segregation and Coring-Eutectics-Compositions and alloys in Cast Irons, FG-CGI- SG structures, Metallic Glass- Mold dilation, Mold metal reactions- Structure and Section sensitivity Cast irons- family & microstructures-Alloying effects- Malleable Iron, ADI, Charge calculations- Effect of normal elements and alloying elements in steels Compositional aspects and properties of alloy steels- melting procedure and composition control for carbon steels- low alloy steels – stainless steels- composition control- slag-metal reactions-desulphurization dephosphorization, specifications for carbon steels- low alloy steels and stainless steels.

Unit – 2	**NON-FERROUS CAST ALLOYS**	9

Copper- Aluminium- Magnesium- zinc – Nickel base alloys- melting practices – Al alloys, Mg alloys, Nickel alloys, Zinc alloys and copper alloys-modification and grain refinement of Al alloys- problems in composition control-degassing techniques -Heat Treatment of Aluminium alloys – Basics of Solution and Precipitation process. – Applications of Aluminium Alloy castings in various fields. Residual Stresses- defects in castings.		
Unit – 3	**PHYSICAL METALLURGY OF WELDING**	9
Welding of ferrous materials: Iron- Iron carbide diagram, TTT and CCT diagrams, effects of steel composition, formation of different microstructural zones in welded plain-carbon steels. Welding of C-Mn and low-alloy steels, phase transformations in weld and heat – affected zones, cold cracking, role of hydrogen and carbon equivalent, formation of acicular ferrite and effect on weld metal toughness.		
Unit – 4	**WELDING OF ALLOY STEELS AND NON-FERROUS METALS**	9
Welding of stainless steels, types of stainless steels, overview of joining ferritic and martensitic types, welding of austenitic stainless steels, Sensitisation, hot cracking, sigma phase and chromium carbide formation, ways of overcoming these difficulties, welding of cast iron. Welding of non-ferrous materials: Joining of aluminium, copper, nickel and titanium alloys, problems encountered and solutions.		
Unit – 5	**DEFECTS, WELDABILITY AND STANDARDS**	9
Defects in welded joints: Defects such as arc strike, porosity, undercut, slag entrapment and hot cracking, causes and remedies in each case. Joining of dissimilar materials, weldability and testing of weldments. Introduction to International Standards and Codes.		
	Total Hours	45
Textbooks:		
1	Heine R W, Loper C R and Rosenthal P C, "Principles of Metal Castings", Tata McGraw Hill, 2017.	
2	A.K.Chakrabarthi, 'Casting Technology and Cast Alloys,Prentice Hall, 2005.	
Reference Books:		
1	ASM International. Handbook Committee, ASM Handbook: Casting. Volume 15, ASM International, 2008.	
2	Baldev Raj, Shankar V, Bhaduri A K, "Welding Technology for Engineers", Narosa Publications, 2009.	
3	Beeley P, "Foundry Technology" Butterworth-Heinemann, 2001.	
4	R.S.Parmar, 'Welding Engineering and Technology', Khanna Publishers, 2010	

Assessment based on Continuous and End Semester Examination

Bloom's Level	Continuous Assessment			Assignment	Attendance	End Semester Examination
	CIA1 (6 Marks)	CIA2 (6 Marks)	Model Exam (8 Marks)			
Remember				(10 Marks)	(10 Marks)	(60 Marks)
Understand	6	2	2			
Apply		4	6			
Analyze						
Evaluate						
Create						
Total (100 Marks)	6	6	8	**10**	**10**	**60**

CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.

The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.

BTL mark split up may vary based on the nature of the subject.

COs/ POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
C601.1	1	1	2	2					1			1	2	1	1
C601.2	1	1	2	2					1			1	2	1	1
C601.3	1	1	2	2					1			1	2	1	1

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C601.4	1	1	2	2					1			1	2	1	1
C601.5	1	1	2	2					1			1	2	1	1

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24ME529	PROCESS PLANNING AND COST ESTIMATION	PE	3	0	0	3
Regulation	**Nature of the Course**	**Semester**	**Data Book/Codes/Standards**			
24	THEORY	VI				
Pre-requisite Course(s)		**Co-requisite Course(s)**				

Course Objectives

1.	Discuss select the process, equipment and tools for various industrial products.
2.	Explain the prepare process planning activity chart
3.	Explain the concept of cost estimation.
4.	Compute the job order cost for different type of shop floor.
5.	. Calculate the machining time for various machining operations

Course Outcomes

Upon completion of the course, students shall have ability to

C605.1	Understand the process, equipment and tools for various industrial products.	U
C650.2	Apply process planning activity chart.	AP
C605.3	Apply the concept of cost estimation in industries.	AP
C605.4	Apply the job order cost for different type of shop floor.	AP
C605.5	Apply the machining time for various machining operations.	AP

Course Contents

Unit – 1	INTRODUCTION TO PROCESS PLANNING	9
Introduction- methods of process planning-Drawing Interpretation-Material evaluation – steps in process selection-. Production equipment and tooling selection		
Unit – 2	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 – 3	NTRODUCTION 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 – 4	PRODUCTION COST ESTIMATION	9
Estimation of Different Types of Jobs - Estimation of Forging Shop, Estimation of Welding Shop,Estimation of Foundry Shop		
Unit – 5	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 Hours	45

Textbooks:

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.

Reference Books:

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 & L.N. Aggarwal, "Production Planning Control and Industrial Management", Khanna Publishers 1990.

Assessment based on Continuous and End Semester Examination						
Bloom's Level	**Continuous Assessment**			**Assignment**	**Attendance**	**End Semester Examination**
	CIA1 (6 Marks)	**CIA2 (6 Marks)**	**Model Exam (8 Marks)**			
Remember				**(10 Marks)**	**(10 Marks)**	**(60 Marks)**
Understand	3		2			
Apply	3	6	6			
Analyze						
Evaluate						
Create						
Total (100 Marks)	6	6	8	**10**	**10**	**60**

CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
BTL mark split up may vary based on the nature of the subject.

COs/ POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PSO1**	**PSO2**	**PSO3**
C605.1	3	3	3	3					2		2	3	2	2
C605.2	3	3	3	3					2		2	3	2	2
C605.3	3	3	3	3					2		2	3	2	2
C605.4	3	3	3	3					2		2	3	2	2
C605.5	3	3	3	3					2		2	3	2	2

Course Code	**Course Name**	**Category**	**Hours/Week**			**C**
			L	**T**	**P**	
24ME530	SURFACE ENGINEERING	PE	3	0	0	3
Regulation	**Nature of the Course**	**Semester**	**Data Book/Codes/Standards**			
24	THEORY					
Pre-requisite Course(s)		**Co-requisite Course(s)**				
Course Objectives						
1	To study the fundamentals of surface features and different types of friction associated with metals and non-metals					
2	To study the different types of wear mechanism and its standard measurement.					
3	To study the different types of corrosion and its preventive measures					
4	To study the different types of surface properties and surface modification techniques					
5	To study the various types of materials used in the friction and wear applications					

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Course Outcomes **Upon completion of the course, students shall have ability to**		
C530.1	Explain the surface characteristics, roughness parameters, friction laws, and friction behavior of engineering materials.	[U]
C530.2	Explain the wear mechanisms, wear models, and international standards used in friction and wear measurements.	[U]
C530.3	Explain the types of corrosion, factors influencing corrosion, testing methods, and corrosion prevention techniques.	[U]
C530.4	Apply surface treatment and coating techniques such as PVD, CVD, ion implantation, and thermal spraying to improve material performance.	[AP]
C530.5	Apply the selection of advanced engineering materials such as alloys, ceramics, polymers, and biomaterials for tribological applications.	[AP]
Course Contents		
Unit – 1	**SURFACES AND FRICTION**	9
Basics of surfaces features – Roughness parameters – surface measurement - Cause of friction- Laws of friction – Static friction – Rolling Friction – Stick-slip Phenomenon - Friction properties of metal and nonmetals – Friction in extreme conditions – Thermal considerations in sliding contact.		
Unit – 2	**WEAR**	9
Laws of Wear - Types of Wear mechanism – wear debris analysis - Theoretical wear models - Wear of metals and nonmetals – International standards in friction and wear measurements		
Unit – 3	**CORROSION**	9
Introduction – Types of corrosion – Factors influencing corrosion – Testing of corrosion – In-service monitoring, Simulated service, Laboratory testing – Prevention of Corrosion – Material selection, Alteration of environment, Design, Cathodic and Anodic Protection, Corrosion inhibitors		
Unit – 4	**SURFACE TREATMENTS**	9
Surface properties – Hydrophobic – Super hydrophobic – Hydrophilic - surface metallurgy –Surface coating Techniques – PVD – CVD – Physical CVD – Ion implantation – Surface welding – Thermal spraying – Laser surface hardening and alloying - New trends in coating technology – DLC – CNC – Thick coatings – Nano-engineered coatings – Other coatings, Corrosion resistant coatings		
Unit – 5	**ENGINEERING MATERIALS**	9
Introduction – High and low friction materials - Advanced alloys – Super alloys, Titanium alloys, Magnesium alloys, Aluminium alloys, and Nickel based alloys – Ceramics – Polymers – Biomaterials – Bio Tribology - Nano Tribology.		
	Total Hours	45
Textbooks:		
1	G.W.Stachowiak and A.W.Batchelor, “Engineering Tribology”, Butterworth-Heinemann, 2005.	
2	S.K.Basu, S.N.Sengupta and B.B.Ahuja ,”Fundamentals of Tribology”, Prentice Hall of India, 2005.	
Reference Books:		
1	Fontana G., “Corrosion Engineering”, McGraw Hill, 1985.	
2	Halling, J. (Editor), “Principles of Tribology “, MacMillian, 1984.	
3	Joseph R. Davis, Corrosion: Understanding the Basics, ASM International, 2000.	

Assessment based on Continuous and End Semester Examination						
Bloom’s Level	**Continuous Assessment**			**Assignment**	**Attendance**	**End Semester Examination**
	CIA1 (6 Marks)	**CIA2 (6 Marks)**	**Model Exam (8 Marks)**			
Remember				**(10 Marks)**	**(10 Marks)**	**(60 Marks)**
Understand						

Apply						
Analyze						
Evaluate						
Create						
Total (100 Marks)				**10**	**10**	**60**

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject.

COs/ POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PS O3**
C530.1	3	2			1							1	2	1	
C530.2	3	3	2	2	2							1	3	2	
C530.3	3	3	2	2	1							1	3	2	
C530.4	2	3	2	1	2							1	2	2	
C530.5	3	2	2	2	2							1	3	3	

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Open elective courses

S No.	Course Code	Course Title	L/T/P	Contact Hrs./Wk.	Credits
1.	24OE631	Foundations of Robotics	3/0/0	3	3
2.	24OE632	Basics of Drone Technology	3/0/0	3	3
3.	24OE633	3D Printing	3/0/0	3	3
4.	24OE634	Digital Manufacturing	3/0/0	3	3
5.	24OE635	Composite Materials	3/0/0	3	3

rse Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE631	**FOUNDATION OF ROBOTICS**	OE	**3**	**0**	**0**	**3**
Regulation	**Nature of the Course**	**Semester**	**Data Book/Codes/Standards**			
R24	**THEORY**		**--------**			
Pre-requisite Course(s)		**Co-requisite Course(s)**				

Course Objectives	
1	To study the kinematics, drive systems and programming of robots.
2	To study the basics of robot laws and transmission systems.
3	To familiarize students with the concepts and techniques of robot manipulator, its kinematics.
4	To familiarize students with the various Programming and Machine Vision application in robots.
5	To build confidence among students to evaluate, choose and incorporate robots in engineering systems.

Course Outcomes **Upon completion of the course, students shall have ability to**		
C101.1	Interpret the features of robots and technology involved in the control.	[U]
C101.2	Apply basic engineering knowledge and relevant laws for the design of robotics.	[AP]
C101.3	Apply the concepts of various configurations, classifications, and parts of end effectors to compare different end effectors, grippers, tools, and sensors used in robots.	[AP]
C101.4	Apply the principles of kinematics, degeneracy, dexterity, and trajectory planning in robotics applications.	[AP]
C101.5	Apply image processing and image analysis techniques using a machine vision system.	[AP]

Course Contents		
Unit – 1	**FUNDAMENTALS OF ROBOT**	9
Robot Definition, Robot Anatomy Co-ordinate systems, Work Envelope, classification – Requirements- Pitch, yaw, Roll, Joint Notations, Speed of Motion, Pay Load - Need for Robots - Applications.		
Unit – 2	**ROBOT KINEMATICS**	9
Forward kinematics, inverse kinematics and the difference- two and three degrees of freedom (in 2 dimensional), four degrees of freedom (in 3 dimensional). Homogeneous transformation matrices, translation and rotation matrices.		
Unit – 3	**ROBOT DRIVE SYSTEMS AND END EFFECTORS**	9
Pneumatic Drives - Hydraulic Drives - Mechanical Drives - Electrical Drives: D.C. Servo Motors, Stepper Motor, A.C. Servo Motors - Applications and Comparison. End Effectors - Grippers : Mechanical , Pneumatic and Hydraulic, Magnetic , vacuum, internal and external grippers- selection and design considerations of a gripper.		
Unit – 4	**SENSORS IN ROBOTICS**	9
Force sensors, touch and tactile sensors, proximity sensors, non-contact sensors for hazarded environment and compliance mechanism. Machine vision system , frame grabber, sensing and digitizing image data signal conversion, image storage, lighting techniques, image processing and analysis - data reduction, segmentation, feature extraction, object recognition and other algorithms. Applications, Inspection, safety considerations , visual serving and navigation.		
Unit – 5	**PROGRAMMING AND APPLICATIONS OF ROBOT**	9
Teach pendant programming, lead through programming, robot programming languages -commands for Motion, Sensors and End-Effector. Robot applications for inspection, assembly, material handling, underwater, space and medical fields.		
	Total Hours	**45**

Textbooks:	
1	Ganesh.S.Hedge, "A textbook of Industrial Robotics", Lakshmi Publications, 2022.
2	Mikell.P.Groover, "Industrial Robotics McGraw Hill 2ND edition 2012. Technology, Programming and applications"
3	
Reference Books:	
1	Fu K.S. Gonalz R.C. and ice C.S.G. "Robotics Control, Sensing, Vision and Intelligence".

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	McGraw Hill book co. 2007
2	YoramKoren, "Robotics for Engineers", McGraw Hill Book, Co., 2002.
3	Janakiraman P.A., "Robotics and Image Processing", Tata McGraw Hill 2005.
4	John. J.Craig, "Introduction to Robotics: Mechanics and Control" 2nd Edition, 2002.
5	Jazar, "Theory of Applied Robotics: Kinematics, Dynamics and Control", Springer India reprint, 2010.
Web References:	
1	https://www.barnesandnoble.com/w/foundations-of-robotics-bruno-siciliano
2	https://www.foundations-of-robotics.org/?utm_source=chatgpt.com

Assessment based on Continuous and End Semester Examination						
Bloom's Level	**Continuous Assessment**			**Assignment**	**Attendance**	**End Semester Examination**
	CIA1 (6 Marks)	**CIA2 (6 Marks)**	**Model Exam (8 Marks)**			
Remember				**(10 Marks)**	**(10 Marks)**	**(60 Marks)**
Understand	4	2	2			
Apply	2	4	6			
Analyze						
Evaluate						
Create						
Total (100 Marks)	**6**	**6**	**8**	**10**	**10**	**60**

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject.

COs/ POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO3**
C101.1	√	√		√	√					√		√	√	√	
C101.2	√	√		√	√					√		√	√	√	
C101.3	√	√		√	√					√		√	√	√	
C101.4	√	√		√	√					√		√	√	√	
C101.5	√	√		√	√					√		√	√	√	

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE632	BASICS OF DRONE TECHNOLOGY	PC	3	0	0	3
Regulation	**Nature of the Course**	**Semester**	**Data Book/Codes/Standards**			
R24	**THEORY**		--------			
Pre-requisite Course(s)		**Co-requisite Course(s)**				
Nil		**Nil**				

Course Objectives	
1	To understand the basics of drone concepts
2	To learn and understand the fundaments of design, fabrication and programming of drone
3	To impart the knowledge of an flying and operation of drone
4	To know about the various applications of drone
5	To understand the safety risks and guidelines of fly safely

Course Outcomes **Upon completion of the course, students shall have ability to**		
C101.1	Know about a various type of drone technology, drone fabrication and programming.	[U]
C101.2	Execute the suitable operating procedures for functioning a drone	[U]
C101.3	Select appropriate sensors and actuators for Drones	[U]
C101.4	Develop a drone mechanism for specific applications	[U]
C101.5	Create the programs for various drones	[U]

Course Contents		
Unit – 1	**INTRODUCTION TO DRONE TECHNOLOGY**	9
Drone Concept - Terminology- History of drone - Overview of the main drone parts- Function of the component parts -Technical characteristics of the Types of current generation of drones based on their method of propulsion- Operation of drone. Classifications of the UAV.		
Unit – 2	**DRONE DESIGN, FABRICATION AND PROGRAMMING**	9
Assembling a drone - The energy sources- Types of autonomy - Drones configurations - methods of programming – programing, compiling and uploading - data collection - Wi-Fi connection.		
Unit – 3	**DRONE OPERATION**	9
Flight modes- Operation in a controlled environment- Drone controls- Multi rotor stabilization –management tools: Sensors, Onboard storage, control system-Removable storage devices – Linked devices and applications.		
Unit – 4	**DRONE COMMERCIAL APPLICATIONS**	9
Selection of a drone based on the application - Drones in the insurance sector- Drones in delivering parcels and other cargo - Drones in agriculture - Drones in inspection of transmission lines and power distribution -Drones in filming and panoramic picturing. Drones in military applications. Drone technology impact on the businesses- Drone business through entrepreneurship - Opportunities/applications for entrepreneurship and employability.		
Unit – 5	**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.		

Textbooks:	
1	Daniel Tal and John Altschuld, “Drone Technology in Architecture, Engineering and Construction: A Strategic Guide to Unmanned Aerial Vehicle Operation and Implementation”, 2021 John Wiley & Sons, Inc.
2	Terry Kilby and Belinda Kilby, “Make:Getting Started with Drones “,Maker Media, Inc, 2016 .

Reference Books:	
1	John Baichtal, “Building Your Own Drones: A Beginners' Guide to Drones, UAVs, and ROVs”, Que Publishing, 2016.
2	Zavrsnik, “Drones and Unmanned Aerial Systems: Legal and Social Implications for Security and Surveillance”, Springer, 2018.

Web References:	
1	https://dronelaunchacademy.com/
2	https://www.airsight.com/knowledge-hub/drone-basics

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Assessment based on Continuous and End Semester Examination						
Bloom's Level	**Continuous Assessment**			**Assignment**	**Attendance**	**End Semester Examination**
	CIA1 (6 Marks)	**CIA2 (6 Marks)**	**Model Exam (8 Marks)**			
Remember				**(10 Marks)**	**(10 Marks)**	**(60 Marks)**
Understand	2	2	2			
Apply	4	4	6			
Analyze						
Evaluate						
Create						
Total (100 Marks)	**6**	**6**	**8**	**10**	**10**	**60**

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject.

COs/ POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO3
C101.1	√	√				√	√	√				√			
C101.2	√	√	√	√								√			
C101.3	√	√				√	√	√				√			
C101.4	√	√	√	√								√			
C101.5	√	√	√	√	√	√						√			

urse Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE633	**3D PRINTING**	PC	**3**	**0**	**0**	**3**
Regulation	**Nature of the Course**	**Semester**	**Data Book/Codes/Standards**			
R24	Theory	**OE**	--------			
Pre-requisite Course(s)		**Co-requisite Course(s)**				
Computer Aided Design & Drafting		Engineering Materials				
Course Objectives						
1	To Know the importance of 3D printing in Manufacturing.					
2	To know the different 3D Printing Technologies.					
3	To select a suitable material for 3D Printing.					
4	To observe the different methods for Post-processing of 3D Printing parts.					
5	To Understand the applications of 3D Printing in Automobile, Aerospace, Bio-medical etc.					
Course Outcomes **Upon completion of the course, students shall have ability to**						
C101.1	Apply the features of robots and the technology involved in their control.					[AP]
C101.2	Apply basic engineering knowledge and relevant laws for the design of robotics.					[AP]
C101.3	Apply the concepts of various configurations, classifications, and parts of end effectors to					[AP]

	compare different end effectors, grippers, tools, and sensors used in robots.	
C101.4	Apply the principles of kinematics, degeneracy, dexterity, and trajectory planning in robotics applications.	[AP]
C101.5	Apply image processing and image analysis techniques using a machine vision system.	[AP]
Course Contents		
Unit – 1	**INTRODUCTION AND BASIC PRINCIPLES**	9
introduction, Generic 3D Printing Process, Benefits, Distinction Between 3D Printing and CNC Machining, Other Related Technologies Development of 3D Printing Technology: Introduction, Computers, Computer-Aided Design Technology, Other Associated Technologies, The Use of Layers, Classification of 3D Printing Processes, Metal Systems, Hybrid Systems, Milestones in 3D Printing Development, 3D Printing around the World.		
Unit – 2	**3D PRINTING PROCESS CHAIN & PHOTOPOLYMERIZATION PROCESSES**	9
Eight Steps in Additive Manufacture, Variations from One 3D Printing Machine to Another, Metal Systems, Maintenance of Equipment, Materials Handling Issues, Design for 3D PRINTING. Introduction to Photopolymerization Processes: Photopolymerization Materials, Reaction Rates, Vector ScanSL, SL Resin Curing Process, SL Scan Patterns, Vector Scan Micro stereolithography, Mask Projection Photopolymerization Technologies and Processes, Two-Photon SL.		
Unit – 3	**POWDER BED FUSION PROCESSES & EXTRUSION-BASED SYSTEMS**	9
Powder Bed Fusion Processes: Introduction, SLS Process Description, Powder Handling, Approaches to Metal and Ceric Part Creation, Variants of Powder Bed Fusion Processes, Process Par3D Printingeters, Applied Energy Correlations and Scan Patterns, Typical Materials and Applications, Materials - Capabilities and Limitations. Extrusion-Based Systems: Introduction, Basic Principles, Plotting and Path Control, Materials, Limitations of FDM, Bioextrusion, Other Systems		
Unit – 4	**DESIGN, GUIDELINES FOR PROCESS SELECTION & SOFTWARE ISSUES**	9
Design for 3D Printing - Design for Manufacturing and Assembly, Core DFM for 3D Printing Concepts and Objectives, 3D Printing Unique Capabilities, Exploring Design Freedoms, Design Tools for 3D Printing.Guidelines for Process Selection - Selection Methods for a Part, Challenges of Selection, Preliminary Selection,Production Planning and Control.Software Issues for 3D Printing - Preparation of CAD Models – the STL File, Problems with STL Files, STL File Manipulation, Beyond the STL File, Additional Software to Assist 3D Printing.		
Unit – 5	**MEDICAL APPLICATIONS & FUTURE DIRECTIONS FOR 3D PRINTING**	9
Medical Applications for 3D Printing - Use of 3D Printing to Support Medical Applications, Software Support for Medical Applications, Limitations of 3D Printing for Medical Applications, Further Development of Medical 3D Printing Applications.Use of Multiple Materials in 3D Printing - Discrete Multiple Material Processes, Porous Multiple Material Processes, Blended Multiple Material Processes, Embedded Component 3D Printing, Commercial Applications Using Multiple Materials, Future Directions, Business Opportunities and Future Directions		
	Total Hours	**45**
Textbooks:		
1	Ian Gibson, David W Rosen, Brent Stucker., "Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing", Springer, 2010.	
2	Khanna Editorial, "3D Printing and Design", Khanna Publishing House, Delhi.	
Reference Books:		
1	Chua Chee Kai, Leong Kah Fai, "Rapid Prototyping: Principles & Applications", World Scientific,2003.	
2	Ali K. Kamrani, Emand Abouel Nasr, "Rapid Prototyping: Theory & Practice", Springer, 2006.	
3	D.T. Pham, S.S. Dimov, Rapid Manufacturing: The Technologies and Applications of Rapid prototyping and Rapid Tooling, Springer 2001.	

Assessment based on Continuous and End Semester Examination						
Bloom's Level	**Continuous Assessment**			**Assignment**	**Attendance**	**End Semester Examination**
	CIA1 (6 Marks)	**CIA2 (6 Marks)**	**Model Exam (8 Marks)**			
Remember				**(10 Marks)**	**(10 Marks)**	**(60 Marks)**
Understand						

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Apply						
Analyze						
Evaluate						
Create						
Total (100 Marks)	**6**	**6**	**8**	**10**	**10**	**60**

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject.

COs/ POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
C101.1	3	3	3	3										2	
C101.2	3	3	3	3								2		2	
C101.3	3	3	3	3								2		2	
C101.4	3	2	3	3								2		2	
C101.5	3	2	2	3								3		2	

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE634	**DIGITAL MANUFACTURING**	OE	**3**	**0**	**0**	**3**
Regulation	**Nature of the Course**	**Semester**	**Data Book/Codes/Standards**			
R24	**THEORY**		**--------**			
Pre-requisite Course(s)		**Co-requisite Course(s)**				

Course Objectives

1	To study the various aspects of digital manufacturing.
2	To inculcate the importance of DM in Product Lifecycle Management and Supply
3	Chain Management.
4	To formulate of smart manufacturing systems in the digital work environment.
5	To interpret IoT to support the digital manufacturing.

Course Outcomes
Upon completion of the course, students shall have ability to

C101.1	Impart knowledge to use various elements in the digital manufacturing.	[U]
C101.2	Differentiate the concepts involved in digital product development life cycle process and supply chain management in digital environment.	[AP]
C101.3	Select the proper procedure of validating practical work through digital validation in Factories.	[AP]
C101.4	Implementation the concepts of IoT and its role in digital manufacturing.	[AP]
C101.5	Analyse and optimize various practical manufacturing process through digital twin	[AP]

Course Contents

Unit – 1	**INTRODUCTION**	9
Introduction – Need – Overview of Digital Manufacturing and the Past – Aspects of Digital Manufacturing: Product life cycle, Smart factory, and value chain management – Practical Benefits of Digital Manufacturing – The Future of Digital Manufacturing.		
Unit – 2	**DIGITAL LIFE CYCLE & SUPPLY CHAIN MANAGEMENT**	9
Collaborative Product Development, Mapping Requirements to specifications – Part Numbering, Engineering Vaulting, and Product reuse – Engineering Change Management, Bill of Material and Process Consistency – Digital Mock up and Prototype development – Virtual testing and collateral. Overview of Digital Supply Chain - Scope& Challenges in Digital SC - Effective Digital Transformation - Future Practices in SCM		
Unit – 3	**SMART FACTORY**	9
Smart Factory – Levels of Smart Factories – Benefits – Technologies used in Smart Factory – Smart Factory in IoT- Key Principles of a Smart Factory – Creating a Smart Factory – Smart Factories and Cyber security		
Unit – 4	**INDUSTRY 4.0**	9
Introduction – Industry 4.0 –Internet of Things – Industrial Internet of Things – Framework: Connectivity devices and services – Intelligent networks of manufacturing – Cloud computing – Data analytics –Cyber physical systems – Machine to Machine communication – Case Studies.		
Unit – 5	**STUDY OF DIGITAL TWIN**	9
Basic Concepts – Features and Implementation – Digital Twin: Digital Thread and Digital Shadow- Building Blocks – Types – Characteristics of a Good Digital Twin Platform – Benefits, Impact & Challenges – Future of Digital Twins.		
	Total Hours	**45**
Textbooks:		
1	Zude Zhou, Shane (Shengquan) Xie and Dejun Chen, Fundamentals of Digital Manufacturing Science, Springer-Verlag London Limited, 2012.	
2	Alasdair Gilchrist, "Industry 4.0: The Industrial Internet of Things", A press, 2016.	
3		
Reference Books:		
1	Lihui Wang and Andrew YehChing Nee, Collaborative Design and Planning for Digital Manufacturing,Springer-Verlag London Limited, 2009	
2	Andrew Yeh Chris Nee, Fei Tao, and Meng Zhang, "Digital Twin Driven Smart Manufacturing", Elsevier Science., United States, 2019	
3	Ustundag and Emre Cevikcan, "Industry 4.0: Managing The Digital Transformation", Springer Series in Advanced Manufacturing., Switzerland, 2017	
4	Ronald R. Yager and Jordan Pascual Espada, "New Advances in the Internet of Things", Springer., Switzerland, 2018.	
Web References:		
1	https://link.springer.com	
2	https://www.reddit.com	
3	https://link.springer.com	

Assessment based on Continuous and End Semester Examination						
Bloom's Level	**Continuous Assessment**			**Assignment**	**Attendance**	**End Semester Examination**
	CIA1 (6 Marks)	**CIA2 (6 Marks)**	**Model Exam (8 Marks)**			
Remember				**(10 Marks)**	**(10 Marks)**	**(60 Marks)**
Understand	4	2	2			
Apply	2	4	6			
Analyze						
Evaluate						
Create						
Total (100 Marks)	**6**	**6**	**8**	**10**	**10**	**60**

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and

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Assignment III marks converted to 10 Marks.

- BTL mark split up may vary based on the nature of the subject.

COs/ POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO3
C101.1	3	2		3	2					2		3	1	3	
C101.2	3	3		2	3					3		3	2	2	
C101.3	3	3		3	3					3		2	2	3	
C101.4	3	2		3	3					3		3	3	3	
C101.5	3	3		3	3					3		3	3	3	

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE635	**Composite Materials**	PC	3	0	0	3
Regulation	**Nature of the Course**	**Semester**	**Data Book/Codes/Standards**			
R24A	**THEORY**		--------			
Pre-requisite Course(s)		**Co-requisite Course(s)**				

Course Objectives

1	To introduce the fundamental concepts, classification, and applications of composite materials.
2	To provide knowledge on different types of reinforcement and matrix materials used in composites.
3	To impart understanding of various composite fabrication methods and processing techniques.
4	To develop knowledge of mechanical behavior, testing methods, and failure mechanisms of composites.
5	To explore advancements and emerging trends in composite materials.

Course Outcomes

Upon completion of the course, students shall have ability to

C101.1	Explain the classification, characteristics, and applications of composite materials	[U]
C101.2	Identify and describe types of reinforcement and matrix materials used in composites	[U]
C101.3	Apply suitable composite manufacturing techniques for specific applications	[AP]
C101.4	Analyze the mechanical behavior and failure mechanisms in composite materials	[AP]
C101.5	Discuss recent trends and developments in advanced composites	[U]

Course Contents

Unit – 1	Introduction:	9

Introduction and overview of composite materials and their need, Enhancement of properties, classification of composites, Matrix-Polymer matrix composites (PMC), Metal matrix composites (MMC), Ceramic matrix composites (CMC), Application of composites.

Unit – 2	Reinforcements Materials:	9

Metallic, Polymer, Ceramic and Composite fibres, Whiskers and Particulates, Nano-fillers used in polymer composites, Reinforcement fibres, Woven fabrics and Nonwoven random mats.
Types of matrix: Commonly used Matrices (Metal matrix, Polymer matrix, Ceramic matrix, Intermetallic matrix, Carbon-Carbon composites), Basic Requirements in Selection of constituents.

Unit – 3	Production techniques:	9

Processing of cast composites - XD process, Spray processes, In-situ Dispersion Processes, Liquidmetal impregnation technique .Hand lay-up processes – Spray up processes, Compression moulding, Reinforced reaction injection moulding, Resin transfer moulding, Pultrusion, Filament winding, Injection moulding.

Unit – 4	Mechanics of Composite Materials:	9
Continuous fibres – iso-stress and iso-strain conditions, discontinuous fibres, Nature of stress vs. strain curves for different composite materials. Mechanical Properties: Mechanical testing of composites – tensile, flexure (3 point and 4 point bend tests), interfacial tests of laminates; Modes of fracture; Toughening mechanisms in composites.		
Unit – 5	Recent developments in Composites:	9
Self healing composites, Molecular composites, Micro and Nanocomposites, Biocomposites, Left handed composites, Stiffer than stiff composites, Carbon / carbon composites (Advantages and limitations of carbon matrix).		
	Total Hours	**45**
Textbooks:		
1	**K. K. Chawla**, *Composite Materials – Science and Engineering*, Springer, 3rd Edition, 2012.	
2	**Gibson, R. F.**, *Principles of Composite Material Mechanics*, CRC Press, 4th Edition, 2016.	
Reference Books:		
1	**Mallick, P. K.**, *Fiber-Reinforced Composites: Materials, Manufacturing, and Design*, CRC Press, 3rd Edition, 2007.	
2	Mathews F.L., Rawlings R.D., Composite Materials: Engineering and Science, Woodhead Publishing, 1999.	
3	Agarwal, B. D., Broutman, L. J., Analysis and Performance of Fiber Composites, Wiley, 3rd Edition, 2006	
4	Sharma S.C., Composite materials, Narosa Publications, 2000.	
5	Mallick, P.K, Composite Materials Technology: Process and Properties, Hanser, New York, 1990.	

Assessment based on Continuous and End Semester Examination						
Bloom's Level	**Continuous Assessment**			**Assignment**	**Attendance**	**End Semester Examination**
	CIA1 (6 Marks)	**CIA2 (6 Marks)**	**Model Exam (8 Marks)**			
Remember				**(10 Marks)**	**(10 Marks)**	**(60 Marks)**
Understand	20	20	20			
Apply	30	30	80			
Analyze						
Evaluate						
Create						
Total (100 Marks)	**6**	**6**	**8**	**10**	**10**	**60**

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject.

COs/ POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO3**
C101.1	√						√								
C101.2	√	√					√								
C101.3	√	√	√		√							√			
C101.4	√	√	√	√	√							√			
C101.5	√				√		√					√			

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Open Elective courses offered to Mechanical Engineering by other Departments

Open Elective courses offered to Mechanical Engineering by other Departments

S No.	Course Code	Course Title	L/T/P	Contact hrs./Wk.	Credits	Cat.
1.	24OE606	Fundamentals of Computer vision	3/0/0	3	3	OE
2.	24OE607	Machine Learning and its applications	3/0/0	3	3	OE
3.	24OE608	Deep Learning Techniques	3/0/0	3	3	OE
4.	24OE609	Language Engineering	3/0/0	3	3	OE
5.	24OE610	Neural Networks	3/0/0	3	3	OE
6.	24OE611	Database Fundamentals	3/0/0	3	3	OE
7.	24OE612	Basics of Image Processing	3/0/0	3	3	OE
8.	24OE613	Agile Methodologies	3/0/0	3	3	OE
9.	24OE614	Web Technology Fundamentals	3/0/0	3	3	OE
10.	24OE615	App Development Fundamentals	3/0/0	3	3	OE
11.	24OE616	Introduction to Augmented Reality/Virtual Reality	3/0/0	3	3	OE
12.	24OE617	Software Engineering	3/0/0	3	3	OE
13.	24OE618	Foundation of Cloud Computing	3/0/0	3	3	OE
14.	24OE619	Java Programming	3/0/0	3	3	OE
15.	24OE620	Blockchain Technology	3/0/0	3	3	OE
16.	24OE621	Introduction to VLSI design	3/0/0	3	3	OE
17.	24OE622	Communication Engineering	3/0/0	3	3	OE
18	24OE623	Sensors and Actuators	3/0/0	3	3	OE
19.	24OE624	Embedded System	3/0/0	3	3	OE
20.	24OE625	Introduction to Internet of Things	3/0/0	3	3	OE
21.	24OE626	Industrial Automation with PLC and SCADA	3/0/0	3	3	OE
22.	24OE627	Electric Vehicle Technology	3/0/0	3	3	OE
23.	24OE628	Energy Technology	3/0/0	3	3	OE
24.	24OE629	Battery Management Systems	3/0/0	3	3	OE
25.	24OE630	Power Converters for Electrical Appliances	3/0/0	3	3	OE
26.	24OE631	Foundation of Robotics	3/0/0	3	3	OE

27.	24OE632	Basics of Drone Technology	3/0/0	3	3	OE
28	24OE633	Industrial Management	3/0/0	3	3	OE
29.	24OE634	Additive Manufacturing	3/0/0	3	3	OE
30.	24OE635	Introduction to Non- Destructive Testing	3/0/0	3	3	OE
31.	24OE636	Fundamentals of Operations Research	3/0/0	3	3	OE
32.	24OE637	Organizational Behaviour	3/0/0	3	3	OE
33.	24OE638	Total Quality Management	3/0/0	3	3	OE
34.	24OE639	Intellectual Property Rights	3/0/0	3	3	OE
35.	24OE640	Emotional Intelligence	3/0/0	3	3	OE
36.	24OE641	Algebra and Number Theory	3/0/0	3	3	OE
37.	24OE642	Linear Algebra	3/0/0	3	3	OE
38	24OE643	Advanced Engineering Chemistry	3/0/0	3	3	OE
39.	24OE644	Nanotechnology and NLO Materials	3/0/0	3	3	OE
40.	24OE645	English for Competitive Examinations	3/0/0	3	3	OE

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE606	FUNDAMENTALS OF COMPUTER VISION	OE	3	0	0	3
Regulation	**Nature of the Course**	**Semester**	**Data Book/Codes/Standards**			
2024	Theory	VI	-			
Pre-requisite Course(s)		**Co-requisite Course(s)**				
Programming in C, Probability and Statistics		-				

Course Objectives

1	To understand the fundamental concepts related to Image formation and processing.
2	To learn feature detection, matching and detection
3	To become familiar with feature-based alignment and motion estimation
4	To develop skills on 3D reconstruction
5	To understand image-based rendering and recognition

Course Outcomes

Upon completion of the course, students will be able to

C606.1	To understand basic knowledge, theories and methods in image processing and computer vision.	[U]
C606.2	To implement basic and some advanced image processing techniques in OpenCV.	[AP]
C606.3	To apply 2D feature- based image alignment, segmentation and motion estimations.	[AP]
C606.4	To apply 3D image reconstruction techniques	[AP]
C606.5	To design and develop innovative image processing and computer vision applications.	[AP]

Course Contents

Unit – 1	**INTRODUCTION TO IMAGE FORMATION AND PROCESSING**	**CO1**	**9 Hrs**

Computer Vision - Geometric primitives and transformations - Photometric image formation - The digital camera - Point operators - Linear filtering - More neighborhood operators - Fourier transforms - Pyramids and wavelets - Geometric transformations - Global optimization.

Unit – 2	**FEATURE DETECTION, MATCHING AND SEGMENTATION**	**CO2**	**9 Hrs**

Points and patches - Edges - Lines - Segmentation - Active contours - Split and merge - Mean shift and mode finding - Normalized cuts - Graph cuts and energy-based methods.

Unit – 3	**FEATURE-BASED ALIGNMENT & MOTION ESTIMATION**	**CO3**	**9 Hrs**

2D and 3D feature-based alignment - Pose estimation - Geometric intrinsic calibration - Triangulation - Two-frame structure from motion - Factorization - Bundle adjustment - Constrained structure and motion - Translational alignment - Parametric motion - Spline-based motion - Optical flow - Layered motion.

Unit – 4	**3D RECONSTRUCTION**	**C04**	**9 Hrs**

Shape from X - Active range finding - Surface representations - Point-based representations - Volumetric representations - Model-based reconstruction - Recovering texture maps and albedosos.

Unit – 5	**IMAGE-BASED RENDERING AND RECOGNITION**	**C05**	**9 Hrs**

View interpolation Layered depth images - Light fields and Lumigraphs - Environment mattes - Video-based rendering-Object detection - Face recognition - Instance recognition - Category recognition - Context and scene understanding- Recognition databases and test sets.

Total Hours	**45**

Textbooks:

1	D. A. Forsyth, J. Ponce, *Computer Vision: A Modern Approach*, 2nd Edition, Pearson India, Latest Reprint 2025.
2	Richard Szeliski, *Computer Vision: Algorithms and Applications*, 2nd Edition, Springer, 2022.

Reference Books:

1	Richard Hartley and Andrew Zisserman, Multiple View Geometry in Computer Vision, Second Edition, Cambridge University Press, March 2004
2	Christopher M. Bishop; Pattern Recognition and Machine Learning, Springer, 2006

Web References:

1	https://archive.nptel.ac.in/courses/106/105/106105216/
2	https://opencv.org/opencv-free-course/

Assessment based on Continuous and End Semester Examination						
BLOOM'S TAXONOMY LEVEL	**CONTINUOUS ASSESSMENT**			**ASSIGNMENT**	**ATTENDANCE**	**END SEMESTER EXAMINATION**
	CIA1 (6 Marks)	**CIA2 (6 Marks)**	**Model Exam (8 Marks)**	**(10 Marks)**	**(10 Marks)**	**(60 Marks)**
Remember				10	10	
Understand	20	20	20			
Apply	80	80	80			
Analyze						
Evaluate						
Create						
Total (100 Marks)	**6**	**6**	**8**	**10**	**10**	**60**

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject.

COs/ POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PSO 1**	**PSO 2**
C606.1	3	2	-	-	2	-	-	-	-	-	2	2	-
C606.2	3	3	2	2	3	-	-	-	-	-	2	3	2
C606.3	3	2	2	2	3	-	-	-	-	-	2	3	2
C606.4	3	3	3	3	2	-	-	-	-	-	2	3	2
C606.5	3	3	2	3	3	2	2	2	2	-	3	3	2

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

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE607	Machine Learning and its Applications	OE	3	0	0	3
Regulation	**Nature of the Course**	**Semester**	**Data Book/Codes/Standards**			
R24	THEORY		--------			
Pre-requisite Course(s)		**Co-requisite Course(s)**				
Nil		-				

Course Objectives

1	To understand the basic concepts of machine learning.
2	To understand and build supervised learning models.
3	To understand and build unsupervised learning models.
4	To design the algorithms based on corresponding metrics identified.
5	To make use of classification algorithms, build the machine learning experiments.

Course Outcomes

Upon completion of the course, students shall have ability to

C607.1	Understand the fundamental concepts and applications of machine learning.	U
C607.2	Apply preprocessing techniques and appropriate machine learning algorithms to real-world problems.	AP
C607.3	Apply supervised learning algorithms and evaluate model performance.	AP
C607.4	Implement ensemble and unsupervised learning techniques.	AP
C607.5	Design, evaluate, and compare machine learning experiments using appropriate statistical tools.	AP

Course Contents

Unit – 1	**INTRODUCTION TO MACHINE LEARNING**	9

Introduction to Machine Learning and its importance, Types of Machine Learning: Supervised, Unsupervised, and Reinforcement Learning, Basic concepts: features, labels, training data, etc., Popular Machine Learning algorithms: Linear Regression, Logistic Regression, Decision Trees, kNearest Neighbors, etc., Evaluation metrics for Machine Learning models: accuracy, precision, recall, F1-score, etc.

Unit – 2	**MACHINE LEARNING TECHNIQUES**	9

Machine Learning Techniques Data preprocessing techniques: handling missing data, feature scaling, feature encoding, etc., Model selection and hyperparameter tuning, Cross-validation techniques, Ensemble methods: Bagging, Boosting, Random Forests, etc., Introduction to deep learning and neural networks

Unit – 3	**SUPERVISED LEARNING**	9

Linear Regression Models: Least squares, single & multiple variables, Bayesian linear regression, gradient descent, Linear Classification Models: Discriminant function – Perceptron algorithm, Probabilistic discriminative model - Logistic regression, Probabilistic generative model – Naive Bayes, Maximum margin classifier – Support vector machine, Decision Tree, Random Forests.

Unit – 4	**APPLICATIONS OF MACHINE LEARNING**	9

Ensemble learning applications, Voting technique, Bagging method, Boosting method, Stacking approach, Recommendation systems, K-means clustering for segmentation, KNN for classification, Anomaly detection.

Unit – 5	**MACHINE LEARNING PROJECT DESIGN AND ANALYSIS**	9

Problem definition, Data collection, Data preprocessing, Model training (classification), Model training (regression), Model evaluation metrics, Model comparison, Model deployment basics, Ethical issues and challenges in real-world machine learning applications.

Total Hours	**45**

Text books:

1	EthemAlpaydin, “Introduction to Machine Learning”, MIT Press, Fourth Edition, 2020.

2	Stephen Marsland, "Machine Learning: An Algorithmic Perspective, "Second Edition", CRC Press, 2022.
Reference Books:	
1	Christopher M. Bishop, "Pattern Recognition and Machine Learning", Springer, 2006.
2	Tom Mitchell, "Machine Learning", McGraw Hill, 3rd Edition, 1997.
3	MehryarMohri, Afshin Rostamizadeh, Ameet Talwalkar, "Foundations of Machine Learning", Second Edition, MIT Press, 2018.
4	Ian Goodfellow, YoshuaBengio, Aaron Courville, "Deep Learning", MIT Press, 2016
5	SebastainRaschka, Vahid Mirjalili , "Python Machine Learning", Packt publishing 3rd Edition, 2019.
Web References:	
1	https://www.coursera.org/lecture/python-machine-learning/introduction-4f2So2
2	https://nptel.ac.in/courses/106/106/106106139/

Assessment based on Continuous and End Semester Examination						
Bloom's Level	**Continuous Assessment**			**Assignment**	**Attendance**	**End Semester Examination**
	CIA1 (6 Marks)	**CIA2 (6 Marks)**	**Model Exam (8 Marks)**			
Remember				**(10 Marks)**	**(10 Marks)**	**(60 Marks)**
Understand	80%	20%	20%			
Apply	20%	80%	80%			
Analyze						
Evaluate						
Create						
Total (100 Marks)	**6**	**6**	**8**	**10**	**10**	**60**

● CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.

● The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.

● BTL mark split up may vary based on the nature of the subject.

COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
C607.1	3	2	-	-	2	-	-	-	-	-	1	-	3
C607.2	3	3	2	2	3	-	-	-	-	-	2	-	3
C607.3	3	3	3	2	3	-	-	-	-	-	2	-	3
C607.4	3	3	3	3	3	-	-	-	-	-	2	-	3
C607.5	3	3	3	3	3	-	-	-	-	-	3	-	3

3 - Strong 2 - Moderate 1 - Weak - - no correlation

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE608	Deep Learning Techniques	OE	3	0	0	3
Regulation	**Nature of the Course**	**Semester**	**Data Book/Codes/Standards**			
2024	Theory	V	-			
Pre-requisite Course(s)		**Co-requisite Course(s)**				
Foundamentals oF Machine Learning		Artificial Intelligence				

Course Objectives

1	To understand principles of deep neural networks.
2	To understand CNN architectures of deep neural networks.
3	To understand RNN architectures of deep neural networks.
4	To comprehend advanced deep learning models.
5	To learn the evaluation metrics for deep learning models.

Course Outcomes

Upon completion of the course, students will be able to

C608.1	Understand the basics in deep neural networks.	U
C608.2	Apply Convolution Neural Network for image processing.	AP
C608.3	Apply Recurrent Neural Network and its variants for text analysis.	AP
C608.4	Demonstrate the model evaluation for various applications.	AP
C608.5	Apply autoencoders and generative models for suitable applications.	AP

Course Contents

Unit – 1	**DEEP NETWORKS BASICS**	**CO1**	**10**
Linear Algebra: Scalars -- Vectors -- Matrices and tensors; Probability Distributions -- Gradient-based Optimization – Machine Learning Basics: Capacity -- Overfitting and underfitting --Hyperparameters and validation sets -- Estimators -- Bias and variance -- Stochastic gradient descent -- Deep Networks: Deep feedforward networks; Regularization -- Optimization.			
Unit – 2	**CONVOLUTIONAL NEURAL NETWORKS**	**CO2**	**10**
Convolution Operation -- Sparse Interactions -- Parameter Sharing -- Equivariance -- Pooling -- Convolution Variants: Strided -- Tiled -- Transposed and dilated convolutions; CNN Learning: Nonlinearity Functions -- Loss Functions -- Regularization -- Optimizers --Gradient Computation.			
Unit – 3	**RECURRENT NEURAL NETWORKS**	**CO3**	**9**
Unfolding Graphs -- RNN Design Patterns: Acceptor -- Encoder --Transducer; Gradient Computation -- Sequence Modeling Conditioned on Contexts -- Bidirectional RNN -- Sequence to Sequence RNN – Deep Recurrent Networks -- Recursive Neural Networks -- Long Term Dependencies; Leaky Units: Skip connections and dropouts; Gated Architecture: LSTM.			
Unit – 4	**MODEL EVALUATION**	**C04**	**8**
Performance metrics -- Baseline Models -- Hyperparameters: Manual Hyperparameter -- Automatic Hyperparameter -- Grid search -- Random search -- Debugging strategies.			
Unit – 5	**AUTOENCODERS AND GENERATIVE MODELS**	**C05**	**8**
Autoencoders: Undercomplete autoencoders -- Regularized autoencoders -- Stochastic encoders and decoders -- Learning with autoencoders; Deep Generative Models: Variational autoencoders – Generative adversarial networks - DALL-E, DALL-E 2 and IMAGEN			
		Total Hours	**45**

Textbooks:

1	Ian Goodfellow, Yoshua Bengio, Aaron Courville, ``Deep Learning'', MIT Press, 2018.
2	Andrew Glassner, “Deep Learning: A Visual Approach”, No Starch Press, 2021.

3	Salman Khan, Hossein Rahmani, Syed Afaq Ali Shah, Mohammed Bennamoun, ``A Guide to Convolutional Neural Networks for Computer Vision'', Synthesis Lectures on Computer Vision, Morgan & Claypool publishers, 2018.
Reference Books:	
1	Francois Chollet, ``Deep Learning with Python'', Manning Publications Co, 2018.
2	Charu C. Aggarwal, ``Neural Networks and Deep Learning: A Textbook'', Springer International Publishing, 2018.
3	Josh Patterson, Adam Gibson, ``Deep Learning: A Practitioner's Approach'', O'Reilly Media, 2021.
4	Yoav Goldberg, ``Neural Network Methods for Natural Language Processing'', Synthesis Lectures on Human Language Technologies, Morgan & Claypool publishers, 2020.
Web References:	
1	https://nptel.ac.in/courses/
2	https://aikosh.indiaai.gov.in/static/Deep+Learning+Ian+Goodfellow.pdf

Assessment based on Continuous and End Semester Examination						
BLOOM'S TAXONOMY LEVEL	**CONTINUOUS ASSESSMENT**			**ASSIGNMENT**	**ATTENDANCE**	**END SEMESTER EXAMINATION**
	CIA1 (6 Marks)	**CIA2 (6 Marks)**	**Model Exam (8 Marks)**	**(10 Marks)**	**(10 Marks)**	**(60 Marks)**
Remember				10	10	60
Understand	80	20	20			
Apply	20	80	80			
Analyze						
Evaluate						
Create						
Total (100 Marks)	**6**	**6**	**8**	**10**	**10**	**60**

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject.

COs/ POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PSO1**	**PSO2**
C608.1	3	2	1	-	1	-	-	-	-	-	-	2	1
C608.2	3	3	2	2	3	-	-	-	-	-	1	3	2
C608.3	2	3	3	2	3	-	-	-	1	-	1	3	3
C608.4	2	3	2	3	2	-	-	-	-	-	1	2	2
C608.5	1	2	3	2	3	-	-	-	1	1	1	3	3

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

Course Code	Course Name	Category	Hours/ Week	C		
			L	T	P	
24OE609	Language engineering	OE	3	0	2	4
Regulation	**Nature of the Course**	**Semester**	**Data Book/Codes/Standards**			
R24	Theory	4	--------			
Pre-requisite Course(s)		**Co-requisite Course(s)**				
Nil		Natural Language processing				

Course Objectives	
1	To understand the fundamentals of natural language processing
2	To construct the word level analysis methods
3	To identify word class methods and models
4	To construct Context Free Grammar in syntactic analysis
5	To develop parsing concepts in syntactic analysis

Course Outcomes **Upon completion of the course, students shall have ability to**		
C609.1	Understand basic language features for the given text.	U
C609.2	Build a rule based system to tackle morphology/syntax of a language	AP
C609.3	Build a rule based tagging and models for word level applications.	AP
C609.4	Apply different statistical approaches for CFG applications.	AP
C609.5	Build innovative parsing concepts to process natural language.	AP

Course Contents		
Unit – 1	INTRODUCTION	9
Origins and challenges of NLP – Language Modeling: Grammar-based LM, Statistical LM - Regular Expressions, Finite-State Automata – English Morphology, Transducers for lexicon and rules, Tokenization, Detecting and Correcting Spelling Errors, Minimum Edit Distance.		
Unit – 2	WORD LEVEL ANALYSIS	9
Unsmoothed N-grams, Evaluating N-grams, Smoothing, Interpolation and Backoff – Word Classes, Part-of-Speech Tagging.		
Unit – 3	WORD LEVEL MODELS	9
Rule-based, Stochastic and Transformation-based tagging, Issues in PoS tagging – Hidden Markov and Maximum Entropy models.		
Unit – 4	SYNTACTIC ANALYSIS -Context-Free Grammars	9

Context-Free Grammars, Grammar rules for English, Treebanks, Normal Forms for grammar – Dependency Grammar.		
Unit – 5	SYNTACTIC ANALYSIS -Parsing concepts	9
Syntactic Parsing, Ambiguity, DynamicProgramming parsing – Shallow 85 parsing – Probabilistic CFG, Probabilistic CYK,Probabilistic Lexicalized CFGs - Feature structures, Unification of feature structures.		
	Total Hours	**45**
Textbooks:		
1	Daniel Jurafsky, James H. Martin―Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech, Pearson Publication, 2014.	
2	Steven Bird, Ewan Klein and Edward Loper, ―Natural Language Processing with Python, First Edition, O'Reilly Media, 2009.	
Reference Books:		
1	Breck Baldwin, ―Language Processing with Java and LingPipe Cookbook, Atlantic Publisher, 2015.	
2	Richard M Reese, ―Natural Language Processing with Java‖, O'Reilly Media, 2015.	
4	Tanveer Siddiqui, U.S. Tiwary, "Natural Language Processing and Information Retrieval", Oxford University Press, 2008.	
Web References:		
1	https://onlinecourses.nptel.ac.in/noc23_cs45/preview	

Assessment based on Continuous and End Semester Examination

Bloom's Level	**Continuous Assessment**			**Assignment**	**Attendance**	**End Semester Examination**
	CIA1 (6 Marks)	**CIA2 (6 Marks)**	**Model Exam (8 Marks)**			
Remember				**(10 Marks)**	**(10 Marks)**	**(60 Marks)**
Understand	80%	20%	20%			
Apply	20%	80%	80%			
Analyze						
Evaluate						
Create						
Total (100 Marks)	**6**	**6**	**8**	**10**	**10**	**60**

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject.

COs/ POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2
C609.1	3	2	1	2	1	-	-	-	-	1	-	-	-	2
C609.2	3	3	2	2	-	-	-	-	-	2	-	-	-	2
C609.3	3	3	2	3	-	-	-	-	-	2	-	-	-	2
C609.4	3	3	2	2	-	-	-	-	-	1	-	-	-	2
C609.5	3	3	3	3	-	-	-	-	-	2	-	-	-	2

3 - Strong2 - Moderate 1 - Weak - - no correlation

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE610	Neural Networks	OE	3	0	0	3
Regulation	**Nature of the Course**	**Semester**	**Data Book/Codes/Standards**			
24	THEORY	VI				
Pre-requisite Course(s)		**Co-requisite Course(s)**				
Programming Fundamentals		Artificial Intelligence				

Course Objectives

1	Introduce the basic concepts of **biological neurons and artificial neural networks**.
2	Explain different **neural network architectures and learning algorithms**.
3	Provide knowledge of **fuzzy sets, fuzzy logic, and fuzzy reasoning systems**.
4	Understand **fuzzy inference systems and fuzzy controllers used in industrial applications**.
5	Explain the principles and applications of **genetic algorithms for optimization problems**.

Course Outcomes

Upon completion of the course, students will be able to

C610.1	Explain the structure and working of biological and artificial neural networks.	[U]
C610.2	Apply perceptron learning and back propagation algorithms to neural network models.	[AP]
C610.3	Understand fuzzy sets, fuzzy relations and operations in fuzzy logic.	[U]
C610.4	Design fuzzy inference systems and fuzzy controllers for real-world applications.	[AP]
C610.5	Apply genetic algorithms for optimization and problem solving	[AP]

Course Contents

Unit – 1	**Introduction & Architecture**	**CO1**	**9 Hrs**

Neuron, nerve structure and synapse. Artificial neuron and its model. Activation functions. Neural network architecture: single layer feed forward networks, multilayer feed forward networks, recurrent networks. Various learning techniques: perceptron learning rule, convergence rule. Auto-associative memory and hetero-associative memory.

Unit – 2	**Back Propagation Networks**	**CO2**	**10 Hrs**

Architecture of neural networks. Perceptron model and solution. Single layer artificial neural network. Multilayer perceptron model. Back propagation learning methods. Effect of learning rule coefficient. Back propagation algorithm. Factors affecting back propagation training. Applications of back propagation networks.

Unit – 3	**Fuzzy Logic – I (Introduction)**	**CO3**	**8 Hrs**

Basic concepts of fuzzy logic. Fuzzy sets and crisp sets. Fuzzy set theory and operations. Properties of fuzzy sets. Fuzzy relations and crisp relations. Fuzzy to crisp conversion.

Unit – 4	**Fuzzy Logic – II (Membership Functions and Rules)**	**C04**	**9 Hrs**

Membership functions. Inference in fuzzy logic. Fuzzy IF–THEN rules. Fuzzy implications and fuzzy algorithms. Fuzzification and defuzzification. Fuzzy controller. Industrial applications of fuzzy logic.

Unit – 5	**Genetic Algorithms (GA)**	**C05**	**9 Hrs**

Basic concepts of genetic algorithms. Working principle of GA. Procedure of GA. Flow chart of GA. Genetic representation (encoding). Initialization and selection. Genetic operators. Mutation. Generational cycle. Applications of genetic algorithms.

Total Hours	**45**

Textbooks:

1	Soft Computing and Machine Learning: A Fuzzy and Neutrosophic View of Reality, Mohd Anas Wajid, Aasim Zafar, Mohammad Saif Wajid, Akib Mohi Ud Din Khanday, Pronaya Bhattacharya, CRC Press, First Edition, 2025.
2	Artificial Neural Networks and Type-2 Fuzzy Set, Snehashish Chakraverty, Arup Kumar Sahoo, Dhabaleswar Mohapatra, Elsevier, First Edition, 2025.

Reference Books:

1	New Horizons for Fuzzy Logic Neural Networks and Metaheuristics, Oscar Castillo, Patricia Melin,

	Springer, First Edition, 2024.
2	Soft Computing in Interdisciplinary Sciences, S. Chakraverty, Springer, First Edition, 2022.
Web References:	
1	**NPTEL Course – Fuzzy Logic and Neural Networks** https://nptel.ac.in
2	**tanford Online – Machine Learning Resources** https://online.stanford.edu

Assessment based on Continuous and End Semester Examination						
BLOOM'S TAXONOMY LEVEL	**CONTINUOUS ASSESSMENT**			**ASSIGNMENT**	**ATTENDANCE**	**END SEMESTER EXAMINATION**
	CIA1 (6 Marks)	**CIA2 (6 Marks)**	**Model Exam (8 Marks)**	**(10 Marks)**	**(10 Marks)**	**(60 Marks)**
Remember						
Understand	60	40	40			
Apply	40	60	60			
Analyze						
Evaluate						
Create						
Total (100 Marks)	**6**	**6**	**8**	**10**	**10**	**60**

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject.

COs/ POs	**PO 1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PSO1**	**PSO2**
C610.1	3	2	2	1	1	1	0	0	0	0	2	2	1
C610.2	3	3	3	2	2	1	2	2	1	0	3	3	2
C610.3	2	2	2	1	1	1	0	0	0	0	2	2	1
C610.4	3	3	3	2	2	2	2	2	1	1	3	3	2
C610.5	3	3	3	3	3	2	2	2	2	1	3	3	3

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

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE611	**DATABASE FUNDAMENTALS**	OE	**3**	**0**	**0**	**3**
Regulation	**Nature of the Course**	**Semester**	**Data Book/Codes/Standards**			
2024	**THEORY**	**-**	**--------**			
Pre-requisite Course(s)		**Co-requisite Course(s)**				
-		**-**				

Course Objectives	
1	To learn the fundamentals of data models, relational algebra and SQL
2	To represent a database system using ER diagrams and to learn normalization techniques
3	To have an introductory knowledge about the Distributed databases, NOSQL and database security

Course Outcomes **Upon completion of the course, students shall have ability to**		
OE611.1	To understand basics of Databases	[U]
OE611.2	To understand basics of Relational Databases	[U]
OE611.3	To design database using ER model and normalize the database	[AP]
OE611.4	To apply database concepts on distributed Databases	[AP]
OE611.5	To apply database concepts on Database Security	[AP]

Course Contents			
Unit – 1	**Introduction**	**CO1**	**8**
Introduction to Databases - Database Models- Components of a DBMS- Types of Databases - Purpose of Database System – Views of data – Data Models – Database System Architecture - Applications of Databases			
Unit – 2	**Relational Databases**	**CO2**	**10**
Introduction to relational databases – Relational Model – Keys – Relational Algebra – SQL fundamentals – Advanced SQL features – Embedded SQL– Dynamic SQL			
Unit – 3	**Database Design**	**CO3**	**9**
Entity-Relationship model – E-R Diagrams – Enhanced-ER Model – ER-to-Relational Mapping – Functional Dependencies – Non-loss Decomposition – First, Second, Third Normal Forms, Dependency Preservation – Boyce/Codd Normal Form – Multi-valued Dependencies and Fourth Normal Form – Join Dependencies and Fifth Normal Form			
Unit – 4	**Distributed Databases**	**CO4**	**9**
Architecture, Data Storage, Transaction Processing, Query processing and optimization – NOSQL Databases: Introduction – CAP Theorem – Document Based systems – Key value Stores – Column Based Systems – Graph Databases			
Unit – 5	**Database Security**	**CO5**	**9**
Security issues – Access control based on privileges – Role Based access control – SQL Injection – Statistical Database security – Flow control – Encryption and Public Key infrastructures – Challenges			
		Total Hours	**45**

Textbooks:	
1	Abraham Silberschatz, Henry F. Korth, S. Sudharshan, “Database System Concepts”, Seventh Edition, McGraw Hill, 2020.
2	Ramez Elmasri, Shamkant B. Navathe, “Fundamentals of Database Systems”, Seventh Edition, Pearson Education, 2017
Reference Books:	
1	C.J.Date, A.Kannan, S.Swamynathan, “An Introduction to Database Systems”, Eighth Edition, Pearson Education, 2006.

2	Thomas Connolly, Carolyn Begg, "Database Systems: A Practical Approach to Design, Implementation and Management", Sixth Edition, Pearson Education, 2015.
3	Hector Garcia-Molina, Jeffrey D. Ullman, Jennifer Widom, "Database Systems: The Complete Book", Second Edition, Pearson Education, 2009.
Web References:	
1.	https://nptel.ac.in/courses/106104135
2.	https://onlinecourses.nptel.ac.in/noc22_cs91/preview

Assessment based on Continuous and End Semester Examination						
Bloom's Level	**Continuous Assessment**			**Assignment**	**Attendance**	**End Semester Examination**
	CIA1 (6 Marks)	**CIA2 (6 Marks)**	**Model Exam (8 Marks)**	**(10 Marks)**	**(10 Marks)**	**(60 Marks)**
Remember				**10**	**10**	**60**
Understand	100	60	80			
Apply		40	20			
Analyze						
Evaluate						
Create						
Total (100 Marks)	**6**	**6**	**8**	**10**	**10**	**60**

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject.

COs/ POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PSO 1**	**PSO 2**	**PSO 3**
OE611.1	3	2	1	1	1	–	–	–	–	–	1	2	1	1
OE611.2	3	2	1	1	2	–	–	–	–	–	1	2	2	2
OE611.3	3	2	3	1	2	–	–	–	–	–	1	3	2	3
OE611.4	3	3	2	2	3	–	–	–	–	–	2	2	3	3
OE611.5	2	2	2	1	2	–	–	–	–	–	1	2	3	2

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE612	BASICS OF IMAGE PROCESSING	OE	3	0	0	3
Regulation	Nature of the Course	Semester	Data Book/Codes/Standards			
2024	THEORY	-	--------			
Pre-requisite Course(s)		Co-requisite Course(s)				
-		-				

Course Objectives	
1	To become familiar with digital image fundamentals.
2	To get exposed to simple image enhancement techniques in Spatial and Frequency domain.
3	To learn concepts of degradation function and restoration techniques.
4	To study the image segmentation and representation techniques.
5	To become familiar with image compression and recognition methods

Course Outcomes Upon completion of the course, students shall have ability to		
OE612.1	To understand the basics and fundamentals of digital image processing, such as digitization, sampling, quantization, and 2D-transforms	[U]
OE612.2	To understand on images using the techniques of smoothing, sharpening and enhancement	[U]
OE612.3	To apply the restoration concepts and filtering techniques.	[AP]
OE612.4	To learn the basics of segmentation methods	[AP]
OE612.5	To Comprehend compression and recognition concepts.	[AP]

Course Contents			
Unit – 1	**DIGITAL IMAGE FUNDAMENTALS**	**CO1**	**10**
Steps in Digital Image Processing – Components – Elements of Visual Perception – Image Sensing and Acquisition – Image Sampling and Quantization – Relationships between pixels - Color image fundamentals - RGB, HSI models, Two-dimensional mathematical preliminaries, 2D transforms - DFT, DCT.			
Unit – 2	**IMAGE ENHANCEMENT**	**CO2**	**8**
Gray level transformations – Histogram processing – Basics of Spatial Filtering, Frequency Domain: Introduction to Fourier Transform– Smoothing and Sharpening frequency domain filters – Ideal, Butterworth and Gaussian filters			
Unit – 3	**IMAGE RESTORATION**	**CO3**	**9**
Image Restoration - degradation model, Properties, Noise models – Mean Filters – Order Statistics – Adaptive filters – Band reject Filters – Band pass Filters – Notch Filters			
Unit – 4	**IMAGE SEGMENTATION**	**CO4**	**9**
Edge detection, Edge linking via Hough transform – Thresholding - Region based segmentation – Region growing – Region splitting and merging – Morphological processing- erosion and dilation, Segmentation by morphological watersheds – basic concepts.			
Unit – 5	**IMAGE COMPRESSION AND RECOGNITION**	**CO5**	**9**
Need for data compression, Huffman, Run Length Encoding, Shift codes, Arithmetic coding, JPEG standard, MPEG. Boundary representation, Boundary description, Fourier Descriptor, Regional Descriptors – Topological feature, Texture - Patterns and Pattern classes - Recognition based on matching.			
		Total Hours	**45**

Textbooks:	
1	Abraham Silberschatz, Henry F. Korth, S. Sudharshan, “Database System Concepts”, Seventh Edition, McGraw Hill, 2020.
2	Ramez Elmasri, Shamkant B. Navathe, “Fundamentals of Database Systems”, Seventh Edition, Pearson Education, 2017

Reference Books:	
1	C.J.Date, A.Kannan, S.Swamynathan, “An Introduction to Database Systems”, Eighth Edition, Pearson Education, 2006.
2	Rafael C. Gonzalez, Richard E. Woods, “Digital Image Processing”, Fourth Edition, Pearson Education, 2018.

3	Anil K. Jain, "Fundamentals of Digital Image Processing", First Edition, Prentice Hall, 1989.
Web References:	
1.	https://onlinecourses.nptel.ac.in/noc22_ee116/preview
2.	https://onlinecourses.nptel.ac.in/noc26_ee31/preview

Assessment based on Continuous and End Semester Examination						
Bloom's Level	**Continuous Assessment**			**Assignment**	**Attendance**	**End Semester Examination**
	CIA1 (6 Marks)	**CIA2 (6 Marks)**	**Model Exam (8 Marks)**	**(10 Marks)**	**(10 Marks)**	**(60 Marks)**
Remember				**10**	**10**	**60**
Understand	100	60	80			
Apply		40	20			
Analyze						
Evaluate						
Create						
Total (100 Marks)	**6**	**6**	**8**	**10**	**10**	**60**

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject.

COs/ POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PSO 1**	**PSO 2**	**PSO 3**
OE612	3	2	1	1	1	–	–	–	–	–	1	2	1	1
OE612	3	2	1	1	2	–	–	–	–	–	1	2	2	2
OE612	3	3	2	2	3	–	–	–	–	–	2	2	3	3
OE612	3	3	2	2	2	–	–	–	–	–	2	2	3	3
OE612	2	2	2	1	2	–	–	–	–	–	2	2	3	2

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE613	**VEHICULAR ADHOC NETWORKS**	OE	3	0	0	3
Regulation	Nature of the Course	**Semester**	**Data Book/Codes/Standards**			
2024	THEORY	-	--------			
Pre-requisite Course(s)		**Co-requisite Course(s)**				
-		-				

Course Objectives	
1	To teach the students concepts of VANET.
2	To understand about Message forwarding and Challenges of vehicular systems
3	To understand implementation scope, applications and case studies of VANET.

Course Outcomes **Upon completion of the course, students shall have ability to**		
OE613.1	To understand VANET Basics	[U]
OE613.2	To comprehend the message forwarding strategies.	[U]
OE613.3	To understand the challenges in VANET	[U]
OE613.4	To apply VANET in different services and to understand through simulation	[AP]
OE613.5	To apply VANET concepts in different applications	[AP]

Course Contents			
Unit – 1	**INTRODUCTION TO VANET**	**CO1**	**9**
VANET Basics – Scenarios – Components of VANET -Need and Characteristics of VANET – Communication in VANET: Types, Introduction to DSRC : IEEE 1609.0, 1609.1,1609.2,1609.3,1609.4, IEEE 802.11P – Physical and MAC layer.			
Unit – 2	**MESSAGING FORWARDING STRATEGIES**	**CO2**	**9**
Types of messages in VANET, Message Forwarding Strategies, Message Packet Format, Need of Priority-Based Message Forwarding, Priority assigning mechanism,			
Unit – 3	**CHALLENGES IN VANET**	**CO3**	**9**
Challenges: Volatility, Critical Time latency, Diverse networking standards, High Mobility of nodes, Network Security, Efficient Message forwarding, Mitigation Techniques to address VANET Security			
Unit – 4	**SCOPE AND APPLICATION OF VANET**	**CO4**	**9**
Scope of VANET, Application of VANET, Traffic Management, User-Oriented Services, Convenience Services, Potential Projects, Tools and Simulation Platform of VANET, Conclusions – VANET and Intelligent Transportation System			
Unit – 5	**CASE STUDIES**	**CO5**	**9**
Learning-Based Rogue Edge Detection in VANETs with Ambient Radio Signals, Learning While Offloading: Task Offloading in Vehicular Edge Computing Network, Intelligent Network Access System for Vehicular Real-Time Service Provisioning, UAV Relay in VANETs Against Smart Jamming with Reinforcement Learning			
		Total Hours	**45**

Textbooks:	
1	Botkar, Sonali P., et al. VANET: challenges and opportunities. CRC Press, 2021.
2	Xiao, Liang, et al. Learning-based VANET communication and security techniques. Springer International Publishing, 2019.
3	Hartenstein, Hannes, and Kenneth Laberteaux, eds. VANET: vehicular applications and inter-networking technologies. John Wiley & Sons, 2009.
Reference Books:	
1	Intelligent Vehicle Technologies Theory and Appications– L Vlacic, M Parent,FHarashima - Butterworth Heinemann, 2015
2	Scorer, A. "Vehicle Location and Navigation Systems. By Yilin Zhao. Artech House, 1997. ISBN: 0-89006-861-5." The Journal of Navigation 51.3 (1998): 445-447.
Web References:	
1.	https://onlinecourses.nptel.ac.in/noc26_cs51/preview
2.	https://nptel.ac.in/courses/106105160

Assessment based on Continuous and End Semester Examination						
Bloom's Level	**Continuous Assessment**			**Assignment**	**Attendance**	**End Semester Examination**
	CIA1 (6 Marks)	**CIA2 (6 Marks)**	**Model Exam (8 Marks)**	**(10 Marks)**	**(10 Marks)**	**(60 Marks)**
Remember				**10**	**10**	**60**
Understand	100	100	60			
Apply			40			
Analyze						
Evaluate						
Create						
Total (100 Marks)	**6**	**6**	**8**	**10**	**10**	**60**

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject.

COs/ POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PSO 1**	**PSO 2**	**PSO 3**
OE613.1	3	2	1	1	1	–	–	–	–	–	1	2	1	1
OE613.2	3	3	1	1	2	–	–	–	–	–	1	2	2	2
OE613.3	3	3	1	2	2	–	–	–	–	–	2	2	2	2
OE613.4	3	2	3	2	3	–	–	–	–	–	2	2	3	3
OE613.5	3	2	3	2	2	–	–	–	–	–	2	3	3	3

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE614	**WEB TECHNOLOGY FUNDAMENTALS**	OE	3	0	0	3
Regulation	**Nature of the Course**	**Semester**	**Data Book/Codes/Standards**			
2024	THEORY	-	--------			
Pre-requisite Course(s)		**Co-requisite Course(s)**				
-		-				

Course Objectives

1	To understand different Internet Technologies
2	To learn java-specific web services architecture
3	To Develop web applications using frameworks

Course Outcomes

Upon completion of the course, students shall have ability to

OE614.1	To understand responsive web pages using HTML5 and CSS3	[U]
OE614.2	To build dynamic client-side functionality with JavaScript and DOM manipulation	[AP]
OE614.3	To implement server-side functionality using PHP, Java Servlets, and Node.js.	[AP]
OE614.4	To create and connect web applications to databases using JDBC and MySQL	[AP]
OE614.5	To understand and apply modern frameworks like Angular, React, and Django for full-stack web development.	[AP]

Course Contents

Unit – 1	**FUNDAMENTALS OF WEB TECHNOLOGIES**	**CO1**	**9**

Web Essentials: Understanding Clients, Servers, and Communication - Internet Fundamentals: World Wide Web – HTTP Request and Response Messages - HTML5: Introduction to HTML5 Tags, Tables, Lists, and Images - HTML5 Control Elements: Forms, Input Types, Drag and Drop, Audio, and Video - CSS3: Inline, Embedded, and External Stylesheets - Rule Cascading and Inheritance in CSS3 - CSS3 Transitions, Animations & Transformations -Bootstrap Framework: Using the Bootstrap Grid System, Responsive Design Principles, and Components

Unit – 2	**CLIENT-SIDE PROGRAMMING**	**CO2**	**9**

JavaScript : Variables, Functions, Loops, Conditional Statements - DOM Manipulation: Selecting Elements, Modifying Content and Attributes- Exception Handling: Try-Catch Blocks, Throwing Custom Errors - Form Validation: Using JavaScript to Validate User Input -DHTML with JavaScript: Creating Dynamic Web Pages - JSON: Parsing JSON.

Unit – 3	**SERVER-SIDE PROGRAMMING**	**CO3**	**9**

Java Servlet Technology: Servlet Architecture and Lifecycle - Handling HTTP Requests and Sessions: Form GET/POST, Cookies, URL Rewriting - JDBC: Connecting to Databases, Performing CRUD Operations - Advanced Java
Concepts: Introduction to JSP Architecture - Database Connectivity: MySQL, SQLite.

Unit – 4	**PHP AND XML**	**CO4**	**9**

PHP Basics: Syntax, Variables, Operators, Data Types, Conditionals, Arrays, Functions, Form Handling, and Validation - XML Basics: Understanding XML Structure, DTD, and XML Schemas - XML Parsing: Using DOM and SAX Parsers in PHP.

Unit – 5	**MODERN WEB APPLICATION FRAMEWORKS**	**CO5**	**9**

Introduction to AngularJS and Angular 2+: MVC Architecture, Components, Directives - Angular Data Binding: Expressions, ngModel, ng-repeat - React Basics: Component-Based Architecture, JSX, Props, State - Node.js Basics: Event-driven, Non-blocking I/O, Server-Side JavaScript -Express Framework: Building RESTful APIs with Express and Node.js - Django Framework: MVC/MVT Architecture, Python in Web Apps.

Total Hours	**45**

Textbooks:

1	Harvey, Harvey Deitel, and Abbey Deitel. "Internet and World Wide Web How To Program." (2011).
2	Jeffrey, C. "Jackson,"Web Technologies A Computer Science Perspective"." (2011).
3	Uluca, Doguhan. Angular 6 for Enterprise-Ready Web Applications: Deliver production-ready and cloud-scale Angular web apps. Packt Publishing Ltd, 2018.

Reference Books:

1	Stephen Wynkoop and John Burke "Running a Perfect Website", QUE, 2nd Edition,1999
2	Chris Bates, Web Programming – Building Intranet Applications, 3rd Edition, Wiley Publications, 2009.
3	Gopalan N.P. and Akilandeswari J., "Web Technology", Prentice Hall of India, 2011
Web References:	
1.	https://onlinecourses.swayam2.ac.in/e-learning/preview/nou24_cs09
2.	https://onlinecourses.swayam2.ac.in/e-learning/preview/nou23_cs03

Assessment based on Continuous and End Semester Examination						
Bloom's Level	**Continuous Assessment**			**Assignment**	**Attendance**	**End Semester Examination**
	CIA1 (6 Marks)	**CIA2 (6 Marks)**	**Model Exam (8 Marks)**	**(10 Marks)**	**(10 Marks)**	**(60 Marks)**
Remember				**10**	**10**	**60**
Understand	80	100	20			
Apply	20		80			
Analyze						
Evaluate						
Create						
Total (100 Marks)	**6**	**6**	**8**	**10**	**10**	**60**

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject.

COs/ POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PSO 1**	**PSO 2**	**PSO 3**
OE614.1	3	2	3	1	3	–	–	–	–	–	1	2	2	3
OE614.2	3	3	2	2	3	–	–	–	–	–	1	2	3	3
OE614.3	3	3	3	2	3	–	–	–	–	–	2	3	3	3
OE614.4	3	3	3	2	3	–	–	–	–	–	2	3	3	3
OE614.5	3	2	3	2	3	–	–	–	–	–	3	3	3	3

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE615	APP DEVELOPMENT FUNDAMENTALS	OE	3	0	0	3
Regulation	Nature of the Course	Semester	Data Book/Codes/Standards			
2024	THEORY	-	--------			
Pre-requisite Course(s)		Co-requisite Course(s)				
-		-				

Course Objectives

1	To learn development of native applications with basic GUI Components
2	To develop cross-platform applications with event handling
3	To develop applications with location and data storage capabilities
4	To develop web applications with database access

Course Outcomes

Upon completion of the course, students shall have ability to

OE615.1	To understand various mobile app development model.	[U]
OE615.2	To design simple native and cross-platform mobile applications	[AP]
OE615.3	To apply frameworks such as React Native and Ionic effectively	[AP]
OE615.4	To evaluate frameworks based on performance and development needs	[AP]
OE615.5	To understand app deployment, debugging, and maintenance fundamentals	[AP]

Course Contents

Unit – 1	**FUNDAMENTALS OF WEB AND MOBILE APPLICATION DEVELOPMENT**	**CO1**	**9**

Introduction to mobile and web app ecosystems -Native apps – architecture and characteristics - Hybrid apps – architecture and use cases - Cross-platform apps – concept and use cases- Progressive Web Apps (PWA) – functionality and offline capabilities- Responsive Web Design – fluid layouts, media queries, flexible grids.

Unit – 2	**NATIVE APP DEVELOPMENT**	**CO2**	**9**

Native Android development – Java and Kotlin basics - Native iOS development – Swift and Objective-C overview - Android Studio and Xcode – IDE walkthrough - Activity lifecycle, Views, and UI components - Permissions, local storage, and app manifest configuration -Introduction to Gradle build process - Play Store and App Store – submission basics and guidelines.

Unit – 3	**HYBRID APP DEVELOPMENT**	**CO3**	**9**

Hybrid app structure – HTML, CSS, JavaScript with WebView - Apache Cordova – plugins and native access - Ionic framework – UI toolkit and component structure - Integration with device features – camera, GPS, storage - Debugging and testing hybrid apps on emulators and devices - Performance considerations and offline support- Enterprise applications – hybrid use cases.

Unit – 4	**CROSS-PLATFORM APP DEVELOPMENT**	**CO4**	**9**

Cross-platform frameworks – need and comparison - React Native – components, JSX, props, state - Flutter – Dart basics, widgets, state management -Navigation and routing in mobile apps - Hot reload and debugging techniques -Platform-specific code in cross-platform apps - Integration with REST APIs and Firebase – Overview.

Unit – 5	**NON-FUNCTIONAL ASPECTS AND DEPLOYMENT STRATEGIES**	**CO5**	**9**

Framework comparison – performance, flexibility, and scalability - App performance – rendering, responsiveness, startup time - Debugging and profiling tools – Android Debug Bridge, Flutter DevTools, React DevTools - Time-to-market and maintainability - UI/UX consistency – Material Design, Human Interface Guidelines - CI/CD pipelines – GitHub Actions, Fastlane - Version control, build automation, and testing workflows - Basics of analytics, crash reporting, and user feedback.

Total Hours	**45**

Textbooks:

1	Griffiths, Dawn, and David Griffiths. Head first android development: a brain-friendly guide. " O'Reilly Media, Inc.", 2017.
2	Camden, Raymond K. Apache Cordova in action. Simon and Schuster, 2015.
3	Abbott, Devin, et al. "Fullstack React Native." (2017).

Reference Books:

1	Horton, John. Android programming for beginners. Packt Publishing Ltd, 2015.
2	Lewis, Shaun, and Mike Dunn. Native mobile development: a cross-reference for iOS and Android.

	O'Reilly Media, 2019.
3	Lingras, Rucha, Matt Triff, and Rucha Lingras. Building Cross-Platform Mobile and Web Apps for Engineers and Scientists. Cengage Learning, Incorporated, 2016.
4	Wargo, John M. Apache Cordova 4 Programming. Pearson Education, 2015.
5	Ward, Dan. React Native Cookbook: Recipes for solving common React Native development problems. Packt Publishing Ltd, 2019.
Web References:	
1.	https://onlinecourses.swayam2.ac.in/e-learning/preview/nou22_ge25
2.	https://onlinecourses.nptel.ac.in/noc20_cs52/preview

Assessment based on Continuous and End Semester Examination						
Bloom's Level	**Continuous Assessment**			**Assignment**	**Attendance**	**End Semester Examination**
	CIA1 (6 Marks)	**CIA2 (6 Marks)**	**Model Exam (8 Marks)**	**(10 Marks)**	**(10 Marks)**	**(60 Marks)**
Remember				**10**	**10**	**60**
Understand	80	100	20			
Apply	20		80			
Analyze						
Evaluate						
Create						
Total (100 Marks)	**6**	**6**	**8**	**10**	**10**	**60**

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject.

COs/ POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PSO 1**	**PSO 2**	**PSO 3**
OE615.1	3	2	1	1	1	–	–	–	–	–	1	2	1	1
OE615.2	3	2	3	1	3	–	–	–	–	–	1	2	2	3
OE615.3	3	3	2	2	3	–	–	–	–	–	2	2	3	3
OE615.4	3	3	2	2	2	–	–	–	–	–	2	3	3	2
OE615.5	3	2	2	2	3	–	–	–	–	–	3	3	3	3

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE616	Introduction to Augmented Reality / Virtual Reality	OE	3	0	0	3
Regulation	**Nature of the Course**	**Semester**	**Data Book/Codes/Standards**			
R24	THEORY	4	--------			
Pre-requisite Course(s)		**Co-requisite Course(s)**				
-		-				

Course Objectives

1	To impart the fundamental aspects and principles of AR/VR technologies.
2	To know the internals of the hardware and software components involved in the development of AR enabled applications.
3	To learn about the graphical processing units and their architectures.
4	To gain knowledge about AR/VR application development.
5	To know the technologies involved in the development of AR/VR based applications.

CourseOutcomes

Upon completion of the course, students shall have ability to

C616.1	Understand the basic concepts of AR and VR.	U
C616.2	Understand the hardware tools and technologies related to AR/VR.	U
C616.3	Apply the working principle of AR/VR software components related to Sensor devices.	AP
C616.4	Design various models using modeling techniques.	AP
C616.5	Develop AR/VR applications in different domains.	AP

Course Contents

Unit – 1	**Introduction**	9

Introduction to Virtual Reality and Augmented Reality – Definition – Introduction to Trajectories and Hybrid Space-Three I's of Virtual Reality – Virtual Reality Vs 3D Computer Graphics – Benefits of Virtual Reality – Components of VR System – Introduction to AR-AR Technologies-Input Devices – 3D Position Trackers – Types of Trackers – Navigation and Manipulation Interfaces – Gesture Interfaces – Types of Gesture Input Devices – Output Devices – Graphics Display – Human Visual System – Personal Graphics Displays – Large Volume Displays – Sound Displays – Human Auditory System.

Unit – 2	**VR MODELING**	9

Modeling – Geometric Modeling – Virtual Object Shape – Object Visual Appearance – Kinematics Modeling – Transformation Matrices – Object Position – Transformation Invariants –Object Hierarchies – Viewing the 3D World – Physical Modeling – Collision Detection – Surface Deformation – Force Computation – Force Smoothing and Mapping – Behavior Modeling – Model Management.

Unit – 3	**VR PROGRAMMING**	9

VR Programming – Toolkits and Scene Graphs – World ToolKit – Java 3D – Comparison of World ToolKit and Java 3D.

Unit – 4	**APPLICATIONS**	9

Human Factors in VR – Methodology and Terminology – VR Health and Safety Issues – VR and Society-Medical Applications of VR – Education, Arts and Entertainment – Military VR Applications – Emerging Applications of VR – VR Applications in Manufacturing – Applications of VR in Robotics – Information Visualization – VR in Business – VR in Entertainment – VR in Education.

Unit – 5	**AUGMENTED REALITY**	9

Introduction to Augmented Reality-Computer vision for AR-Interaction-Modelling and AnnotationNavigation-Wearable devices .	
Total Hours	**45**
Text books:	
1	Charles Palmer, John Williamson, "Virtual Reality Blueprints: Create compelling VR experiences for mobile", Packt Publisher, 2018.
2	Dieter Schmalstieg, Tobias Hollerer, "Augmented Reality: Principles & Practice", Addison Wesley, 2016.
Reference Books:	
1	John Vince, "Introduction to Virtual Reality", Springer-Verlag, 2004.
2	William R. Sherman, Alan B. Craig: Understanding Virtual Reality – Interface, Application, Design", Morgan Kaufmann, 2003
Web References:	
1	https://en.wikipedia.org/wiki/Augmented_reality
2	https://developers.google.com/ar
3	https://unity.com/unity/features/arfoundation

Assessment based on Continuous and End Semester Examination						
Bloom'sLevel	**Continuous Assessment**			**Assignment**	**Attendance**	**End SemesterExamination**
	CIA1 (6 Marks)	**CIA2 (6 Marks)**	**Model Exam (8 Marks)**			
Remember				**(10 Marks)**	**(10 Marks)**	**(60 Marks)**
Understand	100	20%	40%			
Apply		80%	60%			
Analyze						
Evaluate						
Create						
Total (100 Marks)	**6**	**6**	**8**	**10**	**10**	**60**

- CIA1,CIA 2 and Model Exam will be conducted for 50,50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject.

COs/ POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO1 0**	**PO1 1**	**PO1 2**	**PSO 1**	**PSO 2**
C616.1	**3**	2	2	-	**3**	**-**	**-**	**-**	2	2	1	2	2	1
C616.2	**3**	2	2	1	**3**	**-**	**-**	**-**	3	2	2	3	3	1
C616.3	**3**	3	2	2	**3**	**-**	**-**	**-**	3	2	1	2	3	2
C616.4	**3**	3	3	2	**3**	**-**	**-**	**-**	3	2	2	3	3	2
C616.5	**3**	3	3	3	**3**	**-**	**-**	**-**	3	3	3	3	3	3

3 - High 2 - Medium 1 - Low - - no correlation

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE617	Software Engineering	OE	3	0	0	3
Regulation	Nature of Course	Semester	Data Book/Codes/Standards			
R24	Theory	4	—-------			
Pre-requisite Course(s)		Co-requisite Course(s)				
-		–				

Course Objectives	
1	To understand Software Engineering Lifecycle Models
2	To Perform software requirements analysis
3	To gain knowledge of the System Analysis and Design concepts using UML.
4	To understand software testing and maintenance approaches
5	To work on project management scheduling using DevOps

Course Outcomes

Upon completion of the course, students shall have ability to

C617.1	Describe and explain various Software Development Life Cycle (SDLC) models and their differences.	U
C617.2	Explain project management approaches as well as cost and schedule estimation strategies.	U
C617.3	Develop formal analysis models based on software specifications.	AP
C617.4	Apply UML diagrams for analysis and design.	AP
C617.5	Design architectural style, design patterns, and test the system	AP

Course Contents

Unit-1	SOFTWARE PROCESS AND AGILE DEVELOPMENT	9
Introduction to Software Engineering, Software Process, Perspective and Specialized Process Models – Introduction to Agility-Agile process-Extreme programming-XP Process-Case Study.		
Unit – 2	REQUIREMENTS ANALYSIS AND SPECIFICATION	9
Requirement analysis and specification – Requirements gathering and analysis – Software Requirement Specification – Formal system specification – Finite State Machines – Petrinets – Object modelling using UML – Use case Model – Class diagrams – Interaction diagrams – Activity diagrams – State chart diagrams – Functional modelling – Data Flow Diagram- CASE TOOLS.		
Unit – 3	SOFTWARE DESIGN	9
Software design – Design process – Design concepts – Coupling – Cohesion – Functional independence – Design patterns – Model-view-controller – Publish-subscribe – Adapter – Command – Strategy – Observer – Proxy – Facade – Architectural styles – Layered - Client Server - Tiered - Pipe and filter- User interface design-Case Study.		
Unit – 4	SOFTWARE TESTING AND MAINTENANCE	9
Testing – Unit testing – Black box testing– White box testing – Integration and System testing– Regression testing – Debugging - Program analysis – Symbolic execution – Model Checking-Case Study		
Unit – 5	PROJECT MANAGEMENT	9
Software Project Management- Software Configuration Management - Project Scheduling- DevOps: Motivation-Cloud as a platform-Operations- Deployment Pipeline:Overall Architecture Building and Testing-Deployment-Tools- Case Study		
	Total Hours	**45**

Textbooks:

1	Bernd Bruegge and Allen H. Dutoit, "Object-Oriented Software Engineering: Using UML, Patterns and Java", Third Edition, Pearson Education, 2009.

2	Roger S. Pressman, Object-Oriented Software Engineering: An Agile Unified Methodology, First Edition, Mc Graw-Hill International Edition, 2014.
Reference Books:	
1	Carlo Ghezzi, Mehdi Jazayeri, Dino Mandrioli, Fundamentals of Software Engineering, 2nd edition, PHI Learning Pvt. Ltd., 2010.
2	Len Bass, Ingo Weber and Liming Zhu, "DevOps: A Software Architect's Perspective", Pearson Education, 2016
3	Stephen Schach, Object-Oriented and Classical Software Engineering, 8th ed, McGraw-Hill, 2010.
Web References:	
1	Onlinecourses.nptel.ac.in

Assessment based on Continuous and End Semester Examination						
Bloom'sLevel	**ContinuousAssessment**			**Assignment**	**Attendance**	**End SemesterExamination**
	CIA1 (6Marks)	**CIA2 (6Marks)**	**Model Exam (8Marks)**			
Remember				**(10 Marks)**	**(10 Marks)**	**(60Marks)**
Understand	100%	20%	40%			
Apply		80%	60%			
Analyze						
Evaluate						
Create						
Total (100 Marks)	**6**	**6**	**8**	**10**	**10**	**60**

- CIA1,CIA 2 and Model Exam will be conducted for 50,50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject

COs/ POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C617.1	3	3	3	3	2	-	-	-	2	2	2	2	2	2
C617.2	3	3	3	3	3	-	-	-	2	2	2	2	2	2
C617.3	3	3	3	3	3	-	-	-	2	2	2	2	2	2
C617.4	3	3	3	3	3	-	-	-	2	2	2	2	2	2
C617.5	3	3	3	3	3	-	-	-	2	2	2	2	2	2

3 - Strong 2 - Moderate 1 - Weak - - no correlation

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE618	Foundation of cloud computing	OE	3	0	0	3
Regulation	Nature of the Course	Semester	Data Book/Codes/Standards			
R24	THEORY	4	--------			
Pre-requisite Course(s)		Co-requisite Course(s)				
-		-				

Course Objectives	
1	To understand the principles of cloud architecture, models and infrastructure
2	To understand the concepts of virtualization and virtual machines.
3	To gain knowledge about virtualization Infrastructure.
4	To explore and experiment with various Cloud deployment environments.
5	To learn about the security issues in the cloud environment.

Course Outcomes Upon completion of the course, students shall have ability to		
C618.1	Understand the design challenges in the cloud	U
C618.2	Apply the concept of virtualization and its types	AP
C618.3	Demonstrate virtualization of hardware resources and Docker.	AP
C618.4	Develop and deploy services on the cloud and set up a cloud environment.	AP
C618.5	Analyze the security challenges in the cloud environment.	AP

Course Contents		
Unit-1	**CLOUD ARCHITECTURE MODELS AND INFRASTRUCTURE**	9
Cloud Architecture: System Models for Distributed and Cloud Computing – NIST Cloud Computing Reference Architecture – Cloud deployment models – Cloud service models; Cloud Infrastructure: Architectural Design of Compute and Storage Clouds – Design Challenges		
Unit – 2	**VIRTUALIZATION BASICS**	9
Virtual Machine Basics – Taxonomy of Virtual Machines – Hypervisor – Key Concepts – Virtualization structure – Implementation levels of virtualization – Virtualization Types: Full Virtualization – Para Virtualization – Hardware Virtualization – Virtualization of CPU, Memory and I/O devices.		
Unit – 3	**VIRTUALIZATION INFRASTRUCTURE AND DOCKER**	9
Desktop Virtualization – Network Virtualization – Storage Virtualization – System-level of Operating Virtualization – Application Virtualization – Virtual clusters and Resource Management – Containers vs. Virtual Machines – Introduction to Docker – Docker Components – Docker Container – Docker Images and Repositories		
Unit – 4	**CLOUD DEPLOYMENT ENVIRONMENT**	9
Google App Engine – Amazon AWS – Microsoft Azure; Cloud Software Environments – Eucalyptus – OpenStack		
Unit – 5	**CLOUD SECURITY**	9
Virtualization System-Specific Attacks: Guest hopping – VM migration attack – hyperjacking. Data Security and Storage; Identity and Access Management (IAM) - IAM Challenges - IAM Architecture and Practice.		
	Total Hours	**45**

Textbooks:	
1	Kai Hwang, Geoffrey C Fox, Jack G Dongarra, "Distributed and Cloud Computing, From Parallel Processing to the Internet of Things", Morgan Kaufmann Publishers, 2012
2	James Turnbull, "The Docker Book", O'Reilly Publishers, 2014.
3	Krutz, R. L., Vines, R. D, "Cloud security. A Comprehensive Guide to Secure Cloud

	Computing", Wiley Publishing, 2010.(check edition)
Reference Books:	
1	James E. Smith, Ravi Nair, "Virtual Machines: Versatile Platforms for Systems and Processes", Elsevier/Morgan Kaufmann, 2005.
2	Tim Mather, Subra Kumaraswamy, and Shahed Latif, "Cloud Security and Privacy: an enterprise perspective on risks and compliance", O'Reilly Media, Inc., 2009.
Web References:	
1	https://medium.com/beyond-the-build/foundations-of-cloud-computing-saas-paas-iaas-for-product-managers-and-non-tech-professionals-63acf8c1a2bc
2	https://onlinelibrary.wiley.com/

Assessment based on Continuous and End Semester Examination

Bloom'sLevel	ContinuousAssessment			Assignment	Attendance	End SemesterExamination
	CIA1 (6Marks)	CIA2 (6Marks)	Model Exam (8Marks)			
Remember				(10 Marks)	(10 Marks)	(60Marks)
Understand	80%	20%	20%			
Apply	20%	80%	80%			
Analyze						
Evaluate						
Create						
Total (100 Marks)	**6**	**6**	**8**	**10**	**10**	**60**

- CIA1,CIA 2 and Model Exam will be conducted for 50,50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject

COs/ POs	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2
C618.1	3	3	3	3	3	-	-	-	3	3	3	3	3	3
C618.2	3	3	3	3	3	-	-	-	3	3	3	3	3	3
C618.3	3	3	3	3	3	-	-	-	3	3	3	3	3	3
C618.4	3	3	3	3	3	-	-	-	3	3	3	3	3	3
C618.5	3	3	3	3	3	-	-	-	3	3	3	3	3	3

3 - Strong 2 - Moderate 1 - Weak - - no correlation

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE619	JAVA PROGRAMMING	OE	3	0	0	3
Regulation	Nature of the Course	Semester	Data Book/Codes/Standards			
R24	THEORY	-	--------			
Pre-requisite Course(s)		Co-requisite Course(s)				
-		-				

Course Objectives

1.	Learn fundamental features of object oriented language and JAVA.
2.	Set up a Java JDK environment to create, debug and run simple Java programs.
3.	Learn object oriented concepts using programming examples.
4.	Study the concepts of importing packages and exception handling mechanisms.
5.	Discuss the String Handling examples with Object Oriented concepts.

Course Outcomes

Upon completion of the course, students shall have ability to

C619.1	Write simple programs in JAVA	AP
C619.2	Implement JAVA program using operators and statements	AP
C619.3	Demonstrate JAVA with classes and objects	AP
C619.4	Implement JAVA in creating packages and Exception handling	AP
C619.5	Demonstrate JAVA program in String Handling and File Handling	AP

Course Contents

Unit – I	**INTRODUCTION**	**9**

An Overview of Java: Object-Oriented Programming, A First Simple Program, A Second Short Program, Two Control Statements, Using Blocks of Code, Lexical Issues, The Java Class Libraries, Data Types, Variables, and Arrays: The Primitive Data Types, Variables, Type Conversion and Casting, Arrays.

Unit – II	**JAVA OPERATORS AND STATEMENTS**	**9**

Operators: Arithmetic Operators, The Bitwise Operators, Relational Operators, Boolean Logical Operators, The Assignment Operator, The Ternary Operator, Operator Precedence, Using Parentheses, Control Statements: Java's Selection Statements, Iteration Statements, Jump Statements.

Unit – III	**CLASSES AND OBJECTS**	**9**

Introducing Classes: Class Fundamentals, Constructors, the "this" Keyword, Methods and Classes: Overloading Methods, Recursion, Access Control, Inheritance: Inheritance, Using super, Multilevel Hierarchy, Method Overriding, Dynamic Method Dispatch, Using Abstract Classes, Using final with Inheritance, The Object Class.

Unit – IV	**PACKAGES AND EXCEPTION HANDLING**	**9**

Packages and Interfaces: Packages, Access Protection, Importing Packages, Interfaces, Exception Handling: Exception-Handling Fundamentals, Exception Types, Uncaught Exceptions, Using try and catch, Multiple catch Clauses, Nested try Statements, throw, throws, finally, Java's Built-in Exceptions, User Defined Exception Subclasses.

Unit – V	**I/O STREAM AND STRING CLASS**	**9**

I/O Basics, Reading Console Input, Writing Console Output, The PrintWriter Class, Reading and Writing Files. String Handling: The String Constructors, String Length, Special String Operations, Character Extraction, String Comparison, Searching Strings, Modifying a String, Additional String Methods, StringBuffer, StringBuilder.

Total Hours	**45**

Textbooks:

1.	Herbert Schildt, Java The Complete Reference, 13th Edition, McGraw Hill, 2024.

Reference Books:

1.	E Balagurusamy, Programming with Java A primer, Tata McGraw Hill companies, 7th Edition, 2023.
2.	Kathy Sierra, Bert Bates, Trisha Gee, Head First Java: A Brain-Friendly Guide, Third Edition, 2022.
Web References:	
1.	https://onlinecourses.nptel.ac.in/noc25_cs57/preview

Assessment based on Continuous and End Semester Examination						
Bloom'sLevel	**ContinuousAssessment**			**Assignment**	**Attendance**	**End Semester Examination**
	CIA1 (6 Marks)	**CIA2 (6 Marks)**	**Model Exam (8 Marks)**			
Remember				**(10 Marks)**	**(10 Marks)**	**(60 Marks)**
Understand	20%	20%	20%			
Apply	80%	80%	80%			
Analyze						
Evaluate						
Create						
Total (100 Marks)	**6**	**6**	**8**	**10**	**10**	**60**

- CIA1,CIA 2 and Model Exam will be conducted for 50,50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject

COs/ POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2
C619.1	3	3	-	-	-	-	-	-	-	-	-	2	-	-
C619.2	3	3	-	-	-	-	-	-	-	-	-	2	-	-
C619.3	3	3	3	2	-	-	-	-	-	-	-	3	-	-
C619.4	3	3	3	2	-	-	-	-	-	-	-	3	-	-
C619.5	3	3	3	2	-	-	-	-	-	-	-	3	-	-

3 - Strong 2 - Moderate 1 - Weak '-' - no correlation

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE620	BLOCKCHAIN TECHNOLOGY	OE	3	0	0	3
Regulation	Nature of the Course	Semester	Data Book/Codes/Standards			
R24	Theory	4	--------			
Pre-requisite Course(s)		Co-requisite Course(s)				
Data Structures and Algorithms, Programming in C and Java		Operating Systems				

Course Objectives	
1	To understand the basics of Blockchain
2	To learn different protocols and consensus algorithms in Blockchain
3	To learn the Blockchain implementation frameworks
4	To understand Smart contracts and Ethereum 101
5	To understand blockchain alternatives and its applications

Course Outcomes Upon completion of the course, students shall have ability to		
C620.1	Understand emerging abstract models of blockchain technology	U
C620.2	Explain major research challenges and technical gaps existing between theory and practice in the crypto currency domain	U
C620.3	Illustrate the Bitcoin features and its alternative options.	U
C620.4	Describe and deploy the smart contracts and Ethereum platform	U
C620.5	Apply the blockchain features outside of currencies.	AP

Course Contents		
Unit – 1	**INTRODUCTION TO BLOCKCHAIN**	9
Blockchain- Public Ledgers, Blockchain as Public Ledgers - Block in a Blockchain, Transactions- The Chain and the Longest Chain - Permissioned Model of Blockchain, Cryptographic –Hash Function, Properties of a hash function- Hash pointer and Merkle tree		
Unit – 2	**BITCOIN AND CRYPTOCURRENCY**	9
A basic crypto currency, Creation of coins, Payments and double spending, FORTH – the precursor for Bitcoin scripting, Bitcoin Scripts , Bitcoin P2P Network, Transaction in Bitcoin Network, Block Mining, Block propagation and block relay		
Unit – 3	**BITCOIN CONSENSUS**	9
Bitcoin Consensus, Proof of Work (PoW)- Hashcash PoW , Bitcoin PoW, Attacks on PoW ,monopoly problem- Proof of Stake- Proof of Burn - Proof of Elapsed Time - Bitcoin Miner, Mining Difficulty, Mining Pool-Permissioned model and use cases.		
Unit – 4	**SMART CONTRACTS AND ETHEREUM 101**	9
Smart Contracts: Definition, Ricardian contracts. Ethereum 101: Introduction, Ethereum blockchain, Elements of the Ethereum blockchain, Precompiled contracts.		
Unit – 5	**BLOCKCHAIN ALTERNATIVES & ITS APPLICATIONS**	9
Blockchain-Outside of Currencies: Internet of Things, Government, Health, Finance, Media. Blockchain Applications in Supply Chain Management, Logistics, Smart Cities, Banking, Insurance, etc- Case Study.		
	Total Hours	**45**

Textbooks:	
1	Andreas Antonopoulos, "Mastering Bitcoin: Unlocking Digital Cryptocurrencies", O'Reilly, 2014.
2	Bashir and Imran, Mastering Blockchain: Deeper insights into decentralization, cryptography, Bitcoin, and popular Blockchain frameworks, 2017
3	Mastering Blockchain - Distributed ledgers, decentralization and smart contracts explained, Author- Imran Bashir, Packt Publishing Ltd, Second Edition, ISBN 978-1- 78712-544-5, 2017

Reference Books:	
1	Bitcoin and Cryptocurrency Technologies, Author- Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller, Steven Goldfeder, Princeton University, 2016

2	Daniel Drescher, "Blockchain Basics", First Edition, Apress, 2017.
3	Blockchain Basics: A Non-Technical Introduction in 25 Steps, Author- Daniel Drescher, Apress, First Edition, 2017
4	Mastering Bitcoin: Unlocking Digital Cryptocurrencies, Andreas M. Antonopoulos, O'Reilly Media, First Edition, 2014
5	Handbook of Research on Blockchain Technology, published by Elsevier Inc. ISBN: 9780128198162, 2020.
Web References:	
1	https://blockchain-society.science/
2	https://www.coursera.org/learn/blockchain-basics

Assessment based on Continuous and End Semester Examination						
Bloom's Level	**Continuous Assessment**			**Assignment**	**Attendance**	**End Semester Examination**
	CIA1 (6 Marks)	**CIA2 (6 Marks)**	**Model Exam (8 Marks)**			
Remember				**(10 Marks)**	**(10 Marks)**	**(60 Marks)**
Understand	100%	80%	80%			
Apply		20%	20%			
Analyze						
Evaluate						
Create						
Total (100 Marks)	**6**	**6**	**8**	**10**	**10**	**60**

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject.

COs/ POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**
C620.1	3	-	-	-	-	-	-	-	-	-	-	-	3	3
C620.2	3	2	2	2	3	2	2	2	-	-	-	-	3	3
C620.3	3	2	2	2	3	2	2	2	-	-	-	-	3	3
C620.4	3	2	2	2	3	2	2	2	-	-	-	-	3	3
C620.5	3	2	2	2	3	2	2	2	-	-	-	-	3	3

3 - Strong 2 - Moderate 1 - Weak - - no correlation

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE621	Introduction to VLSI design	OE	3	0	0	3
Regulation	Nature of the Course	Semester	Data Book/Codes/Standards			
R24	Theory	-	---------			
Pre-requisite Course(s)		Co-requisite Course(s)				
-		-				

Course Objectives

1	To learn the fundamentals of VLSI design
2	To understand the IC Manufacturing Process
3	To familiarize with VLSI combinational logic circuits design
4	To familiarize with VLSI sequential logic circuits design
5	To familiarize with the different FPGA architectures

Course Outcomes

Upon completion of the course, students shall have ability to

C621.1	Ability to comprehend and appreciate the significance and role of this course in the present contemporary world	U
C621.2	At the end of the course students will be in a position to understand the basics of VLSI design	U
C621.3	At the end of the course students will be in a position to understand the basics of testing	U
C621.4	At the end of the course students will be in a position to understand the basics of different FPGA architectures.	U

Course Contents

Unit – 1	**MOS TRANSISTOR PRINCIPLES**	9

MOS Technology and VLSI, Pass transistors, NMOS, CMOS Fabrication process and Electrical properties of CMOS circuits. Characteristics of CMOS inverter, Scaling principles and fundamental limits. Propagation Delays, CMOS inverter scaling, Stick diagram, Layout diagrams, Elmore's constant, Logical Effort.

Unit – 2	**COMBINATIONAL LOGIC CIRCUITS**	9

Static CMOS logic Design, Design techniques to improve the speed, power dissipation of CMOS logic, low power circuit techniques, Ratioed logic .Pass transistor Logic, Dynamic CMOS logic, Domino logic, Dual Rail logic, NP CMOS logic and NOR array logic.

Unit – 3	**SEQUENTIAL LOGIC CIRCUITS**	9

Static and Dynamic Latches and Registers, Timing Issues, Pipelines, Clocking strategies, Memory Architectures, and Memory control circuits.

Unit – 4	**DESIGNING ARITHMETIC BUILDING BLOCKS & TESTING**	9

Data path circuits, Architectures for Adders, Accumulators, Multipliers, Barrel Shifters, Need for testing- Manufacturing test principles- Design for testability.

Unit – 5	**IMPLEMENTATION STRATEGIES**	9

Full Custom and Semicustom Design, Standard Cell design and cell libraries, FPGA building block architectures, FPGA interconnect routing procedures. Demo: Complete ASIC flow using Backend tool and fabrication flow Overall case study: Development of IC in commercial aspects (design, testing and fab cost)

Total Hours	**45**

Textbooks:

1	Jan Rabaey, AnanthaChandrakasan, B.Nikolic, "Digital Integrated circuits: A design perspective". Second Edition, Prentice Hall of India, 2003.

ReferenceBooks:

1	N.Weste, K.Eshraghian, "Principles of CMOS VLSI DESIGN", A system Perspective, second edition, Addision Wesley 2004
2	A.Pucknell, Kamran Eshraghian, "BASIC VLSI DESIGN", Third edition, Prentice Hall of India, 2007.
3	M.J. Smith, "Application specific integrated circuits", Addisson Wesley, 1997
4	R.Jacob Baker, Harry W.LI., David E.Boyee, "CMOS Circuit Design, Layout and Simulation", 2005 Prentice Hall of India

Assessment based on Continuous and End Semester Examination						
Bloom's Level	**Continuous Assessment**			**Assignment**	**Attendance**	**End Semester Examination**
	CIA1 (6 Marks)	**CIA2 (6 Marks)**	**Model Exam (8 Marks)**			
Remember	12%	12%	6%	**(10 Marks)**	**(10 Marks)**	**(60 Marks)**
Understand	58%	58%	58%			
Apply	30%	30%	36%			
Analyze						
Evaluate						
Create						
Total (100 Marks)	**6**	**6**	**8**	**10**	**10**	**60**

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject.

COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO11**	**PSO 1**	**PSO 2**	**PSO 3**
C621.1	**3**	**3**	**3**	**3**		**3**				**3**	**3**			
C621.2	**3**	**3**	**3**	**3**		**3**				**3**	**3**			
C621.3	**3**	**3**	**3**	**3**		**3**				**3**	**3**			
C621.4	**3**	**3**	**3**	**3**		**3**				**3**	**3**			

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE622	Communication Engineering	OE	3	0	0	3
Regulation	Nature of the Course	Semester	Data Book/Codes/Standards			
R24	Theory	-	--------			
Pre-requisite Course(s)		Co-requisite Course(s)				
Linear Integrated Circuits		-				

Course Out comes:

Upon completion of the course, students shall have ability to

C622.1	Gain insight into communication systems with signal processing, modulation, channel characteristics, and multiple access techniques	[U]
C622.2	Infer the principles of AM generation, demodulation, system comparisons, transmitter and receiver design of FM systems	[U]
C622.3	Understand the generation, detection, and performance analysis of digital modulation schemes, including ASK, FSK, BPSK, QPSK, and QAM	[U]
C622.4	Interpret information theory fundamentals, channel capacity, Shannon's theorems, source coding techniques, and error control coding for efficient and reliable communication	[U]
C622.5	Comprehend advanced wireless communication technologies and their associated standards	[U]

Course Contents

Unit – 1	**PRINCIPLES OF COMMUNICATION**	9

Communication Systems Overview - Types of Communication Channels - Basic Signal Processing Operations in Communication systems - Baseband and Passband Modeling - Signal-to-Noise Ratio, Channel Bandwidth, Modulation, Spectral density - Multiplexing, Multiple Access

Unit – 2	**ANALOG COMMUICATION SYSTEMS**	9

Generation and demodulation of AM - DSB-SC, SSB-SC, VSB Amplitude Modulated Signals - Comparison of AM system - AM transmitters, AM receivers - Angle modulation: Phase Modulation, Frequency Modulation - Narrowband and wideband FM - Non-linear effects in FM systems - FM receivers

Unit – 3	**DIGITAL COMMUNICATION SYSTEMS**	9

Generation and detection of Amplitude Shift Keying (ASK) Modulation - Generation and detection of Frequency Shift Keying (FSK) Modulation - Generation and detection of Binary Phase Shift Keying (BPSK) Modulation - Generation and detection of Quaternary Phase Shift Keying QPSK) - QAM - Bit Error Rate Performance of BPSK, QPSK and QAM in AWGN channel

Unit – 4	**INFORMATION THEORY**	9

Measure of information - Channel capacity and Shannons theorems - Source coding techniques: Prefix code, Huffman Coding, Shannon Fano Coding, Arithmetic Coding, Run length code - Channel coding theorem, Information capacity theorem - Error Control Coding

Unit – 5	**ADVANCED COMMUNICATION SYSTEMS**	9

Spread Spectrum, OFDM, GSM architecture, General Packet Radio Service (GPRS), Enhanced Data Rate for Global Evolution (EDGE), Ultra wideband systems (UWB), Push-To-Talk (PTT) technology, Mobile IP, Bluetooth Technology, IEEE Standards for Wired and Wireless Communications

Total Hours	**45**

Textbooks:

1	Simon Haykin, Communication Systems, John Wiley & sons, NY, 5th Edition, 2016
2	Michael P. Fitz, Fundamentals of Communication Systems, Tata McGraw-Hill, 2nd Edition-2013.

ReferenceBooks:

1	Taub and Schilling, Principles of communication systems, TMH, New Delhi, 4th Edition, 2017
2	Theodore S. Rappaport: Wireless communication principles and practice,2/e, Pearson Education

Assessment based on Continuous and End Semester Examination						
Bloom's Level	**Continuous Assessment**			**Assignment**	**Attendance**	**End Semester Examination**
	CIA1 (6 Marks)	**CIA2 (6 Marks)**	**Model Exam (8 Marks)**			
Remember	20%	20%	20%	**(10 Marks)**	**(10 Marks)**	**(60 Marks)**
Understand	80%	80%	80%			
Apply						
Analyze						
Evaluate						
Create						
Total (100 Marks)	**6**	**6**	**8**	**10**	**10**	**60**

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject.

COs/ POs	**PO 1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
C622.1	2	2	1								1
C622.2	2	2	1								1
C622.3	2	2	1								1
C622.4	2	2	1								1
C622.5	2	2	1								1

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE623	**SENSORS AND ACTUATORS**	OE	3	0	0	3

Course Outcomes (s)		
Upon completion of the course, students shall have ability to		RBT
C623.1	List common types of sensor and actuators used in vehicles	U
C623.2	Design measuring equipment's for the measurement of pressure force, temperature and flow	AP
C623.3	Generate new ideas in designing the sensors and actuators for automotive application	AP
C624.4	Understand the operation of the sensors, actuators and electronic control.	U
C624.5	Design temperature control actuators for vehicles.	AP

Course Content		
Unit – I	INTRODUCTION TO MEASUREMENTS AND SENSORS	9
Sensors: Functions- Classifications- Main technical requirement and trends Units and standards Calibration methods- Classification of errors- Error analysis- Limiting error- Probable error Propagation of error- Odds and uncertainty- principle of transduction-Classification. Static characteristics- mathematical model of transducers- Zero, First and Second order transducers Dynamic characteristics of first and second order transducers for standard test inputs.		
Unit – II	VARIABLE RESISTANCE AND INDUCTANCE SENSORS	9
Principle of operation- Construction details- Characteristics and applications of resistive potentiometer- Strain gauges- Resistive thermometers- Thermistors- Piezoresistive sensors Inductive potentiometer- Variable reluctance transducers:- EI pick up and LVDT		
Unit – III	VARIABLE AND OTHER SPECIAL SENSORS	9
Variable air gap type, variable area type and variable permittivity type- capacitor microphone Piezoelectric, Magnetostrictive, Hall Effect, semiconductor sensor- digital transducers-Humidity Sensor. Rain sensor, climatic condition sensor, solar, light sensor, antiglare sensor.		
Unit – IV	AUTOMOTIVE ACTUATORS	9
Electromechanical actuators- Fluid-mechanical actuators- Electrical machines- Direct-current machines- Three-phase machines- Single-phase alternating-current Machines - Duty-type ratings 318 for electrical machines. Working principles, construction and location of actuators viz. Solenoid, relay, stepper motor etc.		
Unit – V	AUTOMATIC TEMPERATURE CONTROL ACTUATORS	9
Different types of actuators used in automatic temperature control- Fixed and variable displacement temperature control- Semi Automatic- Controller design for Fixed and variable displacement type air conditioning system.		
		TOTAL: 45 Hours

Learning Resources	
Text Books	
1	Doebelin's Measurement Systems: 7th Edition (SIE),Ernest O. DoebelinDhaneshN.Manik,McGraw Hill Publishers, 2019.
2	Robert Brandy, " Automotive Electronics and Computer System", Prentice Hall,2001
3	William Kimberley," Bosch Automotive Handbook", 6th Edition, Robert Bosch GmbH, 2004.
4	Bosch Automotive Electrics and Automotive Electronics Systems and Components, Networking and Hybrid Drive, 5th Edition, 2007, ISBN No: 978-3-658-01783-5.
Reference Books	
1	James D Halderman, " Automotive Electrical and Electronics" , Prentice Hall, USA, 2013
2	Tom Denton, "Automotive Electrical and Electronics Systems," Third Edition, 2004, SAE International.
3	Patranabis.D, " Sensors and Transducers", 2nd Edition, Prentice Hall India Ltd,2003
4	William Ribbens, "Understanding Automotive Electronics -An Engineering Perspective," 7th Edition, Elsevier Butterworth-Heinemann Publishers, 2012.

Assessment based on Continuous and End Semester Examination						
Bloom's Level	**Continuous Assessment**			**Assignment**	**Attendance**	**End Semester Examination**
	CIA1 (6 Marks)	**CIA2 (6 Marks)**	**Model Exam (8 Marks)**			
Remember			10%	**(10 Marks)**	**(10 Marks)**	**(60 Marks)**
Understand	60%	40%	40%			
Apply	40%	60%	50%			
Analyze						
Evaluate						
Create						
Total (100 Marks)	**6**	**6**	**8**	**10**	**10**	**60**

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject.

COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
C622.1.	**2**	**2**	**1**								**1**
C622.2	**3**	**3**	**2**								**1**
C622.3	**3**	**3**	**2**								**1**
C666.4	**2**	**2**	**1**								**1**
C666.5	**3**	**3**	**2**								**1**

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE624	Basics of Hardware Description Languages	OE	3	0	0	3

Pre-requisite Course(s)	Co-requisite Course(s)
Digital Electronics	--------

Course Outcome

Upon completion of the course, students shall have ability to

C624.1	Apply digital logic concepts to build circuits	[AP]
C624.2	Build Programmable devices and learn VLSI with FPGA.	[AP]
C624.3	Construct modules using basic HDL concepts.	[AP]
C624.4	Construct modules using advanced HDL concepts.	[AP]
C624.5	Build various digital circuits using Verilog.	[AP]

CourseContents

Unit – 1	**DIGITAL LOGIC**	9

Number system, Boolean theorem - logic gates, Simplification of logic function- Combinational circuits-Adder, subtractor, Encoder, decoder, multiplexer, demultiplexer. Sequential circuits- latch, flip-flop, counter.

Unit – 2	**PROGRAMMABLE DIGITAL ICS**	9

Introduction to VLSI - Evolution of VLSI Systems - Applications of VLSI Systems – Programmable Logic Devices - ROM, PAL, PLA - CPLD- Introduction to FPGA - Digital IC design flow

Unit – 3	**VERILOG HDL**	9

Introduction to HDL - Lexical Conventions - Ports and Modules - Data Types - Data Flow Modeling -Operators - Gate Level Modeling

Unit – 4	**ADVANCED VERILOG HDL**	9

Behavioral level Modelling - Synthesis of Finite State Machines- Switch Level Modelling- System Tasks & Compiler Directives - Test benches

Unit – 5	**SYSTEM DESIGN USING VERILOG HDL**	9

Design of Combinational circuits -Multiplexers / Demultiplexers, Magnitude comparators, Adders -Multiplier-Divider. Design of Sequential circuits - Flip flops, Registers / Shift registers, counters – Statemachines -Pattern sequence detector design.

Total Hours	**45**

Textbooks:

1	M.Morris Mano, Michael D Ciletti, Digital Design, 4th edition Pearson, 2011
2	Samir Palnitkar,Verilog HDL, Pearson Education, 2nd Edition, 2004.

ReferenceBooks:

1	Stephen Brown and Zvonko Vranesic,Fundamentals of Digital Logic with Verilog Design, 3rd Edition, Tata McGraw Hill, 2014
2	Bob Zeidman, Designing with FPGAs and CPLDs, Elsevier, CMP Books, 2002
3	Ion Grout, Digital Systems Design with FPGAs and CPLDs, Elsevier, 2008

Assessment based on Continuous and End Semester Examination						
Bloom's Level	**Continuous Assessment**			**Assignment**	**Attendance**	**End Semester Examination**
	CIA1 (6 Marks)	**CIA2 (6 Marks)**	**Model Exam (8 Marks)**			
Remember				**(10 Marks)**	**(10 Marks)**	**(60 Marks)**
Understand	20%	20%	20%			
Apply	80%	80%	80%			
Analyze						
Evaluate						
Create						
Total (100 Marks)	**6**	**6**	**8**	**10**	**10**	**60**

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject.

COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
C624.1	**3**	**3**	**2**								
C624.2	**3**	**3**	**2**								
C624.3	**3**	**3**	**2**		**3**						**2**
C624.4	**3**	**3**	**2**								**2**
C624.5	**3**	**3**	**2**								**2**

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE625	**Introduction to Internet of Things**	OE	3	0	0	3

Course Objectives		RBT
C625.1	Explain the concept of IoT	U
C625.2	Understand the communication models and various protocols for IoT	U
C625.3	Design portable IoT using Arduino/Raspberry Pi /open platform	AP
C625.4	Apply data analytics and use cloud offerings related to IoT	AP
C625.5	Analyze applications of IoT in real time scenario	AN

Course Content		
Unit – I	INTRODUCTION TO INTERNET OF THINGS	9
Evolution of Internet of Things – Enabling Technologies – IoT Architectures: oneM2M, IoT World Forum (IoTWF) and Alternative IoT Models – Simplified IoT Architecture and Core IoT Functional Stack – Fog, Edge and Cloud in IoT		
Unit – II	COMPONENTS IN INTERNET OF THINGS	9
Functional Blocks of an IoT Ecosystem – Sensors, Actuators, and Smart Objects – Control Units - Communication modules (Bluetooth, Zigbee,Wifi, GPS, GSM Modules)		
Unit – III	PROTOCOLS AND TECHNOLOGIES BEHIND IOT	9
IOT Protocols - IPv6, 6LoWPAN, MQTT, CoAP - RFID, Wireless Sensor Networks, BigData Analytics, Cloud Computing, Embedded Systems.		
Unit – IV	OPEN PLATFORMS AND PROGRAMMING	9
IOT deployment for Raspberry Pi /Arduino platform-Architecture –Programming – Interfacing – Accessing GPIO Pins – Sending and Receiving Signals Using GPIO Pins – Connecting to the Cloud.		
Unit – V	IOT APPLICATIONS	9
Business models for the internet of things, Smart city, Smart mobility and transport, Industrial IoT, Smart health, Environment monitoring and surveillance – Home Automation – Smart Agriculture		
		TOTAL: 45 Hours

Learning Resources	
Text Books	
1	Robert Barton, Patrick Grossetete, David Hanes, Jerome Henry, Gonzalo Salgueiro, “IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things”, CISCO Press, 2017
2	Samuel Greengard, The Internet of Things, The MIT Press, 2015
Reference Books	
1	Perry Lea, “Internet of things for architects”, Packt, 2018
2	Olivier Hersent, David Boswarthick, Omar Elloumi , “The Internet of Things – Key applications and Protocols”, Wiley, 2012
3	IOT (Internet of Things) Programming: A Simple and Fast Way of Learning, IOT Kindle Edition.
4	Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), “Architecting the Internet of Things”, Springer, 2011.
5	ArshdeepBahga, Vijay Madisetti, “Internet of Things – A hands-on approach”, Universities Press, 2015
Web References	
1	https://www.arduino.cc/
2	https://www.ibm.com/smarterplanet/us/en/?ca=v_smarterplanet

Assessment based on Continuous and End Semester Examination						
Bloom's Level	**Continuous Assessment**			**Assignment**	**Attendance**	**End Semester Examination**
	CIA1 (6 Marks)	**CIA2 (6 Marks)**	**Model Exam (8 Marks)**			
Remember	20%			**(10 Marks)**	**(10 Marks)**	**(60 Marks)**
Understand	80%	20%	40%			
Apply		80%	60%			
Analyze						
Evaluate						
Create						
Total (100 Marks)	**6**	**6**	**8**	**10**	**10**	**60**

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject.

COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
C625.1	**2**	**2**	**1**								
C625.2	**2**	**2**	**1**								**1**
C625.3	**3**	**3**	**2**								**1**
C625.4	**3**	**3**	**2**								**1**
C625.5	**3**	**3**	**2**								**1**

OPEN ELECTIVES OFFERED BY EEE

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE626	Industrial Automation With PLC and SCADA	OE	3	0	0	3

Course Outcomes (s)		
Upon completion of the course, students shall have ability to		RBT
C626.1	Understand the integrated industrial automation system.	U
C626.2	Identify the PLC hardware and programming languages for various applications.	U
C626.3	Develop PLC ladder logic programming for industrial problems.	AP
C626.4	Impart the knowledge about SCADA and understand the components of SCADA.	U
C626.5	Apply PLC and SCADA in real time applications to meet industrial automation.	AP

Course Content		
Unit–I	**INTRODUCTION**	**9**
Architecture of the basic three level Integrated Industrial Automation Systems – Field level for sensors actuators and smart devices, Control level for process and motion control functions, Distributed control system - Supervisory level for Data logging and Acquisition systems – DAS and SCADA for Management functions - Integrated automation through bus structure at the different levels.		
Unit – II	**INTRODUCTION TO PROGRAMMABLE LOGIC CONTROLLER**	**9**
Overview of Programmable Logic Controller – Architecture – Principle of operation – I/O Modules: Discrete, Analog, Special – I/O Specifications – CPU – Memory design and types – Programming devices – Recording and Retrieving data – PLC programming languages. Introduction to Human Machine Interfaces (HMI).		
Unit–III	**BASIC PLC PROGRAMMING**	**9**
Fundamentals of Logic – Program Scan – Relay-Type Instructions – Instruction addressing – Branch and Internal relay instructions – Entering the Ladder diagram – Electromagnetic Control relays – Contactors – Motor Starters – Manual operated switches and Mechanically operated switches.		
Unit–IV	**SCADA**	**9**
Introduction to SCADA – A brief history of SCADA – Real-time systems – Remote control – Communications: communication system components – protocol-modems – Remote terminal units (RTUs) – Master terminal units (MTUs).		
Unit–V	**APPLICATIONS OF SCADA**	**9**
Applications: Real time Revisited – Accounting and grade of data – Scanning and communications – Automatic control. Applications SCADA for Power Utility Network.		
	Total Hours	**45**

Learning Resources	
Text books	
1	Krishnaswamy K, "Process Control", 2nd Edition, New Age International(P) Ltd, NewDelhi, 2015.
2	Frank D. Petruzella, "Programmable Logic Controllers", 5th Edition, Tata McGraw-Hill , New Delhi, 2019.
3	Stuart A. Boyer, "SCADA: Supervisory Control and Data Acquisition", 4th Edition, ISA Press, USA, 2009.
Reference Books	
1	Webb John W & Reis Ronald A, "Programmable Logic Controllers - Principles and Applications", 5th Edition, PHI Learning Private Limited, New Delhi, 2002.
2	Bolton W, "Programmable Logic Controllers", 5th Edition, Elsevie , New York, 2009.
Web References	
1	https://www.nielit.gov.in/calicut/content/online-course-industrial-automation-plc-scada
2	https://www.nielit.gov.in/calicut/content/iad102

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE627	Electric Vehicle Technology	OE	3	0	0	3

Course Outcomes (s)		
Upon completion of the course, students shall have ability to		RBT
C627.1	Summarize about the sustainable transportation through electric vehicle systems	U
C627.2	Design and select EV drive for the desirable performance and control	U
C627.3	Explain the architecture of various types of hybrid Vehicles.	U
C627.4	Apply the various control strategies of series & Parallel HEVs using DC and AC Motor drives.	AP
C62.75	Examine about the battery technologies for Electric vehicle charging schemes.	AP

Course Content		
Unit–I	INTRODUCTION TO ELECTRIC VEHICLES	9
Sustainable Transportation – EV System – EV Advantages – Vehicle Mechanics – Performance of EVs – Electric Vehicle drive train – EV Transmission Configurations and components -Tractive Effort in Normal Driving – Energy Consumption – EV Market – Types of Electric Vehicle in Use Today – Electric Vehicles for the Future		
Unit – II	ELECTRIC VEHICLE DESIGN CONSIDERATIONS	9
General Description of Vehicle Movement - Vehicle Resistance – Dynamic Equation - Power Train Tractive Effort and Vehicle Speed - Vehicle Power Plant and Transmission Characteristics - Vehicle Performance - Brake Performance - EV configurations – General and Typical EV configurations - EV parameters		
Unit–III	HYBRID TRACTION	9
Basic concept of hybrid traction, Introduction to various hybrid drive-train topologies-power flow controls in hybrid drive-train topologies - Basic concept of electric traction- Introduction to various electric drive-train topologies- fuel efficiency analysis.		
Unit–IV	HYBRID VEHICLE CONTROL STRATEGY	9
Vehicle Supervisory Controller- Mode Selection Strategy -Mechanical Power-Split Hybrid Modes - Series-Parallel Hybrid Modes - Modal Control Strategies - Introduction to Electric Components & Drives used in Hybrid and Electric vehicles, Configuration and control of DC Motor drives – configuration and control of AC Motor drives, Configuration and control of Switch Reluctance Motor drive.		
Unit–V	BATTERY TECHNOLOGIES FOR ELECTRIC VEHICLE	9
Introduction - Power and Energy of Electric Propulsion - Basic Terms of Battery Performance and Characterization - Battery Charging Methods and EV Charging Schemes: Charging Methods - EV Charging Schemes - Basic Operation of a Rechargeable Battery - Battery Modeling - Current Status of Battery in Automobile Applications.		
	Total Hours	**45**

Learning Resources	
Text books	
1	Mehrdad Ehsani, Yimin Gao and Ali Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design", 2nd Edition, CRC press, Florida, United States, 2010.
2	Sira -Ramirez, Silva.R Ortigoza, "Control Design Techniques in Power Electronics Devices", 1st Edition, Springer, New York, 2006.
Reference Books	
1	Iqbal Hussain, "Electric and Hybrid Vehicles: Design Fundamentals", 2nd Edition, CRC press, Taylor&Francis Group, Florida, United States, 2011.
2	Chan C. C. and Chau K. T., "Modern electric vehicle technology", 1st Edition, Oxford University Press, New York, 2001.
Web References	
1	https://onlinecourses.nptel.ac.in/noc20_ee18/preview
2	https://www.coursera.org/learn/electric-vehicles-mobility

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE628	Energy Technology	OE	3	0	0	3

Course Outcomes (s)		
Upon completion of the course, students shall have ability to		RBT
C628.1	Describe the fundamentals and main characteristics of renewable energy sources and their differences compared to fossil fuels.	U
C628.2	Excel as professionals in the various fields of energy engineering	U
C628.3	Compare different renewable energy technologies and choose the most appropriate based on local conditions.	U
C628.4	Explain the technological basis for harnessing renewable energy sources.	U
C628.5	Identify and critically evaluate current developments and emerging trends within the field of renewable energy technologies and to develop in-depth technical understanding of energy problems at an advanced level.	U

Course Content		
Unit–I	INTRODUCTION	8
Units of energy, conversion factors, general classification of energy, world energy resources and energy consumption, Indian energy resources and energy consumption, energy crisis, energy alternatives, Renewable and non-renewable energy sources and their availability. Prospects of Renewable energy sources		
Unit – II	CONVENTIONAL ENERGY	8
Conventional energy resources, Thermal, hydel and nuclear reactors, thermal, hydel and nuclear power plants, efficiency, merits and demerits of the above power plants, combustion processes, fluidized bed combustion.		
Unit–III	NON-CONVENTIONAL ENERGY	10
Solar energy, solar thermal systems, flat plate collectors, focusing collectors, solar water heating, solar cooling, solar distillation, solar refrigeration, solar dryers, solar pond, solar thermal power generation, solar energy application in India, energy plantations. Wind energy, types of windmills, types of wind rotors, Darrieus rotor and Gravian rotor, wind electric power generation, wind power in India, economics of wind farm, ocean wave energy conversion, ocean thermal energy conversion, tidal energy conversion, geothermal energy.		
Unit–IV	BIOMASS ENERGY	10
Biomass energy resources, thermo-chemical and biochemical methods of biomass conversion, combustion, gasification, Pyrolysis, biogas production, ethanol, fuel cells, alkaline fuel cell, phosphoric acid fuel cell, molten carbonate fuel cell, solid oxide fuel cell, solid polymer electrolyte fuel cell, magneto hydrodynamic power generation, energy storage routes like thermal energy storage, chemical, mechanical storage and electrical storage.		
Unit–V	ENERGY CONSERVATION	9
Energy conservation in chemical process plants, energy audit, energy saving in heat exchangers, distillation columns, dryers, ovens and furnaces and boilers, steam economy in chemical plants, energy conservation.		
	Total Hours	**45**

Learning Resources	
Textbooks	
1	Rao, S. and Parulekar, B.B., Energy Technology, Khanna Publishers, 2005.
2	Rai, G.D., Non-conventional Energy Sources, Khanna Publishers, New Delhi, 1984.
Reference Books	
1	Bansal, N.K., Kleeman, M. and Meliss, M., Renewable Energy Sources and Conversion Technology, Tata McGraw Hill, 1990.
2	El. Wakil, Power Plant Technology, Tata McGraw Hill, New York, 2002.
3	Nagpal, G.R., Power Plant Engineering, Khanna Publishers, 2008.
Web References	
1	https://onlinecourses.nptel.ac.in/noc24_ge51/preview
2	https://onlinecourses.nptel.ac.in/noc20_ch37/preview

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE629	Battery Management Systems	OE	3	0	0	3

Course Outcomes (s)		
Upon completion of the course, students shall have ability to		RBT
C629.1	Acquire knowledge of different Li-ion Batteries performance.	U
C629.2	Design a Battery Pack and make related calculations.	U
C629.3	Demonstrate a Battery Model or Simulation.	U
C629.4	Estimate State-of-Charges in a Battery Pack.	U
C629.5	Approach different BMS architectures during real world usage.	U

Course Content		
Unit–I	**ADVANCED BATTERIES**	**9**
Li-ion Batteries-different formats, chemistry, safe operating area, efficiency, aging. Characteristics-SOC,DOD, SOH. Balancing-Passive Balancing Vs Active Balancing. Other Batteries-NCM and NCA Batteries. NCR18650B specifications.		
Unit – II	**BATTERY PACK**	**9**
Battery Pack- design, sizing, calculations, flow chart, real and simulation Model. Peak power – definition, testing methods-relationships with Power, Temperature and ohmic Internal Resistance. Cloud based and Local Smart charging.		
Unit–III	**BATTERY MODELLING**	**9**
Battery Modeling Methods-Equivalent Circuit Models, Electrochemical Model, Neural Network Model. ECM Comparisons- Rint model, Thevenin model, PNGV model. State space Models- Introduction. Battery Modelling software/simulation frameworks.		
Unit–IV	**BATTERY STATE ESTIMATION**	**9**
SOC Estimation- Definition, importance, single cell Vs series batteries SOC. Estimation Methods- Load voltage, Electromotive force, AC impedance, Ah counting, Neural networks, Neuro-fuzzy forecast method, Kalman filter. Estimation Algorithms.		
Unit–V	**BMS ARCHITECTURE AND REAL TIME COMPONENTS**	**9**
Battery Management System- needs, operation, classification. BMS ASIC-bq76PL536A-Q1 Battery Monitor IC- CC2662R-Q1 Wireless BMS MCU. Communication Modules- CAN Open-Flex Ray- CANedge1 package. ARBIN Battery Tester. BMS Development with Modeling software and Model Based Design.		
	Total Hours	**45**

Learning Resources	
Text books	
1	Jiuchun Jiang and Caiping Zhang, "Fundamentals and applications of Lithium-Ion batteries in Electric Drive Vehicles'', Wiley, 2015.
2	Davide Andrea ,"Battery Management Systems for Large Lithium-Ion Battery Packs" ARTECH House, 2010.
Reference Books	
1	Developing Battery Management Systems with Simulink and Model-Based Design-whitepaper
Web References	
1	https://nptel.ac.in/courses/113105102
2	https://archive.nptel.ac.in/courses/113/105/113105102/

Course Code	Course Name	Category	Hours / Week			C
			L	T	P	
24OE630	Power Converters For Electrical Appliances	OE	3	0	0	3

Course Outcome (s)		
Upon completion of the course students shall have ability to		RBT
C630.1	Understand how different power electronic devices like diodes, SCRs, BJTs, MOSFETs, and IGBTs work.	U
C630.2	Learn how rectifiers convert AC to DC and how to reduce ripples using filters.	U
C630.3	Know how inverters convert DC to AC and where they are used, like in UPS and solar systems.	U
C630.4	Understand how DC-DC converters (like buck, boost, and buck-boost) work and where to use them.	U
C630.5	Learn how power converters are used in smart systems like smart homes, electric vehicles, and solar energy.	U

Course Contents		
Unit–I	**Introduction to Power Electronic Devices**	**9**
Overview of Power Electronics – Definition, Need, and Applications Power Semiconductor Devices – Diodes, Thyristors (SCR), Power BJT, Power MOSFET, IGBT Switching Characteristics – Turn-on, Turn-off, Losses Basic Drive Circuits for Power Devices		
Unit–II	**AC-DC Converters (Rectifiers)**	**9**
Introduction to Rectifiers – Need and Types Single-Phase Rectifiers – Half-wave, Full-wave (Center-tap & Bridge)Ripple & Smoothing – Why capacitors are used (Like filtering noise in signals)Applications – Laptop adapters, USB chargers, PC power supplies, Applications – Battery Chargers, DC Power Supplies		
Unit–III	**DC-AC Converters (Inverters)**	**9**
Introduction to Inverters – Need and Types (Voltage Source & Current Source) Single-Phase Inverters – Half-bridge, Full-bridge (Square wave & PWM) Applications – UPS, Solar PV Systems, Motor Drives		
Unit–IV	**DC-DC Converters (Choppers)**	**9**
Introduction to DC-DC Converters – Need and Types Step-down (Buck) Converter – Operation and Waveforms Step-up (Boost) Converter – Operation and Waveforms Buck-Boost Converter – Operation and Applications – SMPS, Electric Vehicles, LED Drivers Applications –Smartphone fast charging, LED drivers, Laptop power management		
Unit–V	**Power Converters in Smart Systems**	**9**
Home Automation – How converters work in smart bulbs, Wi-Fi switches, Computer & IT Systems –SMPS (Switched Mode Power Supply) in PCs/Data center power backup systems Renewable Energy – Solar inverters, electric vehicle charging Future Trends – AI in power management, IoT-based energy saving		
	Total Hours	**45**

Text books	
1	Power Electronics: Circuits, Devices and Applications, Muhammad H. Rashid, Pearson Education, 4th Edition, 2017
2	Power Electronics, P.S. Bimbhra, Khanna Publishers,7th Edition, 2018
Reference Books	
1	Power Electronics: Essentials and Applications L. Umanand Wiley India 1st Edition, 2009
2	Power Electronics: Converters, Applications and Design, Ned Mohan, Tore M.Undeland, William P. Robbins, Wiley, 3rd Edition, 2002
Web References	
1	https://nptel.ac.in/courses/108/105/108105066/
2	https://www.allaboutcircuits.com/technical-articles/categories/power/

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE631	FOUNDATION OF ROBOTICS	OE	3	0	0	3
Regulation	Nature of the Course	Semester	Data Book/Codes/Standards			
R24	THEORY		--------			
Pre-requisite Course(s)		Co-requisite Course(s)				

Course Objectives

1	To study the kinematics, drive systems and programming of robots.
2	To study the basics of robot laws and transmission systems.
3	To familiarize students with the concepts and techniques of robot manipulator, its kinematics.
4	To familiarize students with the various Programming and Machine Vision application in robots.
5	To build confidence among students to evaluate, choose and incorporate robots in engineering systems.

Course Outcomes

Upon completion of the course, students shall have ability to

C631.1	Interpret the features of robots and technology involved in the control.	[U]
C631.2	Apply basic engineering knowledge and relevant laws for the design of robotics.	[AP]
C631.3	Apply the concepts of various configurations, classifications, and parts of end effectors to compare different end effectors, grippers, tools, and sensors used in robots.	[AP]
C631.4	Apply the principles of kinematics, degeneracy, dexterity, and trajectory planning in robotics applications.	[AP]
C631.5	Apply image processing and image analysis techniques using a machine vision system.	[AP]

Course Contents

Unit – 1	**FUNDAMENTALS OF ROBOT**	9

Robot Definition, Robot Anatomy Co-ordinate systems, Work Envelope, classification – Requirements- Pitch, yaw, Roll, Joint Notations, Speed of Motion, Pay Load - Need for Robots - Applications.

Unit – 2	**ROBOT KINEMATICS**	9

Forward kinematics, inverse kinematics and the difference- two and three degrees of freedom (in 2 dimensional), four degrees of freedom (in 3 dimensional). Homogeneous transformation matrices, translation and rotation matrices.

Unit – 3	**ROBOT DRIVE SYSTEMS AND END EFFECTORS**	9

Pneumatic Drives - Hydraulic Drives - Mechanical Drives - Electrical Drives: D.C. Servo Motors, Stepper Motor, A.C. Servo Motors - Applications and Comparison. End Effectors - Grippers : Mechanical , Pneumatic and Hydraulic, Magnetic , vacuum, internal and external grippers- selection and design considerations of a gripper.

Unit – 4	**SENSORS IN ROBOTICS**	9

Force sensors, touch and tactile sensors, proximity sensors, non-contact sensors for hazarded environment and compliance mechanism. Machine vision system , frame grabber, sensing and digitizing image data signal conversion, image storage, lighting techniques, image processing and analysis - data reduction, segmentation, feature extraction, object recognition and other algorithms. Applications, Inspection, safety considerations , visual serving and navigation.

Unit – 5	**PROGRAMMING AND APPLICATIONS OF ROBOT**	9

Teach pendant programming, lead through programming, robot programming languages -commands for Motion, Sensors and End-Effector. Robot applications for inspection, assembly, material handling, underwater, space and medical fields.

Total Hours	**45**

Textbooks:

1	Ganesh.S.Hedge, "A textbook of Industrial Robotics", Lakshmi Publications, 2022.

2	Mikell.P.Groover, "Industrial Robotics McGraw Hill 2ND edition 2012. Technology, Programming and applications"
3	
Reference Books:	
1	Fu K.S. Gonalz R.C. and ice C.S.G. "Robotics Control, Sensing, Vision and Intelligence". McGraw Hill book co. 2007
2	YoramKoren, "Robotics for Engineers", McGraw Hill Book, Co., 2002.
3	Janakiraman P.A., "Robotics and Image Processing", Tata McGraw Hill 2005.
4	John. J.Craig, "Introduction to Robotics: Mechanics and Control" 2nd Edition, 2002.
5	Jazar, "Theory of Applied Robotics: Kinematics, Dynamics and Control", Springer India reprint, 2010.
Web References:	
1	https://www.barnesandnoble.com/w/foundations-of-robotics-bruno-siciliano
2	https://www.foundations-of-robotics.org/?utm_source=chatgpt.com

Assessment based on Continuous and End Semester Examination						
Bloom's Level	**Continuous Assessment**			**Assignment**	**Attendance**	**End Semester Examination**
	CIA1 (6 Marks)	**CIA2 (6 Marks)**	**Model Exam (8 Marks)**			
Remember				**(10 Marks)**	**(10 Marks)**	**(60 Marks)**
Understand	4	2	2			
Apply	2	4	6			
Analyze						
Evaluate						
Create						
Total (100 Marks)	**6**	**6**	**8**	**10**	**10**	**60**

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject.

COs/ POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO3**
C631.1	√	√		√	√					√		√	√	√	
C631.2	√	√		√	√					√		√	√	√	
C631.3	√	√		√	√					√		√	√	√	
C631.4	√	√		√	√					√		√	√	√	
C631.5	√	√		√	√					√		√	√	√	

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE632	BASICS OF DRONE TECHNOLOGY	OE	3	0	0	3
Regulation	**Nature of the Course**	**Semester**	**Data Book/Codes/Standards**			
R24	**THEORY**		--------			
Pre-requisite Course(s)		**Co-requisite Course(s)**				
Nil		**Nil**				

Course Objectives

1	To understand the basics of drone concepts
2	To learn and understand the fundaments of design, fabrication and programming of drone
3	To impart the knowledge of an flying and operation of drone
4	To know about the various applications of drone
5	To understand the safety risks and guidelines of fly safely

Course Outcomes

Upon completion of the course, students shall have ability to

C101.1	Know about a various type of drone technology, drone fabrication and programming.	[U]
C101.2	Execute the suitable operating procedures for functioning a drone	[U]
C101.3	Select appropriate sensors and actuators for Drones	[U]
C101.4	Develop a drone mechanism for specific applications	[U]
C101.5	Create the programs for various drones	[U]

Course Contents

Unit – 1	**INTRODUCTION TO DRONE TECHNOLOGY**	9

Drone Concept - Terminology- History of drone - Overview of the main drone parts- Function of the component parts -Technical characteristics of the Types of current generation of drones based on their method of propulsion- Operation of drone. Classifications of the UAV.

Unit – 2	**DRONE DESIGN, FABRICATION AND PROGRAMMING**	9

Assembling a drone - The energy sources- Types of autonomy - Drones configurations - methods of programming – programing, compiling and uploading - data collection - Wi-Fi connection.

Unit – 3	**DRONE OPERATION**	9

Flight modes- Operation in a controlled environment- Drone controls- Multi rotor stabilization –management tools: Sensors, Onboard storage, control system-Removable storage devices – Linked devices and applications.

Unit – 4	**DRONE COMMERCIAL APPLICATIONS**	9

Selection of a drone based on the application - Drones in the insurance sector- Drones in delivering parcels and other cargo - Drones in agriculture - Drones in inspection of transmission lines and power distribution -Drones in filming and panoramic picturing. Drones in military applications. Drone technology impact on the businesses- Drone business through entrepreneurship - Opportunities/applications for entrepreneurship and employability.

Unit – 5	**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.

Textbooks:

1	Daniel Tal and John Altschuld, “Drone Technology in Architecture, Engineering and Construction: A Strategic Guide to Unmanned Aerial Vehicle Operation and Implementation”, 2021 John Wiley & Sons, Inc.
2	Terry Kilby and Belinda Kilby, “Make:Getting Started with Drones “,Maker Media, Inc, 2016 .

Reference Books:

1	John Baichtal, “Building Your Own Drones: A Beginners' Guide to Drones, UAVs, and ROVs”, Que Publishing, 2016.
2	Zavrsnik, “Drones and Unmanned Aerial Systems: Legal and Social Implications for Security and Surveillance”, Springer, 2018.

Web References:

1	https://dronelaunchacademy.com/

2	https://www.airsight.com/knowledge-hub/drone-basics

Assessment based on Continuous and End Semester Examination						
Bloom's Level	**Continuous Assessment**			**ASSIGNMENT**	**ATTENDANCE**	**END SEMESTER EXAMINATION**
	CIA1 (6 Marks)	**CIA2 (6 Marks)**	**Model Exam (8 Marks)**			
Remember				**(10 Marks)**	**(10 Marks)**	**(60 Marks)**
Understand	2	2	2			
Apply	4	4	6			
Analyze						
Evaluate						
Create						
Total (100 Marks)	**6**	**6**	**8**	**10**	**10**	**60**

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject.

COs/ POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO3**
C101.1	√	√				√	√	√				√			
C101.2	√	√	√	√								√			
C101.3	√	√				√	√	√				√			
C101.4	√	√	√	√								√			
C101.5	√	√	√	√	√	√						√			

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE633	3D PRINTING	PC	3	0	0	3
Regulation	Nature of the Course	Semester	Data Book/Codes/Standards			
R24	Theory	OE	--------			
Pre-requisite Course(s)		Co-requisite Course(s)				
Computer Aided Design & Drafting		Engineering Materials				

Course Objectives

1	To Know the importance of 3D printing in Manufacturing.
2	To know the different 3D Printing Technologies.
3	To select a suitable material for 3D Printing.
4	To observe the different methods for Post-processing of 3D Printing parts.
5	To Understand the applications of 3D Printing in Automobile, Aerospace, Bio-medical etc.

Course Outcomes

Upon completion of the course, students shall have ability to

C101.1	Apply the features of robots and the technology involved in their control.	[AP]
C101.2	Apply basic engineering knowledge and relevant laws for the design of robotics.	[AP]
C101.3	Apply the concepts of various configurations, classifications, and parts of end effectors to compare different end effectors, grippers, tools, and sensors used in robots.	[AP]
C101.4	Apply the principles of kinematics, degeneracy, dexterity, and trajectory planning in robotics applications.	[AP]
C101.5	Apply image processing and image analysis techniques using a machine vision system.	[AP]

Course Contents

Unit – 1	**INTRODUCTION AND BASIC PRINCIPLES**	9

introduction, Generic 3D Printing Process, Benefits, Distinction Between 3D Printing and CNC Machining, Other Related Technologies Development of 3D Printing Technology: Introduction, Computers, Computer-Aided Design Technology, Other Associated Technologies, The Use of Layers, Classification of 3D Printing Processes, Metal Systems, Hybrid Systems, Milestones in 3D Printing Development, 3D Printing around the World.

Unit – 2	**3D PRINTING PROCESS CHAIN & PHOTOPOLYMERIZATION PROCESSES**	9

Eight Steps in Additive Manufacture, Variations from One 3D Printing Machine to Another, Metal Systems, Maintenance of Equipment, Materials Handling Issues, Design for 3D PRINTING. Introduction to Photopolymerization Processes: Photopolymerization Materials, Reaction Rates, Vector ScanSL, SL Resin Curing Process, SL Scan Patterns, Vector Scan Micro stereolithography, Mask Projection Photopolymerization Technologies and Processes, Two-Photon SL.

Unit – 3	**POWDER BED FUSION PROCESSES & EXTRUSION-BASED SYSTEMS**	9

Powder Bed Fusion Processes: Introduction, SLS Process Description, Powder Handling, Approaches to Metal and Ceric Part Creation, Variants of Powder Bed Fusion Processes, Process Par3D Printingeters, Applied Energy Correlations and Scan Patterns, Typical Materials and Applications, Materials - Capabilities and Limitations. Extrusion-Based Systems: Introduction, Basic Principles, Plotting and Path Control, Materials, Limitations of FDM, Bioextrusion, Other Systems

Unit – 4	**DESIGN, GUIDELINES FOR PROCESS SELECTION & SOFTWARE ISSUES**	9

Design for 3D Printing - Design for Manufacturing and Assembly, Core DFM for 3D Printing Concepts and Objectives, 3D Printing Unique Capabilities, Exploring Design Freedoms, Design Tools for 3D Printing.Guidelines for Process Selection - Selection Methods for a Part, Challenges of Selection, Preliminary Selection,Production Planning and Control.Software Issues for 3D Printing - Preparation of CAD Models – the STL File, Problems with STL Files, STL File Manipulation, Beyond the STL File, Additional Software to Assist 3D Printing.

Unit – 5	**MEDICAL APPLICATIONS & FUTURE DIRECTIONS FOR 3D PRINTING**	9

Medical Applications for 3D Printing - Use of 3D Printing to Support Medical Applications, Software Support for Medical Applications, Limitations of 3D Printing for Medical Applications, Further Development of Medical 3D Printing Applications.Use of Multiple Materials in 3D Printing - Discrete Multiple Material Processes, Porous Multiple Material Processes, Blended Multiple Material Processes, Embedded Component 3D Printing, Commercial Applications Using Multiple Materials, Future Directions, Business Opportunities and Future Directions

		Total Hours	**45**
Textbooks:		
1	Ian Gibson, David W Rosen, Brent Stucker., "Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing", Springer, 2010.	
2	Khanna Editorial, "3D Printing and Design", Khanna Publishing House, Delhi.	
Reference Books:		
1	Chua Chee Kai, Leong Kah Fai, "Rapid Prototyping: Principles & Applications", World Scientific,2003.	
2	Ali K. Kamrani, Emand Abouel Nasr, "Rapid Prototyping: Theory & Practice", Springer, 2006.	
3	D.T. Pham, S.S. Dimov, Rapid Manufacturing: The Technologies and Applications of Rapid prototyping and Rapid Tooling, Springer 2001.	

Assessment based on Continuous and End Semester Examination						
Bloom's Level	**Continuous Assessment**			**Assignment**	**Attendance**	**End Semester Examination**
	CIA1 (6 Marks)	**CIA2 (6 Marks)**	**Model Exam (8 Marks)**			
Remember				**(10 Marks)**	**(10 Marks)**	**(60 Marks)**
Understand						
Apply						
Analyze						
Evaluate						
Create						
Total (100 Marks)	**6**	**6**	**8**	**10**	**10**	**60**

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject.

COs/ POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**	**PSO3**
C101.1	√	√	√	√										√	
C101.2	√	√	√	√								√		√	
C101.3	√	√	√	√								√		√	
C101.4	√	√	√	√								√		√	
C101.5	√	√	√	√								√		√	

Prepared by **Approved by**

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE634	DIGITAL MANUFACTURING	OE	3	0	0	3
Regulation	Nature of the Course	Semester	Data Book/Codes/Standards			
R24	THEORY		--------			
Pre-requisite Course(s)		Co-requisite Course(s)				

Course Objectives

1	To study the various aspects of digital manufacturing.
2	To inculcate the importance of DM in Product Lifecycle Management and Supply
3	Chain Management.
4	To formulate of smart manufacturing systems in the digital work environment.
5	To interpret IoT to support the digital manufacturing.

Course Outcomes

Upon completion of the course, students shall have ability to

C101.1	Impart knowledge to use various elements in the digital manufacturing.	[U]
C101.2	Differentiate the concepts involved in digital product development life cycle process and supply chain management in digital environment.	[AP]
C101.3	Select the proper procedure of validating practical work through digital validation in Factories.	[AP]
C101.4	Implementation the concepts of IoT and its role in digital manufacturing.	[AP]
C101.5	Analyse and optimize various practical manufacturing process through digital twin	[AP]

Course Contents

Unit – 1	**INTRODUCTION**	9

Introduction – Need – Overview of Digital Manufacturing and the Past – Aspects of Digital Manufacturing: Product life cycle, Smart factory, and value chain management – Practical Benefits of Digital Manufacturing – The Future of Digital Manufacturing.

Unit – 2	**DIGITAL LIFE CYCLE & SUPPLY CHAIN MANAGEMENT**	9

Collaborative Product Development, Mapping Requirements to specifications – Part Numbering, Engineering Vaulting, and Product reuse – Engineering Change Management, Bill of Material and Process Consistency – Digital Mock up and Prototype development – Virtual testing and collateral. Overview of Digital Supply Chain - Scope& Challenges in Digital SC - Effective Digital Transformation - Future Practices in SCM

Unit – 3	**SMART FACTORY**	9

Smart Factory – Levels of Smart Factories – Benefits – Technologies used in Smart Factory – Smart Factory in IoT-Key Principles of a Smart Factory – Creating a Smart Factory – Smart Factories and Cyber security

Unit – 4	**INDUSTRY 4.0**	9

Introduction – Industry 4.0 –Internet of Things – Industrial Internet of Things – Framework: Connectivity devices and services – Intelligent networks of manufacturing – Cloud computing – Data analytics –Cyber physical systems – Machine to Machine communication – Case Studies.

Unit – 5	**STUDY OF DIGITAL TWIN**	9

Basic Concepts – Features and Implementation – Digital Twin: Digital Thread and Digital Shadow- Building Blocks – Types – Characteristics of a Good Digital Twin Platform – Benefits, Impact & Challenges – Future of Digital Twins.

	Total Hours	**45**

Textbooks:

1	Zude Zhou, Shane (Shengquan) Xie and Dejun Chen, Fundamentals of Digital Manufacturing Science, Springer-Verlag London Limited, 2012.
2	Alasdair Gilchrist, "Industry 4.0: The Industrial Internet of Things", A press, 2016.
3	

Reference Books:

1	Lihui Wang and Andrew YehChing Nee, Collaborative Design and Planning for Digital

	Manufacturing,Springer-Verlag London Limited, 2009
2	Andrew Yeh Chris Nee, Fei Tao, and Meng Zhang, "Digital Twin Driven Smart Manufacturing", Elsevier Science., United States, 2019
3	Ustundag and Emre Cevikcan, "Industry 4.0: Managing The Digital Transformation", Springer Series in Advanced Manufacturing., Switzerland, 2017
4	Ronald R. Yager and Jordan Pascual Espada, "New Advances in the Internet of Things", Springer., Switzerland, 2018.
Web References:	
1	https://link.springer.com
2	https://www.reddit.com
3	https://link.springer.com

Assessment based on Continuous and End Semester Examination						
Bloom's Level	**Continuous Assessment**			**Assignment**	**Attendance**	**End Semester Examination**
	CIA1 (6 Marks)	**CIA2 (6 Marks)**	**Model Exam (8 Marks)**			
Remember				**(10 Marks)**	**(10 Marks)**	**(60 Marks)**
Understand	4	2	2			
Apply	2	4	6			
Analyze						
Evaluate						
Create						
Total (100 Marks)	**6**	**6**	**8**	**10**	**10**	**60**

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject.

COs/ POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO3**
C101.1	√	√		√	√					√		√	√	√	
C101.2	√	√		√	√					√		√	√	√	
C101.3	√	√		√	√					√		√	√	√	
C101.4	√	√		√	√					√		√	√	√	
C101.5	√	√		√	√					√		√	√	√	

Prepared by **Approved by**

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE635	**Composite Materials**	PC	**3**	**0**	**0**	**3**
Regulation	**Nature of the Course**	**Semester**	**Data Book/Codes/Standards**			
R24A	**THEORY**		**--------**			
Pre-requisite Course(s)		**Co-requisite Course(s)**				

Course Objectives	
1	To introduce the fundamental concepts, classification, and applications of composite materials.
2	To provide knowledge on different types of reinforcement and matrix materials used in composites.
3	To impart understanding of various composite fabrication methods and processing techniques.
4	To develop knowledge of mechanical behavior, testing methods, and failure mechanisms of composites.
5	To explore advancements and emerging trends in composite materials.

Course Outcomes **Upon completion of the course, students shall have ability to**		
C101.1	Explain the classification, characteristics, and applications of composite materials	[U]
C101.2	Identify and describe types of reinforcement and matrix materials used in composites	[U]
C101.3	Apply suitable composite manufacturing techniques for specific applications	[AP]
C101.4	Analyze the mechanical behavior and failure mechanisms in composite materials	[AP]
C101.5	Discuss recent trends and developments in advanced composites	[U]

Course Contents		
Unit – 1	Introduction:	9
Introduction and overview of composite materials and their need, Enhancement of properties, classification of composites, Matrix-Polymer matrix composites (PMC), Metal matrix composites (MMC), Ceramic matrix composites (CMC), Application of composites.		
Unit – 2	Reinforcements Materials:	9
Metallic, Polymer, Ceramic and Composite fibres, Whiskers and Particulates, Nano-fillers used in polymer composites, Reinforcement fibres, Woven fabrics and Nonwoven random mats. Types of matrix: Commonly used Matrices (Metal matrix, Polymer matrix, Ceramic matrix, Intermetallic matrix, Carbon-Carbon composites), Basic Requirements in Selection of constituents.		
Unit – 3	Production techniques:	9
Processing of cast composites - XD process, Spray processes, In-situ Dispersion Processes, Liquidmetal impregnation technique .Hand lay-up processes – Spray up processes, Compression moulding, Reinforced reaction injection moulding, Resin transfer moulding, Pultrusion, Filament winding, Injection moulding.		
Unit – 4	Mechanics of Composite Materials:	9
Continuous fibres – iso-stress and iso-strain conditions, discontinuous fibres, Nature of stress vs. strain curves for different composite materials. Mechanical Properties: Mechanical testing of composites – tensile, flexure (3 point and 4 point bend tests), interfacial tests of laminates; Modes of fracture; Toughening mechanisms in composites.		
Unit – 5	Recent developments in Composites:	9
Self healing composites, Molecular composites, Micro and Nanocomposites, Biocomposites, Left handed composites, Stiffer than stiff composites, Carbon / carbon composites (Advantages and limitations of carbon matrix).		
	Total Hours	**45**

Textbooks:	
1	**K. K. Chawla**, *Composite Materials – Science and Engineering*, Springer, 3rd Edition, 2012.
2	**Gibson, R. F.**, *Principles of Composite Material Mechanics*, CRC Press, 4th Edition, 2016.
Reference Books:	
1	**Mallick, P. K.**, *Fiber-Reinforced Composites: Materials, Manufacturing, and Design*, CRC Press, 3rd Edition, 2007.
2	Mathews F.L., Rawlings R.D., Composite Materials: Engineering and Science, Woodhead Publishing,

	1999.
3	Agarwal, B. D., Broutman, L. J., Analysis and Performance of Fiber Composites, Wiley, 3rd Edition, 2006
4	Sharma S.C., Composite materials, Narosa Publications, 2000.
5	Mallick, P.K, Composite Materials Technology: Process and Properties, Hanser, New York, 1990.

Assessment based on Continuous and End Semester Examination						
Bloom's Level	**Continuous Assessment**			**Assignment**	**Attendance**	**End Semester Examination**
	CIA1 (6 Marks)	**CIA2 (6 Marks)**	**Model Exam (8 Marks)**			
Remember				**(10 Marks)**	**(10 Marks)**	**(60 Marks)**
Understand	20	20	20			
Apply	30	30	80			
Analyze						
Evaluate						
Create						
Total (100 Marks)	**6**	**6**	**8**	**10**	**10**	**60**

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject.

COs/ POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
C101.1	√						√								
C101.2	√	√					√								
C101.3	√	√	√		√							√			
C101.4	√	√	√	√	√							√			
C101.5	√				√		√					√			

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE637	ORGANISATIONAL BEHAVIOUR	OE	3	0	0	3
Regulation	**Nature of the Course**	**Semester**	**Data Book/Codes/Standards**			
R24	THEORY		--------			
Pre-requisite Course(s)		**Co-requisite Course(s)**				
-						

Course Objectives	
1	To help students to understand the concepts of organizational behavior and basics of personality
2	To help them recognize the role of individual personality, perception and learning in organizational effectiveness
3	To discuss the learning process and development of attitude
4	To explain group dynamics and skills required for working in groups
5	To examine organizational climate and culture

Course Outcomes **Upon completion of the course, students shall have ability to**		
OE637.1	Comprehend the fundamental concepts in organizational behaviour	[U]
OE637.2	Explain the difference in the individual behaviour	[U]
OE637.3	Relate motivation, morale and attitude	[U]
OE637.4	Demonstrate the significance of working as a group and understand leadership	[U]
OE637.5	Outline the importance of organizational climate and culture	[U]

Course Contents		
Unit-1	**INTRODUCTION TO MANAGEMENT**	**9**
Organizational Behaviour: Definition- Importance and Scope of Organizational Behaviour, Factors influencing OB- Contributing disciplines to OB. Individual Differences - Intelligence tests - Measurement of Intelligence.		
Unit – 2	**PERSONALTY, PERCEPTION AND LEARNING**	**9**
Personality: Meaning, Types, Determinants of Personality, Personality Theory (Psycho analytic Theory), Perception – Meaning- Process- Factors affecting Perception. Learning – Meaning –Concepts – Factors affecting learning,		
Unit – 3		**9**
Motivation – Meaning- Theories (Maslow's, Herzberg's, Mc Gregors X and Y theory, Morale – meaning-Importance. Attitude: Meaning & Components, Work attitude,		
Unit – 4	**GROUP DYNAMICS AND LEADERSHIP**	**9**
Group dynamics: Group-Meaning-types, group cohesiveness –Group Norms-Group decision making. Team- Meaning, Types, Difference between group and team. Leadership- Meaning, Characteristics of a Successful Leader, Leadership Styles-Managerial Grid Theory		
Unit – 5	**ORGANISATIONAL DYNAMICS**	**9**
Organizational climate- meaning, components and factors affecting organizational climate. Organizational Culture **-** Types, creating and sustaining culture, managing cultural diversity.		
	Total Hours	**45**

Textbooks:	
1	Prasad.L.M - "Organizational Behaviour, Sultan Chand & Son, New Delhi, 2024
2	Stephen P. Robbins, Timothy A judge & Neharika Vohra- "Organizational Behaviour", 8th Edition, Pearson Education Ltd, 2022
Reference Books:	
1	Aswathappa. K,"Organizational Behavior", Himalaya Publishing House, 2024

2	Fred Luthans, "Organisational Behaviour", McGraw Hill Book Co.,14th edition,2020

Assessment based on Continuous and End Semester Examination						
Bloom's Level	**CONTINUOUS ASSESSMENT**			**ASSIGNMENT**	**ATTENDANCE**	**END SEMESTER EXAMINATION**
	CIA1 (6 Marks)	**CIA2 (6 Marks)**	**Model Exam (8 Marks)**	**(10 Marks)**	**(10 Marks)**	**(60 Marks)**
Remember						
Understand	100%	100%	100%			
Apply						
Analyze						
Evaluate						
Create						
Total (100 Marks)	**6**	**6**	**8**	**10**	**10**	**60**

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject.

COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
OE637.1	-	-	-	-	-	-	-	3	3	-	3	-	-	-
OE637.2	-	-	-	-	-	-	-	3	3	-	3	-	-	-
OE637.3	-	-	-	-	-	-	-	3	3	-	3	-	-	-
OE637.4	-	-	-	-	-	-	-	3	3	-	3	-	-	-
OE637.5	-	-	-	-	-	-	-	3	3	-	3	-	-	-

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE638	Total Quality Management	OE	3	0	0	3
Regulation	**Nature of the Course**	**Semester**	**Data Book/Codes/Standards**			
R24	THEORY	-	--------			
Pre-requisite Course(s)		**Co-requisite Course(s)**				
-						

Course Objectives

1	To introduce the fundamental concepts, principles, and evolution of Total Quality Management (TQM) and their significance in achieving organizational excellence.
2	To develop an understanding of TQM principles such as leadership, employee involvement, continuous improvement, and supplier partnership for quality enhancement.
3	To familiarize students with quality management tools and techniques used for problem-solving and process improvement in manufacturing and service sectors.
4	To provide knowledge of advanced quality tools, process capability analysis, and quality improvement methodologies for organizational performance.
5	To impart an understanding of quality management systems and international standards for implementing effective quality practices in organizations.

Course Outcomes

Upon completion of the course, students shall have ability to

OE638.1	Explain the concepts, principles, frameworks, and importance of Total Quality Management, including customer focus and cost of quality.	[U]
OE638.2	Apply TQM principles such as leadership, employee involvement, continuous improvement, and supplier partnership to enhance organizational quality practices.	[AP]
OE638.3	Apply quality management tools and techniques, including the seven QC tools, Six Sigma, benchmarking, and FMEA, to solve quality-related problems.	[AP]
OE638.4	Apply control charts, process capability analysis, QFD, Taguchi methods, and TPM concepts to improve process performance and product quality.	[AP]
OE638.5	Explain the requirements and implementation of ISO 9000, ISO 9001, ISO 14000, quality auditing, and quality systems in manufacturing and service sectors.	[U]

Course Contents

Unit-1	**INTRODUCTION**	**9**

Introduction - Need for quality - Evolution of quality - Definitions of quality - Dimensions of product and service quality - Basic concepts of TQM - TQM Framework - Contributions of Deming, Juran and Crosby - Barriers to TQM - Quality statements - Customer focus - Customer orientation, Customer satisfaction, Customer complaints, and Customer retention - Costs of quality.

Unit – 2	**TQM PRINCIPLES**	**9**

Leadership - Strategic quality planning, Quality Councils - Employee involvement - Motivation, Empowerment, Team and Teamwork, Quality circles Recognition and Reward, Performance appraisal - Continuous process improvement - PDCA cycle, 5S, Kaizen - Supplier partnership - Partnering, Supplier selection, Supplier Rating.

Unit – 3	**TQM TOOLS & TECHNIQUES I**	**9**

The seven traditional tools of quality - New management tools - Six sigma: Concepts, Methodology, applications to manufacturing, service sector including IT - Bench marking - Reason to bench mark, Bench marking process - FMEA - Stages, Types.

Unit – 4	**TQM TOOLS & TECHNIQUES II**	**9**

Control Charts - Process Capability - Concepts of Six Sigma - Quality Function Development (QFD) - Taguchi quality loss function - TPM - Concepts, improvement needs - Performance measures.

Unit – 5	**QUALITY SYSTEMS**	**9**

Need for ISO 9000 - ISO 9001-2008 Quality System - Elements, Documentation, Quality Auditing - QS 9000 - ISO 14000 - Concepts, Requirements and Benefits – TQM Implementation in manufacturing and service sectors.	
Total Hours	**45**
Textbooks:	
1	Dale H.Besterfiled, Carol B.Michna, Glen H. Besterfield, Mary B.Sacre, Hemant Urdhwareshe and RashmiUrdhwareshe, "Total Quality Management", Pearson Education Asia, Revised Third Edition, Indian Reprint, Sixth Impression,2013.
2	Joel.E. Ross, "Total Quality Management – Text and Cases", Routledge., 2017.
Reference Books:	
1	Kiran. D.R, "Total Quality Management: Key concepts and case studies, Butterworth – Heinemann Ltd, 2016.
2	Suganthi,L and Anand Samuel, "Total Quality Management", Prentice Hall (India) Pvt. Ltd.,2006.
Web References:	
1	https://www.youtube.com/playlist?list=PL2H1lLi34F7gRnoyJer96C5R4dG48G6eO
2	https://www.youtube.com/watch?v=OSz7MvkPhFI
3	https://www.youtube.com/playlist?list=PL8fPvgxF8y0XY6AKVJMq9V_fbT0clL6N

Assessment based on Continuous and End Semester Examination

Bloom's Level	CONTINUOUS ASSESSMENT			ASSIGNMENT	ATTENDANCE	END SEMESTER EXAMINATION
	CIA1 (6 Marks)	CIA2 (6 Marks)	Model Exam (8 Marks)	(10 Marks)	(10 Marks)	(60 Marks)
Remember						
Understand	80%		80%			
Apply	20%	100%	20%			
Analyze						
Evaluate						
Create						
Total (100 Marks)	**6**	**6**	**8**	**10**	**10**	**60**

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject.

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
OE638.1	-	2	2	-	-	-	3	-	2	-	-	-	-	-
OE638.2	-	-	2	1	-	2	2	-	2	-	-	-	-	-
OE638.3	-	3	1	1	2	-	-	-	3	-	-	-	-	2
OE638.4	-	-	1	1	-	2	-	-	1	-	-	-	-	2
OE638.5	-	-	2	-	2	-	-	-	-	-	-	1	-	-

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE639	Intellectual Property Rights		3	0	0	3
Regulation	**Nature of the Course**	**Semester**	**Data Book/Codes/Standards**			
R24	THEORY	-	--------			
Pre-requisite Course(s)		**Co-requisite Course(s)**				
-						

Course Objectives

1	To introduce the fundamental concepts, types, significance, and evolution of Intellectual Property Rights in India and globally.
2	To familiarize students with the procedures and practical aspects involved in registering various forms of intellectual property in India and abroad.
3	To provide knowledge of international treaties and national legislations governing Intellectual Property Rights.
4	To develop an understanding of the protection of digital innovations and the relationship between IP laws, cyber laws, and unfair competition.
5	To impart knowledge on infringement issues, enforcement mechanisms, and emerging challenges in Intellectual Property Rights.

Course Outcomes
Upon completion of the course, students shall have ability to

OE639.1	Explain the fundamental concepts, types, significance, and need for Intellectual Property Rights, including patents, copyrights, geographical indications, TRIPS, and WIPO.	[U]
OE639.2	Describe the procedures and practical aspects involved in the registration of copyrights, trademarks, patents, geographical indications, trade secrets, and industrial designs in India and abroad.	[U]
OE639.3	Summarize the key provisions of international treaties and national legislations related to Intellectual Property Rights, including TRIPS, PCT, Patent Act, Design Act, Trademark Act, and Geographical Indication Act.	[U]
OE639.4	Apply Intellectual Property and cyber law principles to analyze the protection of digital innovations, digital content, and issues related to unfair competition through case studies.	[AP]
OE639.5	Apply appropriate legal provisions and enforcement measures to address Intellectual Property Rights infringement and emerging issues using relevant case studies.	[AP]

Course Contents

Unit-1	**INTRODUCTION TO IPR**	**9**
Introduction to IPRs, Basic concepts and need for Intellectual Property – Patents, copyrights, geographical Indications. IPR in India and Abroad – Genesis and Development – the way from WTO to WIPO – TRIPS, Nature of Intellectual Property, Industrial Property, technological research, inventions and innovations – Important examples of IPR.		
Unit – 2	**REGISTRATION OF IPRs**	**9**
Meaning and practical aspects of registration of copy rights, trademarks, patents, geographical indications, trade secrets and industrial design registration in India and abroad.		
Unit – 3	**AGREEMENTS AND LEGISLATIONS**	**9**
International treaties and conventions on IPRs, TRIPS agreement, PCT agreement, Patent Act of India, Patent Amendment Act, Design Act, Trademarks Act, Geographical Indication Act.		
Unit – 4	**DIGITAL PRODUCTS AND LAW**	**9**

Digital innovations and developments as knowledge assets – IP laws, cyber law and digital content protection – unfair competition – meaning and relationship between unfair competition and IP laws – case studies.		
Unit – 5	**ENFORCEMENT OF IPRS**	**9**
Infringement of IPRs, enforcement measures, emerging issues – case studies.		
	Total Hours	**45**
Textbooks:		
1	Dr. G.B.Reddy, Intellectual Property Rights and The Law, Gogia Law Agency, 2020	
2	B.L. Wadehra, Law Relating to Intellectual Property, Universal Law Publishing Co., 2011	
Reference Books:		
1	P. Narayanan, Intellectual Property Law, Eastern Law House, 2023	
2	Dr.S.R. Myneni, Law of Intellectual Property, Asian Law House, 2012.	
Web References:		
1	https://www.youtube.com/watch?v=IlXGjaCkM6Y	
2	https://www.youtube.com/watch?v=pqRqJ3e4PUE	
3	https://www.youtube.com/watch?v=Oj_VwmI-Q18	

Assessment based on Continuous and End Semester Examination						
Bloom's Level	**CONTINUOUS ASSESSMENT**			**ASSIGNMENT**	**ATTENDANCE**	**END SEMESTER EXAMINATION**
	CIA1 (6 Marks)	**CIA2 (6 Marks)**	**Model Exam (8 Marks)**	**(10 Marks)**	**(10 Marks)**	**(60 Marks)**
Remember						
Understand	100%	100%				
Apply			100%			
Analyze						
Evaluate						
Create						
Total (100 Marks)	**6**	**6**	**8**	**10**	**10**	**60**

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject.

COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
OE639.1	-	-	-	-	-	-	3	3	-	-	3	-	-	-
OE639.2	-	-	-	-	-	-	3	3	-	-	3	-	-	-
OE639.3	-	-	-	-	-	-	3	3	-	-	3	-	-	-
OE639.4	-	-	-	-	-	-	3	3	-	-	3	-	-	-
OE639.5	-	-	-	-	-	-	3	3	-	-	3	-	-	-

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE640	EMOTIONAL INTELLIGENCE	OE	3	0	0	3
Regulation	**Nature of the Course**	**Semester**	**Data Book/Codes/Standards**			
R24	THEORY		--------			
Pre-requisite Course(s)		**Co-requisite Course(s)**				
-						

Course Objectives	
1	To help students gain basic understanding of Emotions
2	To provide them with knowledge regarding concepts and models of emotional Intelligence(EI)
3	To enable them to recognize and regulate their emotions
4	To help students manage relationship in a positive manner.
5	To infer ways to measure and develop strategies for acquiring EQ

Course Outcomes **Upon completion of the course, students shall have ability to**		
OE640.1	Comprehend the basic concepts of management and evolution in management.	[U]
OE640.2	Demonstrate the roles and skills in planning and decision making for the business.	[U]
OE640.3	Discover personal competencies and manage emotions	[U]
OE640.4	Gain insight into positive relationship through EI	[U]
OE640.5	Identify ways to improve emotional Intelligence	[AP]

Course Contents		
Unit-1	**INTRODUCTION TO THE CONCEPT OF EMOTION**	**9**
Emotion- Meaning, characteristics of emotion, components of emotion-cognitive component, physiological component, Behavioural component, Types of emotions,		
Unit – 2	**FUNDAMENTALS OF EMOTIONAL INTELLIGENCE**	**9**
Nature and Significance, Models of emotional intelligence: Ability, Trait and Mixed, Building blocks of emotional intelligence: self-awareness, self-management, social awareness, and relationship management		
Unit – 3	**PERSONAL COMPETENCE**	**9**
Self-Awareness: Observing and recognizing one's own feelings, Knowing one's strengths and areas of development. Self-Management: Managing emotions, anxiety, fear, and anger.		
Unit – 4	**SOCIAL COMPETENCE**	**9**
Social Awareness: Others' Perspectives, Empathy and Compassion, Relationship Management: Effective communication, Collaboration, Teamwork, and Conflict management		
Unit – 5	**EMOTIONAL INTELLIGENCE: MEASUREMENT AND DEVELOPMENT**	**9**
Measures of emotional intelligence, Strategies to enhance emotional intelligence		
	Total Hours	**45**

Textbooks:	
1	Daniel Goleman, Emotional Intelligence: Why it Matters more than IQ, Bloomsbury India, 2021
2	Travis Bradberry, Jean Greaves, Emotional Intelligence 2.0, Talentsmart, 2009
Reference Books:	
1	Dr. Pratik P Surana, Mastering Emotional Intelligence : Making Emotions Work “For” you and not “Against” you, Notion Press, 2021
2	Ryan James, Emotional Intelligence: The Definitive Guide to Understanding Your Emotions, How to Improve Your EQ and Your Relationships, Kindle Edition,2016

Assessment based on Continuous and End Semester Examination						
Bloom's Level	CONTINUOUS ASSESSMENT			ASSIGNMENT	ATTENDANCE	END SEMESTER EXAMINATION
	CIA1 (6 Marks)	CIA2 (6 Marks)	Model Exam (8 Marks)	(10 Marks)	(10 Marks)	(60 Marks)
Remember						
Understand	100%	100%	80%			
Apply			20%			
Analyze						
Evaluate						
Create						
Total (100 Marks)	**6**	**6**	**8**	**10**	**10**	**60**

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject.

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
OE640.1	-	-	-	-	-	-	-	3	3	-	3	-	-	-
OE640.2	-	-	-	-	-	-	-	3	3	-	3	-	-	-
OE640.3	-	-	-	-	-	-	-	3	3	-	3	-	-	-
OE640.4	-	-	-	-	-	-	-	3	3	-	3	-	-	-
OE640.5	-	-	-	-	-	-	-	3	3	-	3	-	-	-

Course Code	Course Name	Semester	Category	Hours/Week			C
				L	T	P	
24OE641	Algebra and Number Theory		OEC	3	0	0	3

Course Outcomes (s)		
Upon completion of the course, students shall have ability to		RBT
CO1	Apply algebraic structures and mappings to solve problems related to groups and rings.	[AP]
CO2	Utilize properties of finite fields to analyze and factor expressions within polynomial systems.	[AP]
CO3	Implement number-theoretic techniques from divisibility and decomposition to perform structured arithmetic computations.	[AP]
CO4	Solve modular equations and systems using methods from Diophantine analysis and congruences.	[AP]
CO5	Apply classical results and arithmetic functions to evaluate and reason about numerical properties.	[AP]

Course Content		
Unit – I	**GROUPS AND RINGS**	09
Groups: Definition - Properties - Homomorphism - Isomorphism - Cyclic groups - Cosets - Lagrange's theorem. Rings: Definition - Sub rings - Integral domain - Field - Integer modulo n - Ring homomorphism.		
Unit – II	**FINITE FIELDS AND POLYNOMIALS**	09
Rings - Polynomial rings - Irreducible polynomials over finite fields - Factorization of polynomials over finite fields.		
Unit – III	**DIVISIBILITY THEORY AND CANONICAL DECOMPOSITIONS**	09
Division algorithm- Base-b representations – Number patterns – Prime and composite numbers – GCD – Euclidean algorithm – Fundamental theorem of arithmetic – LCM.		
Unit – IV	**DIOPHANTINE EQUATIONS AND CONGRUENCES**	09
Linear Diophantine equations – Congruence's – Linear Congruence's - Applications : Divisibility tests - Modular exponentiation - Chinese remainder theorem – 2x2 linear systems		
Unit – V	**CLASSICAL THEOREMS AND MULTIPLICATIVE FUNCTIONS**	09
Wilson's theorem – Fermat's Little theorem – Euler's theorem – Euler's Phi functions – Tau and Sigma functions.		
		TOTAL: 45 Hours

Learning Resources	
Textbooks	
1	R. P. Grimaldi and B. V. Ramana, *Discrete and Combinatorial Mathematics: An Applied Introduction*, 5th ed. New Delhi, India: Pearson Education, 2019.
2	T. Koshy, *Elementary Number Theory with Applications*, 2nd ed. Burlington, MA, USA: Academic Press, 2007.
Reference Books	
1	S. Ling and C. Xing, *Coding Theory: A First Course*, 1st ed. Cambridge, U.K.: Cambridge University Press, 2004.
2	I. Niven, H. S. Zuckerman, and H. L. Montgomery, *An Introduction to the Theory of Numbers*, 5th ed. Singapore: John Wiley and Sons, 2004.
3	R. Lidl and G. Pilz, *Applied Abstract Algebra*, 2nd ed. New Delhi, India: Springer-Verlag, 2006.
Web References	
1	https://archive.nptel.ac.in/courses/111/106/111106113/
2	https://nptel.ac.in/courses/106/106/106106094/
3	https://nptel.ac.in/courses/106/106/106106183/
4	https://nptel.ac.in/courses/106/104/106104137/
5	https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-042j-mathematics-for-computer-science-fall-2005/

Course Code	Course Name	Semester	Category	Hours/Week			C
				L	T	P	
24OE642	**Linear Algebra**		OEC	3	0	0	3

Course Outcomes (s)		
Upon completion of the course, students shall have ability to		RBT
CO1	Test the consistency and solve system of linear equations.	[AP]
CO2	Find the basis and dimension of vector space.	[AP]
CO3	Obtain the matrix of linear transformation and its eigenvalues and eigen vectors	[AP]
CO4	Find orthonormal basis of inner product space and find least square approximation.	[AP]
CO5	Find eigenvalues of a matrix using numerical techniques and perform matrix decomposition.	[AP]

Course Content		
Unit – I	**MATRICES AND SYSTEM OF LINEAR EQUATIONS**	09
Matrices - Row echelon form - Rank - System of linear equations - Consistency - Gauss elimination method - Gauss Jordan method.		
Unit – II	**VECTOR SPACES**	09
Vector spaces over Real and Complex fields - Subspace – Linear space - Linear independence and dependence - Basis and dimension.		
Unit – III	**LINEAR TRANSFORMATION**	09
Linear transformation - Rank space and null space - Rank and nullity - Dimension theorem– Matrix representation of linear transformation - Eigenvalues and eigenvectors of linear transformation – Diagonalization.		
Unit – IV	**INNER PRODUCT SPACES**	09
Inner product and norms - Properties - Orthogonal, Orthonormal vectors - Gram Schmidt orthonormalization process - Least square approximation.		
Unit – V	**EIGEN VALUE PROBLEMS AND MATRIX DECOMPOSITION**	09
Eigen value Problems: Power method, Jacobi rotation method - Singular value decomposition – QR decomposition.		
		TOTAL: 45 Hours

Learning Resources	
Textbooks	
1	J. D. Faires and R. L. Burden, *Numerical Methods*, 4th ed. Boston, MA, USA: Cengage Learning, 2012.
2	S. H. Friedberg, A. J. Insel, and L. E. Spence, Linear Algebra, 5th ed. New Delhi, India: Pearson Education, 2019.
Reference Books	
1	B. Kolman and D. R. Hill, *Introductory Linear Algebra*, 8th ed. New Delhi, India: Pearson Education, 2009.
2	S. Kumaresan, *Linear Algebra: A Geometric Approach*, Reprint, New Delhi, India: Prentice Hall of India, 2010.
3	R. Bronson, *Schaum's Outline of Matrix Operations*, 2nd ed. New York, NY, USA: McGraw-Hill, 2011.
4	G. Strang, *Linear Algebra and Its Applications*, 5th ed. New Delhi, India: Pearson Education, 2023.
5	V. Sundarapandian, *Numerical Linear Algebra*, New Delhi, India: PHI Learning Pvt. Ltd., 2023.
Web References	
1	https://archive.nptel.ac.in/courses/111/106/111106051
2	https://onlinecourses.nptel.ac.in/noc24_ee48/preview
3	https://archive.nptel.ac.in/courses/111/107/111107106/

Course Code	Course Name	Semester	Category	Hours/Week			C
				L	T	P	
24OE643	**Advanced Engineering Chemistry**		OE	**3**	**0**	**0**	**3**

Course Outcomes (s)		
Upon completion of the course, students shall have ability to		RBT
CO1	Understand the basic principles of semiconductors, including periodic trends, band gaps, conductivity, and their applications in various electronic and optoelectronic devices.	[U]
CO2	Select appropriate modern engineering alloys based on their composition and properties for specific applications in electronics, telecommunications, and aerospace.	[AP]
CO3	Classify different types of refractories and abrasives and describe their properties and manufacturing processes with respect to industrial usage.	[U]
CO4	Describe the types and mechanisms of adsorption, interpret adsorption isotherms, and explain their significance in catalytic and surface chemistry applications.	[U]
CO5	Apply suitable spectroscopic techniques such as UV-Visible, IR, XRD, and flame photometry for the qualitative and quantitative analysis of materials.	[AP]

Course Content		
Unit – I	**Chemistry of Semiconductors**	09
Semiconductors – Introduction – Periodic trends –Band gaps, conductivity and colours of semiconductors - compound semiconductors–Semiconductor Technology – An overview of Integrated circuit design and fabrication – uses in FET – BJT, JFET, MOSFET - Semiconductors in traffic lights and electronics, CD/DVD optical discs, microchips in computers and cell phones, solar cells- amorphous semiconductors – an overview		
Unit – II	**Modern Engineering Materials**	09
Metals and Metallic properties-Alloys and Need for Alloys - Modern Electronic grade alloys-Composition, Properties of Aluminium, Silicon, Nickel, Phosphorus and Copper alloys-Applications in electrical components, transducers, electromagnetic shielding of computers, telecommunications equipment and rocket motor casings.		
Unit – III	**Refractories and Abrasives**	09
Refractories – classification – acidic, basic and neutral refractories – properties (refractoriness, refractoriness under load, dimensional stability, porosity, thermal spalling) – manufacture of alumina, magnesite and zirconia bricks. Abrasives – natural and synthetic abrasives – quartz, corundum, emery, garnet, diamond, silicon carbide and boron carbide.		
Unit – IV	**Surface Chemistry**	09
Adsorption- Classification of adsorption-adsorption of gases on solids-adsorption of solutes from Solutions-Types of adsorption isotherms-Freundlich adsorption Isotherm-Langmuir's theory of adsorption- Applications of adsorption - Role of adsorbents in catalysis.		
Unit – V	**Spectroscopic Techniques**	09
Basic concepts of spectroscopy - Electromagnetic spectrum – Lambert and Beers law - Absorption and Emission spectroscopy – Different spectroscopic Techniques - UV- Visible – IR – Colorimetry - Flame photometry (Block Diagram) - XRD technique.		
		TOTAL: 45 Hours

Learning Resources

Textbooks

1	David W. Greve, "Semiconductor Devices and Technology", Squirrel Hill Publications, Pittsburg, USA, 14th Edition, 2011.
2	Jain P. C. & Monica Jain., "Engineering Chemistry", 17th Edition, Dhanpat Rai Publishing Company (P) Ltd, New Delhi, 2015.
3	Dara S.S., "A Text book of Engineering Chemistry", S.Chand Publications, 2004
4	Shashi Chawla "A Text Book Of Engineering Chemistry" Dhanpat Rai & Co. (P) Limited, 2017

Reference Books

1	Joel Irwin Gersten and Frederick William Smith, "The Physics and Chemistry of Materials", Wiley Interscience, New Jersy, 12th Edition, 2012.
2	Sivasankar B., "Engineering Chemistry", Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2012.
3	Friedrich Emich, "Engineering Chemistry", Medtech, 2014.
Web References	
1	https://learncheme.com/
2	https://www.coursera.org/browse/physical-science-and-engineering/chemistry
3	http://www.cheresources.com/

Course Code	Course Name	Semester	Category	Hours/Week			C
				L	T	P	
24OE644	Nanotechnology And NLO Materials		OE	3	0	0	3

Course Outcomes (s)		
Upon completion of the course, students shall have ability to		RBT
CO1	Understand the basic concepts of nanotechnology.	[U]
CO2	Explained the method of synthesizing nanostructures with desired size, shape, and surface properties.	[AP]
CO3	Apply characterization results to optimize the synthesis process and enhance the functionality of nanomaterials for targeted applications.	[AP]
CO4	Utilize nanomaterials for the design of high-performance sensing devices.	[AP]
CO5	Utilize nonlinear optical concepts to enhance and develop technologies in recent engineering.	[AP]

Course Content		
Unit – I	**INTRODUCTION TO NANOMATERIALS**	**09**
History of nanomaterial's, Classification of Nanomaterial's, Scientific Revolutions, Nanotechnology and Nano machines, The Periodic Table, Atomic Structure, Energy, Molecular and Atomic size, Surfaces and Dimensional Space.		
Unit – II	**SYNTHESIS METHOD OF NANO MATERIALS**	**09**
Top down and Bottom-up approach, Ball Milling, Electros pinning, Lithographic techniques, Mechanical milling, Etching, Sputtering, Laser Ablation, Molecular beam epitaxy, CVD, Arc discharge, Flame synthesis, spray pyrolysis and solvated metal atom dispersion, Sol-Gel, Electro deposition.		
Unit – III	**BASICS OF NANO MATERIALS CHARACTERIZATION TECHNIQUES**	**09**
UV- Visible Spectroscopy, Fourier Transform infrared (FTIR) spectroscopy, Raman spectroscopy-X-ray Photoelectron Spectroscopy (XPS), Energy Dispersive X-ray analysis (EDAX), microscopy (SEM), Transmission electron microscopy (TEM), Atomic force microscopy (AFM), Scanning tunneling microscopy (STM). Resistivity by Four Point Probe method, Hall measurement.		
Unit – IV	**NANO MATERIALS AND APPLICATIONS**	**09**
Sensors, Nanotechnology Enabled Sensors, Sensor Characteristics and Terminology, Static Characteristics, Dynamic Characteristics, Resistive and Capacitive Gas Sensors, Potentiometric Sensors, Amperometric Sensors, Electro-Chemical Biosensors.		
Unit – V	**NONLINEAR OPTICS AND APPLICATIONS**	**09**
Nonlinear Optics: Nonlinear Susceptibility, 2nd order nonlinear effect- Optical Rectification, 2nd harmonic generation, , Nonlinear Maxwell's equation, Concept of phase matching Birefringence Phase Matching (BPM) , Kleinman symmetry, Index contraction, d-matrix ,Quasi Phase Matching (QPM), Optical Parametric Oscillator (OPO),Singly Resonant Oscillator (SRO),Doubly Resonant Oscillator.		
		TOTAL: 45 Hours

Learning Resources	
Textbooks	
1	A textbook of Nano science and Nanotechnology, Pradeep.T, Tata McGraw – Hill Education private Ltd, 2012.
2	Nanostructured materials: Processing, Properties and Potential Applications, edited by C.C. Koch, Noyes Publications, 2002.
3	Inorganic Materials Synthesis and Fabrication by J.N. Lalena, D.A. Cleary, E.E. Carpenter, N.F. Dean, John Wiley & Sons Inc,2008.
4	Characterization of nanostructured materials by Z.L. Wang, Wiley India, 1999.
5	Nanotechnology-Enabled Sensors, KouroshKalantar-zadeh, Springer publications, 2007.
6	Chemical Sensors-An Introduction for Scientists and Engineers, Peter Grundler, Springer publications, 2006.
7	Nonlinear Optics. Third Edition. Robert W. Boyd. The Institute of Optics. University of Rochester. Rochester, NY, United States, 2008.
8	Introduction to nonlinear optics by Geoffrey New, Imperial College of Science, Technology and Medicine, London, 2011.
Reference Books	
1	Nanotechnology: Principles and Practices – Sulabha K. Kulkarni – Capital Publishing Company, 2015.

2	Design and Applications of Nanomaterials for Sensors by Jorge M. Seminario, Jerzy Leszczynski, Springer, Volume-16, 2014.
3	Fundamentals of nonlinear optics (2nd Ed.) by Peter E. Powers, Joseph W. Haus , CRC Press, 2017.
4	Nonlinear Optics: Principles and Applications by K Rottwitt, P Tidemand-Lichtenberg , CRC Press, 2014.
5	Introduction to Nano science, S.M. Lindsay, Oxford university Press, 2010.
6	Encyclopedia of Nano Technology by M. BalakrishnaRao and K. Krishna Reddy, Vol I to X, Cumpus Books International, 2006.
7	A practical approach to X-Ray diffraction analysis by C. Suryanarayana, Plenum Press, Newyork, 1998.
8	Atomic and Molecular Spectroscopy: Basic Aspects and Applications by S. Svanberg, Springer, 2001.
Web References	
1	https://archive.nptel.ac.in/courses/118/102/118102003/#
2	https://archive.nptel.ac.in/courses/115/105/115105105/
3	https://archive.nptel.ac.in/courses/115/101/115101008/#
4	https://ocw.mit.edu/courses/2-57-nano-to-macro-transport-processes-spring-2012/resources/lecture-1-intro-to-nanotechnology-nanoscale-transport-phenomena/

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE645	English for Competitive Examinations	HS	3	0	0	3

Course Outcomes (s)		
Upon completion of the course, students shall have ability		**RBT**
C114.1	Understanding of common English words and phrases, building their vocabulary to communicate.	AP
C114.2	Recognize different types of sentence structures.	AP
C114.3	Learn to write précis and notes with clarity.	AP
C114.4	Express ideas in a clear and concise manner.	AP
C114.5	Gain a clear understanding in the use of prepositions and eliminate common errors.	AP

Course Content		
Unit –1	**INTRODUCTION TO BASICS OF ENGLISH**	9
Different kinds of Tenses, Types of Sentences, Phrase, Adverb& Phrases and Idioms. Synonyms and Antonyms.		
Unit –2	**TRANSFORMATION OF SENTENCE**	9
Transformation of simple, Compound and complex sentences, Transformation of communication classification of sentences & Transformation of Degree. Synonyms And Antonyms.		
Unit –3	**PRECIS AND NOTE WRITING**	9
Precise writing, Note making, Paragraph Writing & Essay Writing. Synonyms And Antonyms.		
Unit –4	**COMPREHENSION AND LETTER AND REPORT WRITING**	9
Comprehension, Letter Writing &Report Writing. Synonyms And Antonyms.		
Unit –5	**COMMON ERRORS AND USE OF PREPOSITIONS**	9
Match Words With Their Meanings, Spotting Common Errors In English Grammar, Appropriate Use Of Prepositions. Synonyms And Antonyms.		
	TOTAL: 45Hours	

Learning Resources	
Textbooks	
1	K. S. Sinha, *The King's Grammar*. New Delhi, India: Blackie ELT Books, 2008.
2	C. D. Sidhu, P. Nath, and K. Kapoor, *Comprehensive English Grammar and Composition*. New Delhi, India: Khosla Publishing House, 2004.
3	P. C. Wren and H. Martin, *High School English Grammar & Composition*. New Delhi, India: S. Chand & Company, 2007.
Reference Books	
1	C. Baldick, *The Oxford Dictionary of Literary Terms*. Oxford, U.K.: Oxford University Press, 2009.
3	J. Mathew, *Fine Tune Your English*. New Delhi, India: Orient Blackswan Pvt. Ltd., 2010.
Web References	
1	https://byjus.com/govt-exams/general-english-competitive-exams//

APPENDIX

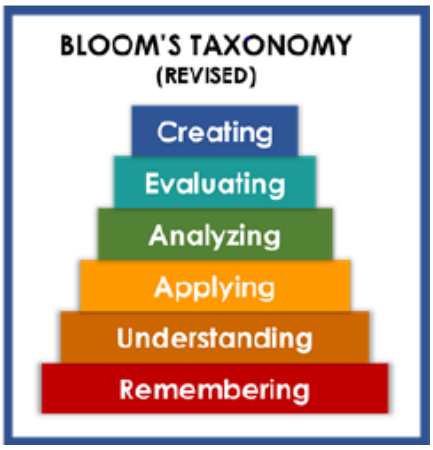
A. Knowledge and Attitude Profile (WK)

WK	Knowledge and Attitude Profile
WK1	A systematic, theory-based understanding of the natural sciences applicable to the discipline and awareness of relevant social sciences.
WK2	Conceptually-based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed analysis and modelling applicable to the discipline.
WK3	A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline.
WK4	Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline.
WK5	Knowledge, including efficient resource use, environmental impacts, whole-life cost, re-use of resources, net zero carbon, and similar concepts, that supports engineering design and operations in a practice area.
WK6	Knowledge of engineering practice (technology) in the practice areas in the engineering discipline.
WK7	Knowledge of the role of engineering in society and identified issues in engineering practice in the discipline, such as the professional responsibility of an engineer to public safety and sustainable development.
WK8	Engagement with selected knowledge in the current research literature of the discipline, awareness of the power of critical thinking and creative approaches to evaluate emerging issues.
WK9	Ethics, inclusive behavior and conduct. Knowledge of professional ethics, responsibilities, and norms of engineering practice. Awareness of the need for diversity by reason of ethnicity, gender, age, physical ability etc. with mutual understanding and respect, and of inclusive attitudes.

B. BLOOMS TAXONOMY

According to revised Blooms taxonomy the levels in the cognitive domain are as follows:

Level	Descriptor	Level of attainment
1	Remembering	Recalling from the memory of the previously learned material
2	Understanding	Explaining ideas or concepts
3	Applying	Using the information in another familiar situation
4	Analysing	Breaking information into the part to explore understanding and relationships
5	Evaluating	Justifying a decision or course of action
6	Creating	Generating new ideas, products or new ways of viewing things



Bloom's taxonomy is hierarchical, meaning that learning at the higher level requires that skills at a lower level are attained.

As per the Examination Reform Policy following are the Action Verbs for Assessment

Level	Question cues / Verbs for tests
1. Remember	list, define, tell, describe, recite, recall, identify, show, label, tabulate, quote, name, who, when, where
2. Understand	describe, explain, paraphrase, restate, associate, contrast, summarize, differentiate interpret, discuss
3. Apply	calculate, predict, apply, solve, illustrate, use, demonstrate, determine, model, experiment, show, examine, modify
4. Analyse	classify, outline, break down, categorize, analyze, diagram, illustrate, infer, select
5. Evaluate	assess, decide, choose, rank, grade, test, measure, defend, recommend, convince, select, judge, support, conclude, argue, justify, compare, summarize, evaluate
6. Create	design, formulate, build, invent, create, compose, generate, derive, modify, develop, integrate