ANNA UNIVERSITY, CHENNAI

UNDERGRADUATE CURRICULUM (UNIVERSITY DEPARTMENTS)

Campus: College of Engineering Guindy

Department: Mechanical Engineering

Programme: B.E. Mechanical Engineering

Regulations: 2023 (Revised 2024), with effect from the AY 2024 – 25 to all the students of UG Programme.

OVERVIEW OF CREDITS

Sem	PCC	PEC	ESC	HSMC	ETC	OEC	SDC	UC	SLC	Total
I			4	11			7	1		23
II			9	11				1		21
III	14		4	4			1			23
IV	18		4				4	2		28
V	14	3					2	4	1	24
VI		12			3	3	1			19
VII	11	3			3	3	3	3		26
VIII							8			8
Total	57	18	21	26	6	6	26	11	1	175
% of Category	33.13	10.46	12.20	15.11	3.48	3.48	15.11	6.39	0.58	

CATEGORY OF COURSES

PCC – Professional Core Course

PEC – Professional Elective Course

ETC – Emerging Technology Course

OEC – Open Elective Course

SLC – Self Learning Course

ESC – Engineering Science Course

HSMC – Humanities Science and Management Course

SDC – Skill Development Course

UC – University Course

For Honours & Minor Degree, please refer the Regulations 2023 (Revised 2024).

Semester – I							
S. No.	**Course Code**	**Course Name**	**Course Type#**	**Periods / Week**		**Credits**	**Category**
				L-T-P	**TCP***		
1	EN23C01	Foundation English	LIT	2-0-2	4	3	HSMC
2	MA23C01	Matrices and Calculus	T	3-1-0	4	4	HSMC
3	CY23C01	Engineering Chemistry	LIT	3-0-2	5	4	HSMC
4	ME23C01	Engineering Drawing and 3D Modelling	LIT	2-0-4	6	4	SDC
5	ME23C03	Engineering Mechanics	T	3-1-0	4	4	ESC
6	ME23C04	Makerspace	LIT	1-0-4	5	3	SDC
7	UC23H01	தமிழர்மரபு/Heritage of Tamils	T	1-0-0	1	1	UC
8	-	NCC / NSS / NSO / YRC	-	0-0-2	2	-	UC
9	-	Audit Course – I	-	-	-	-	UC
				Total Credits		**23**	

*** TCP – Total Contact Period(s)**

#<u>TYPE OF COURSE</u>

LIT – Laboratory Integrated Theory
T – Theory
L – Laboratory Course
IPW – Internship cum Project Work
PW – Project Work
CDP – Capstone Design Project

Semester – II							
S. No.	**Course Code**	**Course Name**	**Course Type#**	**Periods / Week**		**Credits**	**Category**
				L-T-P	**TCP***		
1	EN23C02	Professional Communication	LIT	2-0-2	4	3	HSMC
2	MA23C02	Ordinary Differential Equations and Transform Techniques	T	3-1-0	4	4	HSMC
3	PH23C01	Engineering Physics	LIT	3-0-2	5	4	HSMC
4	CS23C02	Computer Programming in Python	LIT	3-0-2	5	4	ESC
5	EE23C03	Basics of Electrical and Electronics Engineering	LIT	2-0-2	4	3	ESC
6	ME23C06	Design Thinking	LIT	2-0-2	4	3	ESC
7	UC23H02	தமிழரும் தொழில்நுட்பமும் / Tamils and Technology	T	1-0-0	1	1	UC
				Total Credits		**22**	

SEMESTER – III							
S. NO.	**COURSE CODE**	**COURSE NAME**	**COURSE TYPE#**	**PERIODS / WEEK**		**CREDITS**	**CATE GORY**
				L-T-P	**TCP***		
1	MA23C06	Partial Differential Equations and Complex Functions	T	3-1-0	4	4	HSMC
2	ME23C11	Kinematics and Dynamics of Machinery	LIT	3-0-2	5	4	PCC
3	ME23C08	Engineering Thermodynamics	T	3-0-0	3	3	PCC
4	ME23301	Manufacturing Technology	LIT	3-0-2	5	4	PCC
5	MS23C01	Engineering Materials and Metallurgy	T	3-0-0	3	3	PCC
6	CE23C01	Mechanics of Materials	LIT	3-0-2	5	4	ESC
7	-	Audit Course – II	-	-	-	-	UC
8	-	Skill Development Course I	-	-	-	2	SDC
				TOTAL CREDITS		**24**	

SEMESTER – IV							
S. NO.	**COURSE CODE**	**COURSE NAME**	**COURSE TYPE#**	**PERIODS / WEEK**		**CREDITS**	**CATE GORY**
				L-T-P	**TCP***		
1	ME23401	Metal Cutting and Machine Tools	LIT	3-0-2	5	4	PCC
2	ME23402	Thermal Engineering - I	LIT	3-0-2	5	4	PCC
3	CE23C02	Fluid Mechanics and Machinery	LIT	3-0-2	5	4	ESC
4	ME23C15	Design of Machine Elements	T	3-0-0	3	3	PCC
5	ME23403	Fluid Power Automation	LIT	3-0-2	5	4	PCC
6	ME23404	Product Design and Development	LIT	2-0-2	4	3	PCC
7		Skill Development Course II	-	-	-	2	SDC
8		Industry Oriented Course-1/ Industrial lecture	T	1-0-0	1	1	SDC
9	UC23U01	Universal Human Values	LIT	1-0-2	3	2	UC
10	ME23405	Computer Aided Machine Drawing	L	0-0-4	4	2	SDC
				TOTAL CREDITS		**29**	

SEMESTER – V							
S. NO.	COURSE CODE	COURSE NAME	COURSE TYPE#	PERIODS / WEEK		CREDITS	CATE GORY
				L-T-P	TCP*		
1	ME23501	Metrology and Measurements	LIT	3-0-2	5	4	PCC
2	ME23502	Thermal Engineering II	LIT	3-0-2	5	4	PCC
3	ME23503	Project and Financial Management	T	3-0-0	3	3	PCC
4	ME23504	Design of Transmission Systems	T	3-0-0	3	3	PCC
5	ME23U02	Perspectives of Sustainable Development	T	2-0-2	4	3	UC
6		Professional Elective - I	T	3-0-0	3	3	PEC
7		Industry Oriented Course II	-	-	-	1	SDC
8	ME23L01	Self-Learning Course	T	1-0-0	1	1	SLC
9		Skill Development Course III	-	-	-	2	SDC
10	ME23U01	Standards - Mechanical Engineering	T	1-0-0	1	1	UC
TOTAL CREDITS						**25**	

COURSES FOR HONOURS DEGREE							
S. NO.	COURSE CODE	COURSE NAME	COURSE TYPE#	PERIODS / WEEK		CREDITS	CATE GORY
				L-T-P	TCP*		
1.	ME23D01	Capstone Design Project – Level I	CDP	0-0-12	12	6	SDC
(OR)							
1.		Honours Elective – I	T	3-0-0	3	3	
2.		Honours Elective – II	T	3-0-0	3	3	

COURSES FOR MINOR DEGREE							
S. NO.	COURSE CODE	COURSE NAME	COURSE TYPE#	PERIODS / WEEK		CREDITS	CATE GORY
				L-T-P	TCP*		
1.		Minor Elective – I	T	3-0-0	3	3	
2.		Minor Elective – II	T	3-0-0	3	3	

Semester – VI (Preference for Foreign Exchange)							
S. No.	Course Code	Course Name	Course Type#	Periods / Week		Credits	Category
				L-T-P	TCP*		
1		Professional Elective - II	T	3-0-0	3	3	PEC
2		Professional Elective - III	T	3-0-0	3	3	PEC
3		Professional Elective - IV	T	3-0-0	3	3	PEC
4		Professional Elective - V	T	3-0-0	3	3	PEC
5		Open Elective – I	T	3-0-0	3	3	OEC
6		Emerging Technology Course - I	T	3-0-0	3	3	ETC
7		Industry Oriented Course - III	-	-	-	1	SDC
				Total Credits		**19**	
Courses for Honours Degree							
S. No.	Course Code	Course Name	Course Type#	Periods / Week		Credits	Category
				L-T-P	TCP*		
1.	ME23D02	Capstone Design Project – Level II	CDP	0-0-12	12	6	SDC
(OR)							
1.		Honours Elective – III	T	3-0-0	3	3	
2.		Honours Elective – IV	T	3-0-0	3	3	
Courses for Minor Degree							
S. No.	Course Code	Course Name	Course Type#	Periods / Week		Credits	Category
				L-T-P	TCP*		
1.		Minor Elective – III	T	3-0-0	3	3	
2.		Minor Elective – IV	T	3-0-0	3	3	

Semester – VII							
S. No.	Course Code	Course Name	Course Type#	Periods / Week		Credits	Category
				L-T-P	TCP*		
1	ME23C12	Mechatronics and IoT	LIT	3-0-2	5	4	PCC
2	ME23C09	Finite Element Analysis	T	3-0-0	3	3	PCC
3	ME23701	Heat and Mass Transfer	LIT	3-0-2	5	4	PCC
4		Emerging Technology Course – II	T	3-0-0	3	3	ETC
5		Professional Elective - VI	T	3-0-0	3	3	PEC

6		Open Electives -II	T	3-0-0	3	3	OEC
7	UC23E01	Engineering Entrepreneurship Development	LIT	2-0-2	4	3	UC
8	ME23702	Simulation and Analysis Laboratory	L	0-0-4	4	2	SDC
9	ME23703	Summer Internship	-	0-0-2	2	1	SDC
				Total Credits		**26**	

Courses for Honours Degree

S. No.	Course Code	Course Name	Course Type#	Periods / Week		Credits	Category
				L-T-P	TCP*		
1.	ME23D03	Capstone Design Project – Level III	CDP	0-0-12	12	6	SDC
		(OR)					
1.		Honours Elective – V	T	3-0-0	3	3	
2.		Honours Elective – VI	T	3-0-0	3	3	

Courses for Minor Degree

1.		Minor Elective – V	T	3-0-0	3	3	
2.		Minor Elective – VI	T	3-0-0	3	3	

Semester – VIII

S. No.	Course Code	Course Name	Course Type#	Periods / Week		Credits	Category
				L-T-P	TCP*		
1.	ME23801	Project Work / Internship Cum Project Work	PW/IPW	0-0-16	16	8	SDC
				Total Credits		**8**	

PROFESSIONAL ELECTIVE COURSES: VERTICALS						
VERTICAL 1	**VERTICAL 2**	**VERTICAL 3**	**VERTICAL 4**	**VERTICAL 5**	**VERTICAL 6**	**VERTICAL 7**
PRODUCT DESIGN AND PROCESS DEVELOPMENT	**ROBOTICS AND AUTOMATION**	**DIGITAL AND GREEN MANUFACTURING**	**PROCESS EQUIPMENT AND PIPING DESIGN**	**CLEAN AND GREEN ENERGY TECHNOLOGIES**	**ADVANCED MANUFACTURING**	**DIVERSIFIED COURSES GROUP 1**
Value Engineering	Electrical Drives and Actuators	Machine Learning for Intelligent Systems	Design of Pressure Vessels	Bioenergy Conversion Technologies	Non-traditional Machining Processes	Measurements and Controls
Additive Manufacturing	Embedded Systems and Programming	Environment Sustainability and Impact Assessment	Failure Analysis and NDT Techniques	Carbon Footprint estimation and reduction techniques	Casting and Welding Processes	Design Concepts in Engineering
Product Life Cycle Management	Robotics	Green Manufacturing Design and Practices	Material Handling and solid processing Equipment	Energy Conservation in Industries	Process Planning and Cost Estimation	Composite Materials and Mechanics
Design for X	Sensors and Instrumentation	Lean Manufacturing	Rotating Machinery Design	Wind Energy Technologies	Surface Engineering	Refrigeration and Air Conditioning
Ergonomics in Design	Smart Mobility and Intelligent Vehicles	Green Supply Chain Management	Thermal and Fired Equipment design	Energy Storage Devices	Precision Manufacturing	Energy Efficient Buildings
Integrated product design and manufacturing using GD&T	Haptics and Immersive Technologies	Modern Robotics	Industrial Layout Design and Safety	Renewable Energy Technologies	Industry 4.0 in Manufacturing	Turbo Machines
CAD/CAM	Drone Technologies		Design Codes and Standards	Polygeneration Systems	Computer Integrated Manufacturing	Computational Fluid Dynamics
Materials Selection	Marine robotics		-	Solar Power generation	Applied Operation Research	Advanced Statistics and Data Analytics
				Green Hydrogen Production Storage and Transportation		

Registration of Professional Elective Courses from Verticals:

Professional Elective Courses will be registered from Semesters V to VII. These courses are listed in groups called verticals that represent a particular area of specialisation / diversified group. Students are permitted to choose all the Professional Electives from a particular vertical or from different verticals. Further, only one Professional Elective course shall be chosen in a semester horizontally (row-wise). However, more than one course is permitted from the same row, provided each course is enrolled in a different semester.

The registration of courses for B.E./B.Tech (Hons) shall be done from Semester V to VIII. The procedure for registration of courses explained above shall be followed for the courses of B.E/B.Tech (Hons) also. For more details on B.E./B.Tech (Hons) refer to the Regulations 2023, Clause 4.11.

PROFESSIONAL ELECTIVE COURSES (PEC)

VERTICAL 1: PRODUCT DESIGN AND PROCESS DEVELOPMENT							
S. No.	Course Code	Course Name	Course Type	Periods / Week		Credits	Category
				L-T-P	TCP		
1.	ME23001	Value Engineering	T	3-0-0	3	3	PEC
2.	MF23C01	Additive Manufacturing	T	3-0-0	3	3	PEC
3.	IE23C04	Product Life Cycle Management	T	3-0-0	3	3	PEC
4.	ME23002	Design for X	T	3-0-0	3	3	PEC
5.	ME23003	Ergonomics in Design	T	3-0-0	3	3	PEC
6.	ME23004	CAD/CAM	T	3-0-0	3	3	PEC
7.	ME23005	Materials Selection	T	3-0-0	3	3	PEC
8.	ME23006	Integrated Product Design and Manufacturing using GD&T	T	3-0-0	3	3	PEC

VERTICAL 2: ROBOTICS AND AUTOMATION							
S. No.	Course Code	Course Name	Course Type	Periods / Week		Credits	Category
				L-T-P	TCP		
1.	ME23007	Electrical Drives and Actuators	T	3-0-0	3	3	PEC
2.	ME23008	Embedded Systems and Programming	T	3-0-0	3	3	PEC
3.	ME23009	Robotics	T	3-0-0	3	3	PEC
4.	ME23010	Sensors and Instrumentation	T	3-0-0	3	3	PEC
5.	ME23011	Smart Mobility and Intelligent Vehicles	T	3-0-0	3	3	PEC
6.	ME23C10	Haptics and Immersive Technologies	T	3-0-0	3	3	PEC
7.	ME23C16	Drone Technologies	T	3-0-0	3	3	PEC
8.	ME23012	Marine robotics	T	3-0-0	3	3	PEC

VERTICAL 3: DIGITAL AND GREEN MANUFACTURING							
S. No.	Course Code	Course Name	Course Type	Periods / Week		Credits	Category
				L-T-P	TCP		
1.	ME23013	Machine Learning for Intelligent Systems	T	3-0-0	3	3	PEC
2.	ME23014	Environment Sustainability and Impact Assessment	T	3-0-0	3	3	PEC
3.	ME23015	Green Manufacturing Design and Practices	T	3-0-0	3	3	PEC
4.	ME23016	Lean Manufacturing	T	3-0-0	3	3	PEC
5.	ME23017	Green Supply Chain Management	T	3-0-0	3	3	PEC
6.	ME23C13	Modern Robotics	T	3-0-0	3	3	PEC

VERTICAL 4: PROCESS EQUIPMENT AND PIPING DESIGN							
S. No.	Course Code	Course Name	Course Type	Periods / Week		Credits	Category
				L-T-P	TCP		
1.	ME23018	Design of Pressure Vessels	T	3-0-0	3	3	PEC
2.	ME23019	Failure Analysis and NDT Techniques	T	3-0-0	3	3	PEC
3.	ME23020	Material Handling and solid processing Equipment	T	3-0-0	3	3	PEC
4.	ME23021	Rotating Machinery Design	T	3-0-0	3	3	PEC
5.	ME23022	Thermal and Fired Equipment design	T	3-0-0	3	3	PEC
6.	ME23023	Industrial Layout Design and Safety	T	3-0-0	3	3	PEC
7.	ME23024	Design Codes and Standards	T	3-0-0	3	3	PEC

VERTICAL 5: CLEAN AND GREEN ENERGY TECHNOLOGIES							
S. No.	Course Code	Course Name	Course Type	Periods / Week		Credits	Category
				L-T-P	TCP		
1.	ME23025	Bioenergy Conversion Technologies	T	3-0-0	3	3	PEC
2.	ME23026	Carbon Footprint estimation and reduction techniques	T	3-0-0	3	3	PEC
3.	ME23027	Energy Conservation in Industries	T	3-0-0	3	3	PEC
4.	ME23028	Wind Energy Technology	T	3-0-0	3	3	PEC
5.	ME23029	Energy Storage Devices	T	3-0-0	3	3	PEC
6.	ME23030	Renewable Energy Technologies	T	3-0-0	3	3	PEC
7.	ME23031	Polygeneration Systems	T	3-0-0	3	3	PEC
8.	ME23032	Solar Power generation	T	3-0-0	3	3	PEC
9.	ME23C18	Green Hydrogen Production Storage and Transportation	T	3-0-0	3	3	PEC

VERTICAL 6: ADVANCED MANUFACTURING							
S. No.	Course Code	Course Name	Course Type	Periods / Week		Credits	Category
				L-T-P	TCP		
1.	ME23033	Non-traditional Machining Processes	T	3-0-0	3	3	PEC
2.	ME23034	Casting and Welding Processes	T	3-0-0	3	3	PEC
3.	ME23064	Process Planning and Cost Estimation	T	3-0-0	3	3	PEC
4.	ME23035	Surface Engineering	T	3-0-0	3	3	PEC
5.	ME23036	Precision Manufacturing	T	3-0-0	3	3	PEC
6.	ME23037	Industry 4.0 in Manufacturing	T	3-0-0	3	3	PEC
7.	ME23038	Computer Integrated manufacturing	T	3-0-0	3	3	PEC
8.	ME23039	Applied Operation Research	T	3-0-0	3	3	PEC

VERTICAL 7: DIVERSIFIED COURSES GROUP 1							
S. No.	**Course Code**	**Course Name**	**Course Type**	**Periods / Week**		**Credits**	**Category**
				L-T-P	**TCP**		
1.	ME23040	Measurements and Controls	T	3-0-0	3	3	PEC
2.	ME23041	Design Concepts in Engineering	T	3-0-0	3	3	PEC
3.	ME23042	Composite Materials and Mechanics	T	3-0-0	3	3	PEC
4.	ME23043	Refrigeration and Air Conditioning	T	3-0-0	3	3	PEC
5.	ME23C07	Energy Efficient Buildings	T	3-0-0	3	3	PEC
6.	ME23044	Turbo Machines	T	3-0-0	3	3	PEC
7.	ME23045	Computational Fluid Dynamics	T	3-0-0	3	3	PEC
8.	ME23046	Advanced Statistics and Data Analytics	T	3-0-0	3	3	PEC

Honors Degree Courses							
S. No.	Course Code	Course Name	Course Type	Periods / Week		Credits	Category
				L-T-P	TCP		
1.	ME23047	Automotive Materials, Components, Design & Testing	T	3-0-0	3	3	
2.	ME23048	Conventional and Futuristic Vehicle Technology	T	3-0-0	3	3	
3.	ME23049	Renewable Powered Off Highway Vehicles and Emission Control Technology	T	3-0-0	3	3	
4.	ME23050	Vehicle Health Monitoring, Maintenance and Safety	T	3-0-0	3	3	
5.	ME23051	Gas Dynamics and Jet Propulsion	T	3-0-0	3	3	
6.	ME23052	Hybrid and Electric Vehicle Technology	T	3-0-0	3	3	
7.	ME23053	Thermal Management of Batteries and Fuel Cells	T	3-0-0	3	3	
8.	ME23054	Advanced Vehicle Engineering	T	3-0-0	3	3	
9	ME23055	Hydrogen Powered Vehicles	T	3-0-0	3	3	

MINOR SPECIALISATION IN HYBRID ELECTRIC VEHICLE TECHNOLOGY (Offered jointly by Department of Electrical and Electronics Engineering and Department of Mechanical Engineering)							
S. No.	Course Code	Course Name	Course Type	Periods / Week		Credits	Category
				L-T-P	TCP		
1.	ME23056	* Power Electronics for Electric Vehicles	T	3-0-0	3	3	PCC
2.	ME23057	* Applied Thermodynamics	T	3-0-0	3	3	PCC
3.	ME23058	* Electrical machines and Drives	T	3-0-0	3	3	PEC
4.	ME23059	Control System Design for Electric Vehicle Applications	T	3-0-0	3	3	PCC
5.	ME23060	Electric Vehicle Architecture	T	3-0-0	3	3	PEC

MINOR SPECIALISATION IN HYBRID ELECTRIC VEHICLE TECHNOLOGY (Offered jointly by Department of Electrical and Electronics Engineering and Department of Mechanical Engineering)							
S. No.	**Course Code**	**Course Name**	**Course Type**	**Periods / Week**		**Credits**	**Category**
				L-T-P	**TCP**		
6.	ME23061	Design of Hybrid Electric Vehicles	T	3-0-0	3	3	PEC
7.	ME23062	Energy Storage Devices for Hybrid Electric Vehicles	T	3-0-0	3	3	PEC
8.	ME23063	Electric Vehicle Charging Systems	T	3-0-0	3	3	PEC

Emerging Technology Courses							
S. No.	**Course Code**	**Course Name**	**Course Type**	**Periods / Week**		**Credits**	**Category**
				L-T-P	**TCP**		
Semester V							
1	ME23E01	Industrial 5.0 and IoT	T	3-0-0	3	3	ETC
2	ME23E02	Digital Manufacturing	T	3-0-0	3	3	ETC
3	ME23E03	Topology Optimization and Generative Design	T	3-0-0	3	3	ETC
Semester VI							
4	ME23E04	Digital Twins	T	3-0-0	3	3	ETC
5	ME23E05	Augmented Reality & Virtual Reality	T	3-0-0	3	3	ETC
6	ME23E06	Semiconductor Manufacturing	T	3-0-0	3	3	ETC

Open Elective Courses							
S. No.	Course Code	Course Name	Course Type	Periods / Week		Credits	Category
				L-T-P	TCP		
1	ME23901	Basic Automobile Engineering	T	3-0-0	3	3	OEC
2	ME23902	Product Design and Process Development	T	3-0-0	3	3	OEC
3	ME23903	Applications of 3D printing Techniques	T	3-0-0	3	3	OEC
4	ME23904	Fuel Cells	T	3-0-0	3	3	OEC
5	ME23905	Sustainable Energy Technologies and Assessment	T	3-0-0	3	3	OEC
6	ME23906	Modern Healthcare Machines	T	3-0-0	3	3	OEC
7	ME23907	Energy Auditing and Conservation	T	3-0-0	3	3	OEC
8	ME23908	Future Energy Resources and Mobility	T	3-0-0	3	3	OEC
9	ME23909	Hydrogen as a fuel for powertrains	T	3-0-0	3	3	OEC
10	ME23910	Concepts of competitive manufacturing	T	3-0-0	3	3	OEC
11	ME23911	Solar Energy Technologies	T	3-0-0	3	3	OEC

Bridge Course for Lateral Entry Students (Diploma)							
S. No.	Course Code	Course Name	Course Type	Periods / Week		Credits	Category
				L-T-P	TCP		
1.	ME23C03	Engineering Mechanics	T	3-1-0	4	4	ESC
2.	ME23C06	Design Thinking	LIT	2-0-2	4	3	ESC

Bridge Course for Lateral Entry Students (B.Sc.)							
S. No.	Course Code	Course Name	Course Type	Periods / Week		Credits	Category
				L-T-P	TCP		
1.	ME23C03	Engineering Mechanics	T	3-1-0	4	4	ESC
2.	ME23C06	Design Thinking	LIT	2-0-2	4	3	ESC
3.	ME23C01	Engineering Drawing & 3D Modelling	T	2-0-4	6	4	SDC

List of Skill Development Courses							
S. No.	Course Code	Course Name	Course Type	Periods / Week		Credits	Category
				L-T-P	TCP		
1.	ME23S01	Fundamentals of Practical Manufacturing Skills	L	0-0-2	2	1	SDC
2.	ME23S02	Practical Proficiency in Machining and Measurement	L	0-0-2	2	1	SDC
3.	ME23S03	TURNING – Numerical control programming	L	0-0-2	2	1	SDC
4.	ME23S04	Non-Destructive Evaluation	T	1-0-0	1	1	SDC
5.	ME23S05	Piping Design	T	1-0-0	1	1	SDC
6.	ME23S06	Fundamentals of Practical Analysis Skills Using ANSYS	L	0-0-2	2	1	SDC
7.	ME23S07	Physical Modelling and Analysis of Mechanical Engineering Systems	L	0-0-2	2	1	SDC
8.	ME23S08	Virtual Modelling and Analysis of Thermal Power Plants	L	0-0-2	2	1	SDC

EN23C01	FOUNDATION ENGLISH	L T P C
		2 0 2 3

COURSE OBJECTIVES:

- To develop students' foundational skills in reading, writing, grammar and vocabulary to enable them to understand and produce various forms of communication.
- To enhance students' proficiency in reading comprehension, narrative and comparative writing.
- To comprehend and analyse descriptive texts and visual images
- To articulate similarities and differences in oral and written forms.
- To improve students' proficiency in reading and writing formal letters and emails.

UNIT I BASICS OF COMMUNICATION 6

Reading - Telephone message, bio-note; Writing – Personal profile; Grammar – Simple present tense, Present continuous tense, wh-questions, indirect questions; Vocabulary – Word formation (Prefix and Suffix).

LAB ACTIVITY: 6

Listening – Telephone conversation; Speaking Self-introduction; Telephone conversation – Video conferencing etiquette

UNIT II NARRATION 6

Reading – Comprehension strategies - Newspaper Report, An excerpt from an autobiography; Writing – Narrative Paragraph writing (Event, personal experience etc.); Grammar – Subject-verb agreement, Simple past, Past continuous Tenses; Vocabulary – One-word substitution

LAB ACTIVITY: 6

Listening – Travel podcast; Speaking – Narrating and sharing personal experiences through a podcast

UNIT III DESCRIPTION 6

Reading – A tourist brochure, Travel blogs, descriptive article/excerpt from literature, visual images; Writing –Descriptive Paragraph writing, Grammar – Future tense, Perfect tenses, Preposition; Vocabulary – Descriptive vocabulary

LAB ACTIVITY: 6

Listening – Railway / Airport Announcements, Travel Vlogs; Speaking – Describing a place or picture description

UNIT IV COMPARE AND CONTRAST 6

Reading – Reading and comparing different product specifications - Writing – Compare and Contrast Essay, Coherence and cohesion; Grammar – Degrees of Comparison; Vocabulary – Transition words (relevant to compare and contrast)

LAB ACTIVITY: 6

Listening – Product reviews, Speaking – Product comparison based on product reviews - similarities and differences

UNIT V EXPRESSION OF VIEWS 6

Reading – Formal letters, Letters to Editor ; Writing – Letter writing/ Email writing (Enquiry / Permission, Letter to Editor); Grammar – Compound nouns, Vocabulary – Synonyms, Antonyms

LAB ACTIVITY: **6**

Listening – Short speeches; Speaking – Making short presentations (JAM)

TOTAL: 60 PERIODS

TEACHING METHODOLOGY

Interactive lectures, role plays, group discussions, listening and speaking labs, technology enabled language teaching, flipped classroom.

EVALUATION PATTERN

Internal Assessment
Written assessments
Assignment

Lab assessment

Listening
Speaking

External Assessment
End Semester Examination

LEARNING OUTCOMES

By the end of the courses, students will be able to

- Use appropriate grammar and vocabulary to read different types of text and converse appropriately.
- Write coherent and engaging descriptive and comparative essay writing.
- Comprehend and interpret different kinds of texts and audio visual materials
- Critically evaluate reviews and articulate similarities and differences
- Write formal letters and emails using appropriate language structure and format

TEXT BOOKS:

1. “English for Engineers and Technologists” Volume I by Orient Blackswan, 2022
2. “English for Science & Technology - I” by Cambridge University Press, 2023

REFERENCES

1. “Interchange” by Jack C.Richards, Fifth Edition, Cambridge University Press, 2017.
2. “English for Academic Correspondence and Socializing” by Adrian Wallwork, Springer, 2011.
3. “The Study Skills Handbook” by Stella Cortrell, Red Globe Press, 2019
4. www.uefap.com

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1										√		√
CO2										√		
CO3										√		√
CO4										√		
CO5										√		√

MA23C01 **MATRICES AND CALCULUS** **L T P C**
3 1 0 4

OBJECTIVES:

- To develop the use of matrix algebra techniques in solving practical problems.
- To familiarize the student with functions of several variables.
- To solve integrals by using Beta and Gamma functions.
- To acquaint the student with mathematical tools needed in evaluating multiple integrals.
- To acquaint the students with the concepts of vector calculus which naturally arise in many engineering problems.

UNIT I MATRICES 9+3

Eigenvalues and Eigenvectors of a real matrix – Properties of Eigenvalues and Eigenvectors- Cayley-Hamilton theorem (excluding proof) – Diagonalization of matrices - Reduction of Quadratic form to canonical form by using orthogonal transformation - Nature of a Quadratic form.

UNIT II FUNCTIONS OF SEVERAL VARIABLES 9+3

Limit, continuity, partial derivatives – Homogeneous functions and Euler's theorem - Total derivative – Differentiation of implicit functions – Jacobians -Taylor's formula for two variables - Errors and approximations – Maxima and Minima of functions of two variables – Lagrange's method of undermined multipliers.

UNIT III INTEGRAL CALCULUS 9+3

Improper integrals of the first and second kind and their convergence – Differentiation under integrals - Evaluation of integrals involving a parameter by Leibnitz rule – Beta and Gamma functions-Properties – Evaluation of single integrals by using Beta and Gamma functions.

UNIT IV MULTIPLE INTEGRALS 9+3

Double integrals – Change of order of integration – Double integrals in polar coordinates – Area enclosed by plane curves – Triple integrals – Volume of Solids – Change of variables in double and triple integrals-
Evaluation of double and triple integrals by using Beta and Gamma functions.

UNIT V VECTOR CALCULUS 9+3

Gradient of a scalar field, directional derivative – Divergence and Curl – Solenoidal and Irrotational vector fields - Line integrals over a plane curve - Surface integrals – Area of a curved surface – Volume Integral - Green's theorem, Stoke's and Gauss divergence theorems (without proofs)– Verification and applications in evaluating line, surface and volume integrals**.**

TOTAL: 60 PERIODS

Laboratory based exercises / assignments / assessments will be given to students wherever applicable from the content of the course.

General engineering applications / branch specific applications from the content of each units wherever possible will be introduced to students.

Suggested Laboratory based exercises / assignments / assessments :

Matrices

1. Finding eigenvalues and eigenvectors
2. Verification of Cayley-Hamilton theorem
3. Eigenvalues and Eigenvectors of similar matrices
4. Eigenvalues and Eigenvectors of a symmetric matrix

5. Finding the powers of a matrix
6. Quadratic forms

Functions of Several Variables

1. Plotting of curves and surfaces
2. Symbolic computation of partial and total derivatives of functions

Integral Calculus

1. Evaluation of beta and gamma functions
2. Computation of error function and its complement

Multiple Integrals

1. Plotting of 3D surfaces in Cartesian and Polar forms

Vector Calculus

1. Computation of Directional derivatives
2. Computation of normal and tangent to the given surface

OUTCOMES:

CO 1 :Use the matrix algebra methods for solving practical problems.
CO 2 :Use differential calculus ideas on several variable functions.
CO 3 :Apply different methods of integration in solving practical problems by using Beta and Gamma functions.
CO 4 :Apply multiple integral ideas in solving areas and volumes problems.
CO 5 :Apply the concept of vectors in solving practical problems.

TEXT BOOKS:

1. Joel Hass, Christopher Heil, Maurice D.Weir "'Thomas' Calculus", Pearson Education., New Delhi, 2018.
2. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, 45th Edition, New Delhi, 2020.
3. James Stewart, Daniel K Clegg & Saleem Watson "Calculus with Early Transcendental Functions", Cengage Learning, 6th Edition, New Delhi,2023.

REFERENCES:

1. Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, Wiley India Pvt Ltd., New Delhi, 2018.
2. Greenberg M.D., "Advanced Engineering Mathematics", Pearson Education2nd Edition, 5th Reprint, Delhi, 2009.
3. Jain R.K. and Iyengar S.R.K., "Advanced Engineering Mathematics",Narosa Publications, 5th Edition, New Delhi, 2017.
4. Narayanan S. and Manicavachagom Pillai T. K., "Calculus" Volume I and II, S. Viswanathan Publishers Pvt. Ltd., Chennai, 2009.
5. Peter V.O'Neil, "Advanced Engineering Mathematics", Cengage Learning India Pvt., Ltd, 7 th Edition, New Delhi , 2012.
6. Ramana B.V., "Higher Engineering Mathematics", Tata McGraw Hill Co. Ltd., 11th Reprint, New Delhi, 2010.

CO – PO Mapping:

Course Outcomes	PROGRAMME OUTCOMES											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	P12
CO1 :	3	3	2	3	1	2	1	1	1	1	1	3
CO2 :	3	3	2	3	1	2	1	1	1	1	1	3
CO3 :	3	3	2	3	1	2	1	1	1	1	1	3
CO4 :	3	3	2	3	1	2	1	1	1	1	1	3
CO5 :	3	3	2	3	1	2	1	1	1	1	1	3

PH23C01 **ENGINEERING PHYSICS** **L T P C**

(Common to all branches of B.E/B.Tech Programmes) **3 0 2 4**

COURSE OBJECTIVES

- To familiarize with crystal structure, bonding and crystal growth.
- To impart knowledge on Mechanics of Materials.
- To impart knowledge of oscillations, sound and Thermal Physics
- To facilitate understanding of optics and its applications, different types of Lasers and fiber optics.
- To introduce the basics of Quantum Mechanics and its importance.

UNIT I CRYSTAL PHYSICS 9+6

Crystal Bonding – Ionic – covalent – metallic and van der Walls's/ molecular bonding. Crystal systems - unit cell, Bravais lattices, Miller indices - Crystal structures - atomic packing density of BCC, FCC and HCP structures. NaCl, Diamond, Graphite, Graphene, Zincblende and Wurtzite structures - crystal imperfections- point defects - edge and screw dislocations – grain boundaries. Crystal Growth – Czocharalski method – vapor phase epitaxy – Molecular beam epitaxy- Introduction to X-Ray Diffractometer.

1. Determination of Lattice parameters for crystal systems.
2. Crystal Growth – Slow Evaporation method
3. Crystal Growth Sol – Gel Method

UNIT II MECHANICS OF MATERIALS 9+6

Rigid Body – Centre of mass – Rotational Energy - Moment of inertia (M.I)- Moment of Inertia for uniform objects with various geometrical shapes. Elasticity –Hooke's law - Poisson's ratio - stress-strain diagram for ductile and brittle materials – uses- Bending of beams – Cantilever - Simply supported beams - uniform and non-uniform bending - Young's modulus determination - I shaped girders –Twisting couple – Shafts. Viscosity – Viscous drag – Surface Tension.

1. Non-uniform bending -Determination of Young's modulus of the material of the beam.
2. Uniform bending -Determination of Young's modulus of the material of the beam
3. Viscosity – Determination of Viscosity of liquids.

UNIT III OSCILLATIONS, SOUND AND THERMAL PHYSICS 9+6

Simple harmonic motion - Torsional pendulum –- Damped oscillations –Shock Absorber -Forced oscillations and Resonance –Applications of resonance.- Waves and Energy Transport –Sound waves – Intensity level – Standing Waves - Doppler effect and its applications - Speed of blood flow. Ultrasound – applications - Echolocation and Medical Imaging. Thermal Expansion – Expansion joints – Bimetallic strip – Seebeck effect – thermocouple -Heat Transfer Rate – Conduction – Convection and Radiation.

1. Torsional pendulum-Determination of rigidity modulus of wire and moment of inertia of the disc
2. Melde's string experiment - Standing waves.
3. Ultrasonic interferometer – determination of sound velocity and liquids compressibility

UNIT IV OPTICS AND LASERS 9+6

Interference - Thin film interference - Air wedge- Applications -Interferometers–Michelson Interferometer -– Diffraction - CD as diffraction grating – Diffraction by crystals -Polarization - polarizers -– Laser – characteristics – Spontaneous and Stimulated emission- population – inversion - Metastable states - optical feedback - Nd-YAG laser, CO_2 laser, Semiconductor laser - Industrial and medical applications - Optical Fibers – Total internal reflection – Numerical aperture and acceptance angle – Fiber optic communication – Fiber sensors – Fiber lasers.

1. Laser - Determination of the width of the groove of the compact disc using laser.
   Laser Parameters
   Determination of the wavelength of the laser using grating
2. Air wedge -Determination of the thickness of a thin sheet/wire
3. Optical fibre - Determination of Numerical Aperture and acceptance angle
   -Determination of bending loss of fibre.
4. Michelson Interferometer (Demonstration)

UNIT V QUANTUM MECHANICS 9+6

Black body radiation (Qualitative) – Planck's hypothesis – Einstein's theory of Radiation - Matter waves–de Broglie hypothesis - Electron microscope – Uncertainty Principle – The Schrodinger Wave equation (time-independent and time-dependent) – Meaning and Physical significance of wave function - Normalization - Particle in an infinite potential well-particle in a three-dimensional box - Degenerate energy states - Barrier penetration and quantum tunneling - Tunneling microscope.

1. Photoelectric effect – Determination of Planck's constant.
2. Black Body Radiation (Demonstration)
3. Electron Microscope (Demonstration)

TOTAL: 75 PERIODS

COURSE OUTCOMES:

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

CO1: Understand the significance of crystal structure and bonding. Learn to grow crystals.
CO2: Obtain knowledge on important mechanical and thermal properties of materials and determine them through experiments.
CO3: Conceptualize and visualize the oscillations and sound.
CO4: Grasp optical phenomenon and their applications in real life.
CO5: Appreciate and evaluate the quantum phenomenon.
CO6 Develop skill set to solve engineering problems and design experiments.

TEXT BOOKS:

1. Raymond A. Serway, John W. Jewett, Physics for Scientists and Engineers, Thomson Brooks/Cole, 2013.
2. D. Halliday, R. Resnick and J. Walker, Principles of Physics. John Wiley & Sons, 10th Edition, 2015.
3. N. Garcia, A. Damask and S. Schwarz, Physics for Computer Science Students, Springer-Verlag, 2012.
4. Alan Giambattista, Betty McCarthy Richardson and Robert C. Richardson, College Physics, McGraw-Hill Higher Education, 2012.

REFERENCES:

1. R. Wolfson, Essential University Physics. Volume 1 & 2. Pearson, 2016.
2. D. Kleppner and R. Kolenkow. An Introduction to Mechanics, McGraw Hill Education, 2017.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1		1							
CO2	3	2	1	1								
CO3	3	2	1	1								
CO4	3	2	1	1	1							
CO5	3	2	1	1	1							
CO6	3	2	1	2								

ME23C01 ENGINEERING DRAWING AND 3D MODELLING

L	T	P	C
2	0	4	4

COURSE OBJECTIVES

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

1. Understand and use the engineering curves in engineering applications and projection techniques to construct conic curves, points and lines.
2. Develop skills in projecting surfaces and solids and create 2D models using CAD software.
3. Develop skills in 3D projection and 3D modeling of simple parts manually as well as using CAD software.
4. Understand and apply sectioning techniques to solids and assemble components.
5. Develop skills in lateral surface development and sheet metal design.

INTRODUCTION

Manual drawing tools (Mini Drafter, Set Squares, Protractor, Compass, and different grades of pencil). **'**BIS' specifications and rules of Engineering Drawing – Arrows (2H thin line body, HB Filled head and L:W = 3:1 ratio), lettering (Digital fonts, font sizes pertaining to usage and representation), types of line and their syntax (Drawing based – Continuous thin & thick, dashed, dashed dotted and Application based – extension, dimensioning, construction, projection, reference, axis, section, hatching, and break lines), scaling (up, down and equal), and dimensioning. Placing and positioning the 'A3' size drawing sheet over the drawing table. Principal planes and projection, Division of line and circle in to equal parts, and construction of polygons

UNIT i: ENGINEERING CURVES, PROJECTION OF POINTS AND LINES 6+12

Construction of conic curves with their tangent and normal – ellipse, parabola, and hyperbola by eccentricity method

Construction of special curves with their tangent and normal – cycloid, epicycloid, and involute

Projection of points and I angle projection of lines inclined to both principal planes by rotating line method and trapezoidal rule – marking their traces.

Lab exercises: Study exercise – Introduction to Sketching (or) Drawing, and modification tools in CAD software (AutoCAD, CREO, CATIA, Solid Works, Inventor, Fusion 360)

Activities based learning: Identification of the curves used in the application given in the flash card, demonstration of the instantaneous centre of rotation of governors with respect to angle of inclination of the arms of the governors

UNIT II PROJECTION OF SURFACES & SOLIDS, AND 2D MODELING 6+12

Projection of surfaces inclined to both the principal planes – polygonal, trapezoidal, rhomboidal and circular

Projection of solids – prisms, pyramids, and axisymmetric solids when the axis inclined to both the principal planes – freely hanging – contour resting condition on either of the planes by rotating object method

Lab exercises: Construction of basic sketches – lines, circle, polygon, spline curves, coils, along with dimensioning. Familiarizing with geometric constraints and their types

Activities based learning: Making the solids using cardboards, shadow mapping and contour drawing at different orientation of the solids using torches

UNIT III 3D PROJECTION OF SOLIDS AND 3D MODELING OF SIMPLE PARTS 6+12

Free hand sketching – I & III angle projections of engineering parts and components
Isometric projection of combination of solids – prisms, pyramids, axisymmetric solids, frustum
Perspective projection of prisms, pyramids and axisymmetric solids by visual ray method
Lab exercises: 3D Modeling and 2D drafting of machine parts
Activities based learning: Flipped classroom for Free hand sketching, Jig saw activity for Isometric projection, arts and crafts for perspective view

UNIT IV SECTION OF SOLIDS AND SECTIONED DRAFTING OF ASSEMBLED COMPONENTS 6+12

Section of simple and hollow solids – prisms, pyramids and axisymmetric solids, solids with holes/ slots when the section plane perpendicular to one principal plane and inclined to other principal plane (‘On the axis’ and ‘from the axis’ conditions)
Application based – section of beams (I, T, L, and C), section of pipe bracket, wood joints, composite walls, shells, flange of a coupling and other similar applications
Lab exercises: Assembly of parts with respect to engineering constraints, and sectioned drafting of assembled components
Activities based learning: Making of mitered joint in wood, sectioning the beams in different angles of orientation and identifying the true shape

UNIT V LATERAL SURFACE DEVELOPMENT AND SHEET METAL DESIGN 6+12

Lateral surface development of sectioned solids when the section plane perpendicular to VP and inclined to HP.
Application based – construction of funnel, chimney, dish antenna, door latch, trays, AC vents, lamp shade, commercial packaging boxes with respect to sectioning conditions and other similar applications
Lab exercises: Sheet metal design and drafting, drafting of coils, springs and screw threads
Activities based learning: Fabrication of funnels, chimney, lamp shade, boxes using card boards, ply woods, acrylics

Total: 90 Hours

Note: Activities based learning should not be covered in the regular class hours. It should be given as assignments to the group of maximum 3 members
Question pattern suggestion: Part – A (Either or type) (5 × 16 = 80) & Part – B (Compulsory) (1 × 20 = 20)

COURSE OUTCOME:-

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

CO1: Construct and identify different types of conic curves and special curves, and project the points and lines pertaining to engineering applications
CO2: Project and visualize surfaces and solids in different orientations and utilize the CAD tools for designing.
CO3: Create and draft accurate 3D models and 2D drawings of machine parts manually as well as using CAD softwares
CO4: Determine the true shape of a sectioned solid and draft the assemble parts accordingly
CO5: Develop lateral surfaces of sectioned solids and design sheet metal components

TEXTBOOKS:

1. Engineering Drawing” by N S Parthasarathy and Vela Murali
2. Engineering Drawing and Graphics with Auto CAD” by Venugopal K

REFERENCE BOOKS:

1. “Basic Engineering Drawing: Mechanical Semester Pattern” by Mehta and Gupta
2. "Engineering Drawing” by Basant Agrawal and C M Agrawal
3. “Engineering Drawing With Auto CAD” by B V R Gupta
4. "Engineering Drawing” by P S Gill
5. “Engineering Drawing with an Introduction to AutoCAD” by Dhananjay Jolhe
6. “Engineering Drawing” by M B Shah
7. "Fundamentals of Engineering Drawing” by Imtiaz Hashmi
8. “Computer Aided Engineering Drawing” by S Trymbaka Murthy
9. “CAED : Computer Aided Engineering Drawing for I/II Semester BE/Btech Courses” by Reddy K B
10. “Computer-Aided Engineering Drawing” by Subrata Pal

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	2		1				3	1		3	3	3	2
2	3	3	2		2				3	2		3	3	3	2
3	3	3	3	1	2				3	3		3	3	3	2
4	3	3	3	1	3				3	3		3	3	3	2
5	3	3	3	1	3				3	3		3	3	3	2

ME23C03	ENGINEERING MECHANICS	L T P C 3 1 0 4

COURSE OBJECTIVES:

The main learning objective of this course is to prepare the students for:

- Determining the resultant forces acting on a particle in 2D and 3D and for applying methods of equilibrium on a particle in 2D and 3D.
- Evaluating the reaction forces for bodies under equilibrium, for determining the moment of a force, moment of a couple, for resolving force into a force-couple system and for analyzing trusses
- Assessing the centroids of 2D sections / center of gravity of volumes and for calculating area moments of inertia for the sections and mass moment of inertia of solids.
- Evaluating the frictional forces acting at the contact surfaces of various engineering systems and for applying the work-energy principles on a particle.
- Determining kinetic and kinematic parameters of the rigid bodies subjected to concurrent coplanar forces.

UNIT I STATICS OF PARTICLES 9+3

Fundamental Concepts and Principles, Systems of Units, Method of Problem Solutions, Statics of Particles -Forces in a Plane, Resultant of Forces, Resolution of a Force into Components, Rectangular Components of a Force, Unit Vectors. Equilibrium of a Particle- Newton's First Law of Motion, Space and Free-Body Diagrams, Forces in Space, Equilibrium of a Particle in Space.

UNIT II EQUILIBRIUM OF RIGID BODIES AND TRUSSES 9+3

Principle of Transmissibility, Equivalent Forces, Vector Product of Two Vectors, Moment of a Force about a Point, Varignon's Theorem, Rectangular Components of the Moment of a Force, Scalar Product of Two Vectors, Mixed Triple Product of Three Vectors, Moment of a Force about an Axis, Couple - Moment of a Couple, Equivalent Couples, Addition of Couples, Resolution of a Given Force into a Force -Couple system, Further Reduction of a System of Forces, Equilibrium in Two and Three Dimensions - Reactions at Supports and Connections – Analysis of Trusses – Method of Joints and Method of Sections.

UNIT III DISTRIBUTED FORCES 9+3

Centroids of lines and areas – symmetrical and unsymmetrical shapes, Determination of Centroids by Integration, Theorems of Pappus-Guldinus, Distributed Loads on Beams, Centre of Gravity of a Three-Dimensional Body, Centroid of a Volume, Composite Bodies, Determination of Centroids of Volumes by Integration.

Moments of Inertia of Areas and Mass - Determination of the Moment of Inertia of an Area by Integration, Polar Moment of Inertia , Radius of Gyration of an Area , Parallel-Axis Theorem , Moments of Inertia of Composite Areas, Moments of Inertia of a Mass - Moments of Inertia of Thin Plates, Determination of the Moment of Inertia of a Three-Dimensional Body by Integration.

UNIT IV FRICTION AND WORK PRINCIPLES 9+3

The Laws of Dry Friction. Coefficients of Friction, Angles of Friction, Wedges, Wheel Friction. Rolling Resistance, Ladder friction. Work of a Force, Kinetic Energy of a Particle, Principle of Work and Energy, Principle of Impulse and Momentum, Impact, Method of Virtual Work - Work of a Force, Potential Energy, Potential Energy and Equilibrium.

UNIT V DYNAMICS OF PARTICLES AND RIGID BODIES 9+3

Kinematics - Rectilinear Motion and Curvilinear Motion of Particles. Kinetics- Newton's Second Law of Motion -Equations of Motions, Dynamic Equilibrium, Energy and Momentum Methods – Kinematics of Rigid Bodies and Plane Kinetics.

TOTAL : 60 Periods

COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

1. To determine the resultant forces acting on a particle in 2D and 3D and to apply methods of equilibrium on a particle in 2D and 3D.
2. Evaluate the reaction forces for bodies under equilibrium, to determine moment of a force, moment of a couple, to resolve force into a force-couple system and to analyze trusses
3. Assess the centroids of 2D sections / center of gravity of volumes and to calculate area moments of inertia for the sections and mass moment of inertia of solids.
4. Evaluate the frictional forces acting at the contact surfaces of various engineering systems and apply the work-energy principles on a particle. evaluate the kinetic and kinematic parameters of a particle.
5. Determine kinetic and kinematic parameters of the rigid bodies subjected to concurrent coplanar forces.

TEXT BOOKS:

1. Beer Ferdinand P, Russel Johnston Jr., David F Mazurek, Philip J Cornwell, Sanjeev Sanghi, Vector Mechanics for Engineers: Statics and Dynamics, McGraw Higher Education., 12th Edition, 2019.
2. Vela Murali, "Engineering Mechanics-Statics and Dynamics", Oxford University Press, 2018.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	2	3									3		
2	3	3	2	3									3		
3	3	3	2	3									3		
4	3	3	2	3									3		
5	3	3	2	3									3		
Avg	3	3	2	3									3		

ME23C04	MAKERSPACE	L T P C
		1 0 4 3

COURSE OBJECTIVES:

1. To practice the usage of various tools towards assembly and dis-assembly of different items / equipment.
2. To make simple part / component using welding processes.
3. To train on the basic wiring practices of boards, machines, etc.
4. To provide a hands-on experience on the use of electronic components, equipment, sensors and actuators.
5. To expose to modern computer tools and advanced manufacturing / fabrication processes.

LIST OF ACTIVITIES **1L,4P**

(A). Dis-assembly & Assembly Practices

i. Tools and its handling techniques.
ii. Dis-assembly and assembly of home appliances – Grinder Mixer Grinder, Ceiling Fan, Table Fan & Washing Machine.
iii. Dis-assembly and assembly of Air-Conditioners & Refrigerators.
iv. Dis-assembly and assembly of a Bicycle.

(B). Welding Practices

i. Welding Procedure, Selection & Safety Measures.
ii. Power source of Arc Welding – Gas Metal Arc Welding & Gas Tungsten Arc Welding processes.
iii. Hands-on session of preparing base material & Joint groove for welding.
iv. Hands-on session of MAW, GMAW, GTAW, on Carbon Steel & Stainless Stell plates / pipes, for fabrication of a simple part.

(C). Electrical Wiring Practices

i. Electrical Installation tools, equipment & safety measures.
ii. Hands-on session of basic electrical connections for Fuses, Miniature Circuit Breakers and Distribution Box,
iii. Hands-on session of electrical connections for Lightings, Fans, Calling Bells.

iv. Hands-on session of electrical connections for Motors & Uninterruptible Power Supply.

(D). Electronics Components / Equipment Practices

i. Electronic components, equipment & safety measures.

ii. Dis-assembly and assembly of Computers.

iii. Hands-on session of Soldering Practices in a Printed Circuit Breaker.

iv. Hands-on session of Bridge Rectifier, Op-Amp and Transimpedance amplifier.

v. Hands-on session of integration of sensors and actuators with a Microcontroller.

vi. Demonstration of Programmable Logic Control Circuit.

(E). Contemporary Systems

i. Demonstration of Solid Modelling of components.

ii. Demonstration of Assembly Modelling of components.

iii. Fabrication of simple components / parts using 3D Printers.

iv. Demonstration of cutting of wood / metal in different complex shapes using Laser Cutting Machine.

TOTAL: 75 Periods (15 Lecture + 60 Practical)

COURSE OUTCOMES:

Upon the successful completion of the course, students will be able to:

CO1: Assemble and dis-assemble various items / equipment.
CO2: Make simple parts using suitable welding processes.
CO3: Setup wiring of distribution boards, machines, etc.
CO4: Utilise the electronic components to fabricate a simple equipment, aided with sensors and actuators.
CO5: Take advantage of modern manufacturing practices.

REFERENCES:

1. Stephen Christena, Learn to Weld: Beginning MIG Welding and Metal Fabrication Basics, Crestline Books, 2014.
2. H. Lipson, Fabricated - The New World of 3D Printing, Wiley, 1st edition, 2013.
3. Code of Practice for Electrical Wiring Installations (IS 732:2019)

4. A.S. Sedra and K.C. Smith, Microelectronic Circuits, Oxford University Press, 7th ed. (Indian edition), 2017.
5. Mazidi, Naimi, Naimi, AVR Microcontroller and Embedded Systems: Using Assembly and C, Pearson India, 1st edition 2013.
6. Visualization, Modeling, and Graphics for Engineering Design, D.K. Lieu, S.A. Sorby, Cengage Learning; 2nd edition.

UC23H01 **தமிழர் மரபு** **L T P C**
1 0 0 1

அலகு I **<u>மொழி மற்றும் இலக்கியம்</u>**: **3**

இந்திய மொழிக் குடும்பங்கள் – திராவிட மொழிகள் – தமிழ் ஒரு செம்மொழி – தமிழ் செவ்விலக்கியங்கள் - சங்க இலக்கியத்தின் சமயச் சார்பற்ற தன்மை – சங்க இலக்கியத்தில் பகிர்தல் அறம் – திருக்குறளில் மேலாண்மைக் கருத்துக்கள் – தமிழ்க் காப்பியங்கள், தமிழகத்தில் சமண பௌத்த சமயங்களின் தாக்கம் - பக்தி இலக்கியம், ஆழ்வார்கள் மற்றும் நாயன்மார்கள் – சிற்றிலக்கியங்கள் – தமிழில் நவீன இலக்கியத்தின் வளர்ச்சி – தமிழ் இலக்கிய வளர்ச்சியில் பாரதியார் மற்றும் பாரதிதாசன் ஆகியோரின் பங்களிப்பு.

அலகு II **மரபு – பாறை ஓவியங்கள் முதல் நவீன ஓவியங்கள் வரை – சிற்பக் கலை**: **3**

நடுகல் முதல் நவீன சிற்பங்கள் வரை – ஐம்பொன் சிலைகள்– பழங்குடியினர் மற்றும் அவர்கள் தயாரிக்கும் கைவினைப் பொருட்கள், பொம்மைகள் – தேர் செய்யும் கலை – சுடுமண் சிற்பங்கள் – நாட்டுப்புறத் தெய்வங்கள் – குமரிமுனையில் திருவள்ளுவர் சிலை – இசைக் கருவிகள் – மிருதங்கம், பறை, வீணை, யாழ், நாதஸ்வரம் – தமிழர்களின் சமூக பொருளாதார வாழ்வில் கோவில்களின் பங்கு.

அலகு III **<u>நாட்டுப்புறக் கலைகள் மற்றும் வீர விளையாட்டுகள்</u>**: **3**

தெருக்கூத்து, கரகாட்டம், வில்லுப்பாட்டு, கணியான் கூத்து, ஒயிலாட்டம், தோல்பாவைக் கூத்து, சிலம்பாட்டம், வளரி, புலியாட்டம், தமிழர்களின் விளையாட்டுகள்.

அலகு IV **<u>தமிழர்களின் திணைக் கோட்பாடுகள்</u>**: **3**

தமிழகத்தின் தாவரங்களும், விலங்குகளும் – தொல்காப்பியம் மற்றும் சங்க இலக்கியத்தில் அகம் மற்றும் புறக் கோட்பாடுகள் – தமிழர்கள் போற்றிய அறக்கோட்பாடு – சங்ககாலத்தில் தமிழகத்தில் எழுத்தறிவும், கல்வியும் – சங்ககால நகரங்களும் துறை முகங்களும் – சங்ககாலத்தில் ஏற்றுமதி மற்றும் இறக்குமதி – கடல்கடந்த நாடுகளில் சோழர்களின் வெற்றி.

அலகு V **<u>இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்பாட்டிற்குத் தமிழர்களின் பங்களிப்பு</u>**: **3**

இந்திய விடுதலைப்போரில் தமிழர்களின் பங்கு – இந்தியாவின் பிறப்பகுதிகளில் தமிழ்ப் பண்பாட்டின் தாக்கம் – சுயமரியாதை இயக்கம் – இந்திய மருத்துவத்தில், சித்த மருத்துவத்தின் பங்கு – கல்வெட்டுகள், கையெழுத்துப்படிகள் - தமிழ்ப் புத்தகங்களின் அச்சு வரலாறு.

TOTAL : 15 PERIODS

TEXT-CUM-REFERENCE BOOKS

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.

7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).

8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)

9. Keeladi - 'Sangam City C ivilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)

10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Publishedby: The Author)

11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)

12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

UC23H01 **HERITAGE OF TAMILS** **L T P C**
1 0 0 1

UNIT I LANGUAGE AND LITERATURE 3
Language Families in India - Dravidian Languages – Tamil as aClassical Language - Classical Literature in Tamil – Secular Nature of Sangam Literature – Distributive Justice in Sangam Literature - Management Principles in Thirukural - Tamil Epics and Impact of Buddhism & Jainism in Tamil Land - Bakthi Literature Azhwars and Nayanmars - Forms of minor Poetry - Development of Modern literature in Tamil - Contribution of Bharathiyar and Bharathidhasan.

UNIT II HERITAGE - ROCK ART PAINTINGS TO MODERN ART – SCULPTURE 3
Hero stone to modern sculpture - Bronze icons - Tribes and their handicrafts - Art of temple car making - - Massive Terracotta sculptures, Village deities, Thiruvalluvar Statue at Kanyakumari, Making of musical instruments - Mridhangam, Parai, Veenai, Yazh and Nadhaswaram - Role of Temples in Social and Economic Life of Tamils.

UNIT III FOLK AND MARTIAL ARTS 3
Therukoothu, Karagattam, Villu Pattu, Kaniyan Koothu, Oyillattam, Leatherpuppetry, Silambattam, Valari, Tiger dance - Sports and Games of Tamils.

UNIT IV THINAI CONCEPT OF TAMILS 3
Flora and Fauna of Tamils & Aham and Puram Concept from Tholkappiyam and Sangam Literature - Aram Concept of Tamils - Education and Literacy during Sangam Age - Ancient Cities and Ports of Sangam Age - Export and Import during Sangam Age - Overseas Conquest of Cholas.

UNIT V CONTRIBUTION OF TAMILS TO INDIAN NATIONAL MOVEMENT AND INDIAN CULTURE
3

Contribution of Tamils to Indian Freedom Struggle - The Cultural Influence of Tamils over the other parts of India – Self-Respect Movement - Role of Siddha Medicine in Indigenous Systems of Medicine – Inscriptions & Manuscripts – Print History of Tamil Books.

TOTAL : 15 PERIODS

TEXT-CUM-REFERENCE BOOKS

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).

2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).

3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)

4. பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)

5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)

6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.

7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).

8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)

9. Keeladi - 'Sangam City C ivilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)

10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Publishedby: The Author)

11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)

12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

NCC Credit Course Level 1*

UC23P01	(ARMY WING) NCC Credit Course Level - I	L T P C 2 0 0 2

NCC GENERAL		**6**
NCC 1	Aims, Objectives & Organization of NCC	1
NCC 2	Incentives	2
NCC 3	Duties of NCC Cadet	1
NCC 4	NCC Camps: Types & Conduct	2
NATIONAL INTEGRATION AND AWARENESS		**4**
NI 1	National Integration: Importance & Necessity	1
NI 2	Factors Affecting National Integration	1
NI 3	Unity in Diversity & Role of NCC in Nation Building	1
NI 4	Threats to National Security	1
PERSONALITY DEVELOPMENT		**7**
PD 1	Self-Awareness, Empathy, Critical & Creative Thinking, Decision Making and Problem Solving	2
PD 2	Communication Skills	3
PD 3	Group Discussion: Stress & Emotions	2
LEADERSHIP		**5**
L 1	Leadership Capsule: Traits, Indicators, Motivation, Moral Values, Honour ‘Code	3
L 2	Case Studies: Shivaji, Jhasi Ki Rani	2
SOCIAL SERVICE AND COMMUNITY DEVELOPMENT		**8**
SS 1	Basics, Rural Development Programmes, NGOs, Contribution of Youth	3
SS 4	Protection of Children and Women Safety	1
SS 5	Road / Rail Travel Safety	1
SS 6	New Initiatives	2
SS 7	Cyber and Mobile Security Awareness	1

TOTAL : 30 PERIODS

NCC Credit Course Level 1*

UC23P02	(NAVAL WING) NCC Credit Course Level – I	L T P C
		2 0 0 2

NCC GENERAL		**6**
NCC 1	Aims, Objectives & Organization of NCC	1
NCC 2	Incentives	2
NCC 3	Duties of NCC Cadet	1
NCC 4	NCC Camps: Types & Conduct	2
NATIONAL INTEGRATION AND AWARENESS		**4**
NI 1	National Integration: Importance & Necessity	1
NI 2	Factors Affecting National Integration	1
NI 3	Unity in Diversity & Role of NCC in Nation Building	1
NI 4	Threats to National Security	1
PERSONALITY DEVELOPMENT		**7**
PD 1	Self-Awareness, Empathy, Critical & Creative Thinking, Decision Making and Problem Solving	2
PD 2	Communication Skills	3
PD 3	Group Discussion: Stress & Emotions	2
LEADERSHIP		**5**
L 1	Leadership Capsule: Traits, Indicators, Motivation, Moral Values, Honour Code	3
L 2	Case Studies: Shivaji, Jhasi Ki Rani	2
SOCIAL SERVICE AND COMMUNITY DEVELOPMENT		**8**
SS 1	Basics, Rural Development Programmes, NGOs, Contribution of Youth	3
SS 4	Protection of Children and Women Safety	1
SS 5	Road / Rail Travel Safety	1
SS 6	New Initiatives	2
SS 7	Cyber and Mobile Security Awareness	1

TOTAL : 30 PERIODS

NCC Credit Course Level 1*

UC23P03	(AIR FORCE WING) NCC Credit Course Level – I	L T P C
		2 0 0 2

NCC GENERAL		**6**
NCC 1	Aims, Objectives & Organization of NCC	1
NCC 2	Incentives	2
NCC 3	Duties of NCC Cadet	1
NCC 4	NCC Camps: Types & Conduct	2
NATIONAL INTEGRATION AND AWARENESS		**4**
NI 1	National Integration: Importance & Necessity	1
NI 2	Factors Affecting National Integration	1
NI 3	Unity in Diversity & Role of NCC in Nation Building	1
NI 4	Threats to National Security	1
PERSONALITY DEVELOPMENT		**7**
PD 1	Self-Awareness, Empathy, Critical & Creative Thinking, Decision Making and Problem Solving	2
PD 2	Communication Skills	3
PD 3	Group Discussion: Stress & Emotions	2
LEADERSHIP		**5**
L 1	Leadership Capsule: Traits, Indicators, Motivation, Moral Values, Honour Code	3
L 2	Case Studies: Shivaji, Jhasi Ki Rani	2
SOCIAL SERVICE AND COMMUNITY DEVELOPMENT		**8**
SS 1	Basics, Rural Development Programmes, NGOs, Contribution of Youth	3
SS 4	Protection of Children and Women Safety	1
SS 5	Road / Rail Travel Safety	1
SS 6	New Initiatives	2
SS 7	Cyber and Mobile Security Awareness	1

TOTAL : 30 PERIODS

EN23C02 PROFESSIONAL COMMUNICATION

L	T	P	C
2	0	2	3

COURSE OBJECTIVES:

- To read and comprehend different forms of official texts.
- To develop students' writing skills in professional context.
- To actively listen, read and understand written and oral communication in a professional context.
- To comprehend and analyse the visual content in authentic context.
- To write professional documents with clarity and precision

UNIT I CAUSE AND EFFECT 6

Reading – Newspaper articles on Social and Environmental issues; Writing – Instructions, Cause and effect essay; Grammar - Modal verbs; Vocabulary – Cause and effect, Idioms

LAB ACTIVITY: 6

Listening and Speaking – Listen to news reports and summarise in oral form.

UNIT II CLASSIFICATION 6

Reading – An article, social media posts and classifying based on the content; Writing – Definition, Note making, Note taking (Cornell notes etc.) and Summarising; Grammar – Connectives; Vocabulary – Phrasal verbs

LAB ACTIVITY: 6

Listening and speaking: Social interaction (Conversation including small talk)

UNIT III PROBLEM AND SOLUTION 6

Reading – Visual content (Tables/charts/graphs) for comprehension; Writing - Problem and Solution Essay; Grammar – If conditionals; Vocabulary – Sequential words.

LAB ACTIVITY: 6

Listening – Group discussion; Speaking – Participating in a group discussion

UNIT IV REPORT 6

Reading – Formal report on accidents (industrial/engineering); Writing – Industrial Accident report; Grammar – Active and passive voice, Direct and Indirect speech; Vocabulary – Numerical adjectives.

LAB ACTIVITY: 6

Listening / watching – Television documentary and discussing its content, purpose etc.

UNIT V JOB APPLICATION AND INTERVIEW 6

Reading - Job advertisement and company profile; Writing – Job application (cover letter and CV) Grammar – Mixed Tenses; Vocabulary – Collocations related to work environment

LAB ACTIVITY: 6

Listening – Job interview; Speaking – Mock interviews

TOTAL: 60 PERIODS

TEACHING METHODOLOGY

Interactive lectures, role plays, group discussions, listening and speaking labs, technology enabled language teaching, flipped classroom.

EVALUATION PATTERN

Internal Assessment
Written assessments
Assignment
Lab Assessment
Group discussion (Peer assessment)
Listening
External Assessment
End Semester Examination

LEARNING OUTCOMES

By the end of the courses, students will be able to

- To apply appropriate language structure and vocabulary to enhance both spoken and written communication in formal contexts.
- Comprehend different forms of official documents
- Write professional documents coherently and cohesively.
- Interpret verbal and graphic content in authentic context
- Analyse and evaluate verbal and audio visual materials.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1										√		√
CO2										√		√
CO3										√		√
CO4										√		√
CO5										√		√

TEXT BOOKS:

1. “English for Engineers and Technologists” Volume 2 by Orient Blackswan, 2022
2. “English for Science & Technology - II” by Cambridge University Press, 2023.

REFERENCES:

1. “Communicative English for Engineers and Professionals” by Bhatnagar Nitin, Pearson India, 2010.
2. ”Take Off – Technical English for Engineering” by David Morgan, Garnet Education, 2008. 3. “Advanced Communication Skills” by Mathew Richardson, Charlie Creative Lab, 2020.
4. www.uefap.com

MA23C02	ORDINARY DIFFERENTIAL EQUATIONS AND TRANSFORM TECHNIQUES	L	T	P	C
		3	1	0	4

OBJECTIVES:

- To acquaint the students with Differential Equations which are significantly used in engineering problems.
- To make the students to understand the Laplace transforms techniques.
- To develop the analytic solutions for partial differential equations used in engineering by Fourier series.
- To acquaint the student with Fourier transform techniques used in wide variety of situations in which the functions used are not periodic.
- To develop Z- transform techniques in solving difference equations.

UNIT I ORDINARY DIFFERENTIAL EQUATIONS 9+3

Homogeneous linear ordinary differential equations of second order -superposition principle - general solution- Particular integral - Operator method - Solution by variation of parameters - Method of undetermined coefficients - Homogeneous equations of Euler–Cauchy and Legendre's type – System of simultaneous linear differential equations with constant coefficients.

UNIT II LAPLACE TRANSFORMS 9+3

Existence theorem - Transform of standard functions – Transform of Unit step function and Dirac delta function – Basic properties - Shifting theorems - Transforms of derivatives and integrals – Transform of periodic functions - Initial and Final value theorem - Inverse Laplace transforms- Convolution theorem (without proof) – Solving Initial value problems by using Laplace Transform techniques.

UNIT III FOURIER SERIES 9+3

Dirichlet's conditions – General Fourier series – Odd and even functions – Half-range Sine and Cosine series – Complex form of Fourier series – Parseval's identity – Computation of harmonics.

UNIT IV FOURIER TRANSFORMS 9+3

Fourier integral theorem – Fourier transform pair - Fourier sine and cosine transforms – Properties – Transform of elementary functions – Inverse Fourier Transforms - Convolution theorem (without proof) – Parsevals's identity.

UNIT V Z – TRANSFORM AND DIFFERENCE EQUATIONS 9+3

Z-transform – Properties of Z-transform – Inverse Z-transform – Convolution theorem – Evaluation of Inverse Z transform using partial fraction method and convolution theorem - Initial and final value theorems – Formation of difference equations – Solution of difference equations using Z - transform.

TOTAL: 60 PERIODS

Laboratory based exercises / assignments / assessments will be given to students from the content of the course wherever applicable.
Branch specific / General Engineering applications based on the content of each units will be introduced to students wherever possible.

Suggested Laboratory based exercises / assignments / assessments :
Ordinary differential equations

1. Symbolic computation of linear ordinary differential equations
2. Solving System of simultaneous linear differential equations using ODE SOLVER

Laplace transforms

1. Symbolic computation of Laplace transform and Inverse Laplace transform
2. Plotting Laplace transforms

Fourier Series

1. Symbolic computation of Fourier Coefficients
2. Computation of harmonics
3. Plotting truncated Fourier Series

Fourier Transform

1. Symbolic computation of Fourier Transforms
2. Plotting truncated Fourier Transforms

Z – transform

1. Symbolic computation of Z-Transforms

OUTCOMES:

CO1 :Solve higher order ordinary differential equations which arise in engineering applications.
CO2 :Apply Laplace transform techniques in solving linear differential equations.
CO3 :Apply Fourier series techniques in engineering applications.
CO4 :Understand the Fourier transforms techniques in solving engineering problems.
CO5 :Understand the Z-transforms techniques in solving difference equations.

TEXT BOOKS:

1. Grewal B.S., “Higher Engineering Mathematics”, Khanna Publishers, 45th Edition, New Delhi, 2020.
2. Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, Wiley India Pvt Ltd., New Delhi, 2018.

REFERENCES:

1. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008
2. Greenberg M.D., “Advanced Engineering Mathematics”, Pearson Education2nd Edition, 5th Reprint, Delhi, 2009.
3. Jain R.K. and Iyengar S.R.K., “Advanced Engineering Mathematics”,Narosa Publications, 5 th Edition, New Delhi, 2017.
4. Peter V.O’Neil, “Advanced Engineering Mathematics”, Cengage Learning India Pvt., Ltd, 7 th Edition, New Delhi , 2012.
5. Ramana B.V., “Higher Engineering Mathematics”, Tata McGraw Hill Co. Ltd., 11th Reprint, New Delhi, 2010.

CO – PO Mapping:

Course Outcomes	PROGRAMME OUTCOMES											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**P10**	**P11**	**P12**
CO 1 :	3	3	2	3	1	2	1	1	1	1	1	3
CO 2 :	3	3	2	3	1	2	1	1	1	1	1	3
CO 3 :	3	3	2	3	1	2	1	1	1	1	1	3
CO 4 :	3	3	2	3	1	2	1	1	1	1	1	3
CO 5 :	3	3	2	3	1	2	1	1	1	1	1	3

CY23C01 **ENGINEERING CHEMISTRY** **L T P C**

3 0 2 4

UNIT I WATER TECHNOLOGY

Water – sources and impurities – water quality parameters: colour, odour, pH, hardness, alkalinity, TDS, COD, BOD, and heavy metals. Boiler feed water – requirement – troubles (scale & sludge, caustic embrittlement, boiler corrosion and priming & foaming. Internal conditioning – phosphate, Calgon, and carbonate treatment. External conditioning – demineralization. Municipal water treatment (screening, sedimentation, coagulation, filtration, disinfection-ozonolysis, UV treatment, chlorination), Reverse Osmosis – desalination.

PRACTICAL:

- Estimation of HCl using Na_2CO_3 as the primary standard
- Determination of alkalinity in the water sample.
- Determination of hardness of water by EDTA method.
- Determination of DO content of water sample by Winkler's method.

UNIT II NANOCHEMISTRY

Basics-distinction between molecules, nanomaterials and bulk materials; size-dependent properties (optical, electrical, mechanical, magnetic and catalytic). Types –nanoparticle, nanocluster, nanorod, nanowire and nanotube. Preparation of nanomaterials: sol-gel, solvothermal, laser ablation, chemical vapour deposition, electrochemical deposition and electro-spinning. Characterization - Scanning Electron Microscope and Transmission Electron Microscope - Principle and instrumentation (block diagram). Applications of nanomaterials – medicine including AYUSH, automobiles, electronics, and cosmetics.

PRACTICAL:

- Preparation of nanoparticles by Sol-Gel method/sonication method.
- Preparation of nanowire by Electrospinning.
- Study of morphology of nanomaterials by scanning electron microscopy

UNIT III CORROSION SCIENCE

Introduction to corrosion – chemical and electrochemical corrosions – mechanism of electrochemical and galvanic corrosions – concentration cell corrosion-soil, pitting, inter-granular, water line, stress and microbiological corrosions-galvanic series-factors influencing corrosion- measurement of corrosion rate. Electrochemical protection – sacrificial anodic protection and impressed current cathodic protection. Protective coatings-metallic coatings (galvanizing, tinning), organic coatings (paints). Paints: Constituents and functions.

PRACTICAL:

- Corrosion experiment-weight loss method.
- Salt spray test for corrosion study.
- Corrosion prevention by electroplating.
- Estimation of corroded Iron by Potentiometry/UV-visible spectrophotometer

UNIT IV ENERGY SOURCES

Electrochemical cell, redox reaction, electrode potential – oxidation and reduction potential. Batteries – Characteristics; types of batteries; primary battery (dry cell), secondary battery (lead acid, lithium-ion battery) and their applications. Emerging energy sources – metal hydride battery, hydrogen energy, Fuel cells – H_2-O_2 fuel cell. Supercapacitors –Types and Applications, Renewable Energy: solar heating and solar cells. Recycling and disposal of batteries.

PRACTICAL:

- Study of components of Lead acid battery.
- Measurement of voltage in a photovoltaic cell.
- Working of $H_2 - O_2$ fuel cell

UNIT V POLYMER CHEMISTRY

Introduction: Functionality-degree of polymerization. Classification of polymers (Source, Structure, Synthesis and Intermolecular forces). Mechanism of free radical addition polymerization. Properties of polymers: Tg, tacticity, molecular weight-number average, weight average, viscosity average and polydispersity index (Problems). Techniques of polymerization: Bulk, emulsion, solution and suspension. Compounding and Fabrication Techniques: Injection, Extrusion, Blow and Calendaring. Polyamides, Polycarbonates and Polyurethanes – structure and applications. Recycling of polymers.

PRACTICAL:

- Determination of molecular weight of a polymer using Ostwald viscometer.
- Preparation of a polymer.
- Determination of molecular weight by Gel Permeation Chromatography.

TOTAL: 75 PERIODS

COURSE OUTCOMES:

CO1: To demonstrate knowledge of water quality in various industries and develop skills in analyzing water quality parameters for both domestic and industrial purposes.

CO2: To identify and apply fundamental concepts of nanoscience and nanotechnology for engineering and technology applications, and to develop skills in synthesizing nanomaterials and studying their morphology.

CO3: To apply fundamental knowledge of corrosion protection techniques and develop skills to conduct experiments for measuring and preventing corrosion.

CO4: To study the fundamentals of energy storage devices and develop skills in constructing and experimenting with batteries.

CO5: To recognize and apply basic knowledge of different types of polymeric materials and develop skills in preparing and determining their applications for futuristic material fabrication needs.

TEXT BOOKS:

1. Jain P. C. & Monica Jain., "Engineering Chemistry", 17th Edition, Dhanpat Rai Publishing Company (P) Ltd, New Delhi, 2015.
2. Sivasankar B., "Engineering Chemistry", Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2012.
3. Dara S.S., "A Textbook of Engineering Chemistry", Chand Publications, 2004.
4. Laboratory Manual - Department of Chemistry, CEGC, Anna University (2023).

REFERENCES:

1. Schdeva M.V., "Basics of Nano Chemistry", Anmol Publications Pvt Ltd, 2011.
2. Friedrich Emich, "Engineering Chemistry", Medtech, 2014.
3. Gowariker V.R., Viswanathan N.V. and Jayadev Sreedhar, "Polymer Science" New AGE International Publishers, 2009.
4. Vogel's Textbook of Quantitative Chemical Analysis (8th edition, 2014).

CO - PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	-	-	-	-	3	-	-	-	-	-
CO2	3	-	2	-	2	-	3	-	-	-	-	-
CO3	3	3	2	-	2	-	3	-	-	-	-	-
CO4	3	3	-	-	-	-	3	-	-	-	-	-
CO5	3	-	-	-	-	-	3	-	-	-	-	-
Avg	3	3	-	-	-	-	3	-	-	-	-	-

1' = Low; '2' = Medium; '3' = High

CS23C02 **COMPUTER PROGRAMMING IN PYTHON**

L	T	P	C
3	0	2	4

COURSE OBJECTIVES:

- To understand fundamental structural programming concepts and problem-solving process.
- To solve problems using modular programming and decomposition techniques.
    - To solve problems using data structures and abstraction techniques.
    - To create programming solutions using libraries and packages.
    - To design solutions to domain problems using programming problem-solving techniques.

UNIT I – STRUCTURED PROGRAMMING **9+6**

Problem-Solving Strategies. Basic Problem-Solving Tools: Flowcharts, Pseudocode. Introduction to Programming Languages and Development Environments. Programming. Basic Concepts and Syntax: Variables, Identifiers, Data Types: Primitive Types and Strings, Statements, Operators, Expressions and its evaluation, Operator Precedence, Basic Arithmetic Operations. Principles of Structured Programming – Control Structures: Sequence, Selection, Iteration and Branching.

PRACTICALS:

- Design algorithms for simple computational problems
- Create Pseudo-code and Flow charts for simple computational problems
- Create Python programs using simple and nested selective control statements
- Create Python programs using simple and nested sequence & iterative control statements
- Create Python programs to generate series/patterns using control statements

UNIT II – MODULARITY AND DECOMPOSITION **9+6**

Principles of Modular and Decomposition. Functions: Defining functions –Argument types – Function Name-spaces – Scoping: Global and Non-local. Principles of Recursion: Base case and Recursive cases – Develop and Analyze Recursive functions: Factorial, Fibonacci. Principles of First-Class and Higher-Order functions: Lambda functions – Functions as arguments.

PRACTICALS:

- Create Python programs using functions
- Create python program using recursion
- Create Python programs using lambda functions
- Create Python programs using first-class functions
- Create Python programs using higher-order functions

UNIT III – DATA STRUCTURES AND ABSTRACTIONS **9+6**

Principles of Data Structures and Abstractions. String Methods and Manipulations,.Lists: List Operations and Methods, List comprehensions, Nested List comprehensions, Matrix operations using Lists. Tuples and sequences. Sets and Operations. Dictionaries: Dictionary operations, Dictionary comprehensions, Nested Dictionary comprehensions. Comparing Data Structures. Search and Sort Data Structures. Principle of Functional Programming and Tools : map, filter, and reduce.

PRACTICALS:

- Create Python programs for strings manipulations.
- Design Python programs using Lists, Nested Lists and Lists comprehensions
- Create Python programs using Tuples, Nested Tuples, and Tuple comprehensions
- Create Python programs creating Sets and performing set operations

- Create Python programs using Dictionary, Nested Dictionary and comprehensions
- Create Python programs by applying functional programming concepts

UNIT IV – LIBRARIES AND MODULES **9+6**

Exceptions: Syntax errors, Exceptions, Exception types, Handling exceptions, Raising exceptions. Files: File Path, Type of files, opening modes, Reading and Writing text files, Handling other format Data files. Modules: Creating Modules, import and from statements, Executing modules as scripts, Standard modules. Packages and Importing from packages

PRACTICALS:

- Design Python programs to handle errors and exceptions
- Create, import, and use pre-defined modules and packages
- Create, import, and use user-defined modules and packages
- Create Python programs to perform various operations on text files
- Create Python programs to perform various operations on other data file formats.

UNIT V – SIMPLE PROBLEM SOLVING TECHNIQUES IN PROGRAMMING **9+6**

Data Structures for Problem Solving: Stack, Queue. Principles of Divide and Conquer: Binary Search. Principles of Greedy Algorithms: Minimum Coin Change Problem. Case studies on programming application of problem-solving techniques in different fields of engineering.

PRACTICALS:

- Create python programs to implement stack and queue.
- Create python programs to implement binary search.
- Create python programs to solve minimum coin change problem.
- Case study on developing python solution to a domain specific problems.

TOTAL = 45 + 30 = 75 PERIODS

COURSE OUTCOMES

1. Understand fundamental structural programming concepts and problem-solving process.
2. Solve problems using modular programming and decomposition techniques.
3. Solve problems using data structures and abstraction techniques.
4. Create programming solutions using libraries and packages.
5. Design solutions to domain problems using programming problem-solving techniques.

TEXT BOOKS

1. Reema Thareja, Python Programming using Problem Solving Approach, Oxford University Press, First Edition, 2017.
2. S. Sridhar, J. Indumathi, V. M. Hariharan, Python Programming, Pearson Education, First Edition, 2023

REFERENCE BOOKS

1. Paul Deitel, Harvey Deitel, Python for Programmers, Pearson Education, 2020.
2. John V Guttag. Introduction to Computation and Programming Using Python, With Application to Computational Modeling and Understanding Data. Third Edition, The MIT Press, 2021
3. Mark Lutz, Learning Python, 5th Edition, O'Reilly Media, Inc.
4. Python official documentation and tutorial, https://docs.python.org/3/
5. Numerical Python official documentation and tutorial, https://numpy.org/

CO's-PO's & PSO's MAPPING

CO	PO1	PO2	PO3	PO4	POS	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2		2		1								1	1	
2	2		2		1								1	1	
3	2	1	2		1								1	1	
4	2	1	2	1	1								1	1	
5	2	1	2	1	1								1	1	
Avg	2	1	2	1	1								1	1	

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

EE23C03	**BASICS OF ELECTRICAL AND ELECTRONICS ENGINEERING**	**L**	**T**	**P**	**C**
		2	**0**	**2**	**3**

UNIT-I BASIC ELECTRICAL CIRCUITS **6**

Basic Elements: R,L,C- DC Circuits: Ohm's Law - Kirchhoff's Laws –Mesh and Nodal Analysis(Only Independent Sources). AC Circuits: Average Value, RMS Value, Impedance Instantaneous Power, Real Power, Reactive Power and Apparent Power, Power Factor-Steady state Analysis of RL,RC and RLC circuits.

UNIT II AC AND DC MACHINES **6**

Magnetic Circuit Fundamentals -DC Machines - Construction and Working Principle, Types and Application of DC generator and Motor, EMF and Torque Equation.
AC Machines: Principle, Construction, Working and Applications of Transformer -Three phase Alternator - Three Phase Induction Motor.

UNIT III ANALOG AND DIGITAL ELECTRONICS **6**

Operation and Characteristics of electronic devices: PN Junction Diodes, Zener Diode and BJT Applications: Diode Bridge Rectifier and Shunt Regulator.
Introduction to Digital Electronics: Basics Logic Gates-Flip Flops.

UNIT IV SENSORS AND TRANSDUCERS **6**

Solenoids, electro-pneumatic systems, proximity sensors, limit switches, Strain gauge, LVDT, Piezo electric transducer, optical and digital transducers, Smart sensors, Thermal Imagers.

UNIT V MEASUREMENTS AND INSTRUMENTATION **6**

Functional Elements of an Instrument, Operating Principle of Moving Coil and Moving Iron Instruments,Power Measurement, Energy Meter, Instrument Transformers - CT and PT, Multimeter- DSO - Block Diagram Approach.

TOTAL 30

LAB COMPONENET:

1. Verification of ohms and Kirchhoff's Laws.
2. Load test on DC Shunt Motor.
3. Load test on Single Phase Transformer.
4. Load test on 3 Phase Induction Motor.
5. Uncontrolled diode bridge Rectifiers.
6. Application of Zener diode as shunt regulator.
7. Verification of truth table of logic gates and flip flops.
8. Characteristics of LVDT.
9. Three phase power measurement using two wattmeter method.
10. Study of DSO.

COURSE OUTCOMES:
Students will be able to

CO1	Compute the electric circuit parameters for simple circuits.
CO2	Understand the working principles and characteristics of electrical machines.
CO3	Understand the basic electronic devices.
CO4	Understand the basic operating principles of sensors and transducer.
CO5	Understand the operating principles measuring devices

TEXT BOOKS:

1. Kotharai DP and Nagarath IJ, “Basic Electrical and Electronics Enigneering”, McGraw Hill Education, Second Edition, 2020.
2. Bhattacharya SK, “Basic Electrical and Electronics Engineering”, Pearson Education, Second Edition, 2017.

REFERENCES:

1. Mehta V.K. & Mehta Rohit, “Principles of Electrical Engineering and Electronics”, McGraw Hill Education, Second Edition, 2020.
2. Mehta V.K. & Mehta Rohit, “Principles of Electrical Machines”, S. Chand Publishing, second edition 2006.
3. Albert Malvino & David Bates, “Electronic principles”, McGraw Hill Education, Seventh Edition, 2017.

Mapping COs and POs:																
COs	**Pos**												**PSOs**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	2	1														
CO2	2	1														
CO3	2	1														
CO4	2	1														
CO5	2	1														
Avg	2	1														

ME23C06	DESIGN THINKING	L T P C
		2 0 2 3

OBJECTIVES:

The main learning objective of this course is to prepare the students to understand, apply and analyze the various design thinking concepts and tools for better innovative ideas.

THEORY

UNIT I INTRODUCTION TO DESIGN THINKING 6

An insight into Design, Design Methodology, the origin of Design thinking, Design thinking Vs Engineering thinking, the importance of Design Thinking, Design Vs Design thinking, understanding Design thinking and its various process models or frameworks, Stanford process models and its five stages, features of design thinking, application of Design thinking

UNIT II EMPATHIZE IN DESIGN THINKING 6

Human-Centered Design (HCD) process, explanation of HCD design thinking with examples, Role of Empathy in design thinking, persona creation and its importance, tools of empathy: Empathy maps, advantages and disadvantages of empathy maps, Customer journey map and its advantages & disadvantages, Mind Maps, and its uses, understanding empathy tools.

UNIT III DEFINE PHASE AND IDEATION PHASE 6

Explore define phase in Design Thinking, Methods of Define phase. Introduction to ideation Methods, convention methods for ideation, intuitive methods: Brainstorming, storyboard telling, select ideas from ideation Methods: Bingo Selection, Six Thinking Hats.

UNIT IV PROTOTYPING PHASE AND TESTING PHASE 6

Prototyping and methods of prototyping, Difference between low fidelity and high-fidelity prototypes, paper prototyping, techniques for implementing paper prototyping, Digital prototyping, user testing methods, Advantages, and disadvantages of user Testing/ Validation.

UNIT V DESIGN THINKING FOR INNOVATION 6

Innovation in Design Thinking, Definition of innovation, the art of innovation, types of innovations, product innovation, process innovation, and organizational innovation, characteristics of innovation, levels of innovation, Innovation towards design, Case studies

TOTAL: 30 PERIODS

Introduction to Design Thinking

Exercise 1: Load Reduction Instruction (LRI) activity

Exercise 2: Reflection - The Marshmallow Challenge

Exercise 3: Round-Robin Brainstorming - Mind Tools

Ideation Tools & Exercises

Exercise 4: The Wallet Challenge -Team Activity

Exercise 5: Thirty circle - Story Telling

Exercise 6: Framing the Design Challenge with mind mapping

Analysis & Drawing Inferences - User research

Exercise 7: Persona Creation & User Research

Exercise 8: Creating Empathy maps

Exercise 9: Creating Customer Journey maps

The art of the pitch

Exercise 10: Make a paper prototype for user testing (mock-up model)

Exercise 11: Develop & Present a 3-Minute Pitch (Sample Pitches)

Exercise 12: The Design Challenge – Testing Documentation and Pitching

TOTAL: 30 PERIODS

COURSE OUTCOMES: Upon completion of this course, the students will be able to:

1. Understand the principles of design thinking and it approaches.
2. Apply empathy and its tools in ideation techniques in human-centered design problems.
3. Apply the design thinking techniques for Define and Ideation Phase of the design thinking context.
4. Build the prototype, analyze and test it in a design thinking context.
5. Apply design thinking tools toward innovative ideas.

TEXT BOOK:

1. Tim Brown, "Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation", Harper Collins Publishers Ltd., 2009.
2. Hasso Plattner, Christoph Meinel and Larry Leifer (eds), "Design Thinking: Understand – Improve– Apply", Springer, 2011.

REFERENCES:

1. Roger Martin, "The Design of Business: Why Design Thinking is the Next Competitive Advantage", Harvard Business Press, 2009.
2. Idris Mootee, "Design Thinking for Strategic Innovation: What They Can't Teach You at Business or Design School", John Wiley & Sons, 2013.
3. Jeanne Liedtka, Andrew King, Kevin Bennett, “Book - Solving Problems with Design Thinking - Ten Stories of What Works” (Columbia Business School Publishing), 2013.
4. Maurício Vianna, Ysmar Vianna, Isabel K. Adler, Brenda Lucena, Beatriz Russo, “Design thinking: Business Innovation”, MJV Press, 2011.
5. Burgelman, Christensen, and Wheelwright, “Strategic Management of Technology and Innovation”, 5th Edition, McGraw Hill Publications, 2017.
6. Brenda Laurel, "Design Research methods and perspectives", MIT press, 2003.

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2			2	2		3	3	2	2	1	3	2	1	2
2	2			2	2		3	3	2	2	1	3	2	1	2
3	2			2	2		3	3	2	2	1	3	2	1	2
4	2			2	2		3	3	2	2	1	3	2	1	2
5	2			2	2		3	3	2	2	1	3	2	1	2

UC23H02 தமிழரும் தொழில்நுட்பமும்/Tamils and Technology **L T P C**
1 0 0 1

அலகு I **<u>நெசவு மற்றும் பானைத் தொழில்நுட்பம்</u>**: **3**

சங்க காலத்தில் நெசவுத் தொழில் – பானைத் தொழில்நுட்பம் – கருப்பு சிவப்பு பாண்டங்கள் – பாண்டங்களில் கீறல் குறியீடுகள்.

அலகு II **<u>வடிவமைப்பு மற்றும் கட்டிடத் தொழில்நுட்பம்</u>**: **3**

சங்க காலத்தில் வடிவமைப்பு மற்றும் கட்டுமானங்கள் & சங்க காலத்தில் வீட்டுப் பொருட்களில் வடிவமைப்பு- சங்க காலத்தில் கட்டுமான பொருட்களும் நடுகல்லும் – சிலப்பதிகாரத்தில் மேடை அமைப்பு பற்றிய விவரங்கள் – மாமல்லபுரச் சிற்பங்களும், கோவில்களும் – சோழர் காலத்துப் பெருங்கோயில்கள் மற்றும் பிற வழிபாட்டுத் தலங்கள் – நாயக்கர் காலக் கோயில்கள் - மாதிரி கட்டமைப்புகள் பற்றி அறிதல், மதுரை மீனாட்சி அம்மன் ஆலயம் மற்றும் திருமலை நாயக்கர் மஹால் – செட்டிநாட்டு வீடுகள் – பிரிட்டிஷ் காலத்தில் சென்னையில் இந்தோ-சாரோசெனிக் கட்டிடக் கலை.

அலகு III **<u>உற்பத்தித் தொழில் நுட்பம்</u>**: **3**

கப்பல் கட்டும் கலை – உலோகவியல் – இரும்புத் தொழிற்சாலை – இரும்பை உருக்குதல், எஃகு – வரலாற்றுச் சான்றுகளாக செம்பு மற்றும் தங்க நாணயங்கள் – நாணயங்கள் அச்சடித்தல் – மணி உருவாக்கும் தொழிற்சாலைகள் – கல்மணிகள், கண்ணாடி மணிகள் – சுடுமண் மணிகள் – சங்கு மணிகள் – எலும்புத்துண்டுகள் – தொல்லியல் சான்றுகள் – சிலப்பதிகாரத்தில் மணிகளின் வகைகள்.

அலகு IV **<u>வேளாண்மை மற்றும் நீர்ப்பாசனத் தொழில் நுட்பம்</u>**: **3**

அணை, ஏரி, குளங்கள், மதகு – சோழர்காலக் குமுழித் தூம்பின் முக்கியத்துவம் – கால்நடை பராமரிப்பு – கால்நடைகளுக்காக வடிவமைக்கப்பட்ட கிணறுகள் – வேளாண்மை மற்றும் வேளாண்மைச் சார்ந்த செயல்பாடுகள் – கடல்சார் அறிவு – மீன்வளம் – முத்து மற்றும் முத்துக்குளித்தல் – பெருங்கடல் குறித்த பண்டைய அறிவு – அறிவுசார் சமூகம்.

அலகு V **<u>அறிவியல் தமிழ் மற்றும் கணித்தமிழ்</u>**: **3**

அறிவியல் தமிழின் வளர்ச்சி –கணித்தமிழ் வளர்ச்சி – தமிழ் நூல்களை மின்பதிப்பு செய்தல் – தமிழ் மென்பொருட்கள் உருவாக்கம் – தமிழ் இணையக் கல்விக்கழகம் – தமிழ் மின் நூலகம் – இணையத்தில் தமிழ் அகராதிகள் – சொற்குவைத் திட்டம்.

TOTAL : 15 PERIODS

TEXT-CUM-REFERENCE BOOKS

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும்

   கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)

5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils – The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi – 'Sangam City C ivilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Publishedby: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

UC23H02	**TAMILS AND TECHNOLOGY**	**L T P C**
		1 0 0 1

UNIT I WEAVING AND CERAMIC TECHNOLOGY 3

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

UNIT II DESIGN AND CONSTRUCTION TECHNOLOGY 3

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

UNIT III MANUFACTURING TECHNOLOGY 3

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

UNIT IV AGRICULTURE ANDIRRIGATION TECHNOLOGY 3

Dam, Tank, ponds, Sluice, Significance of KumizhiThoompuof Chola Period,Animal Husbandry - Wells designed for cattle use - Agriculture and Agro Processing -KnowledgeofSea -Fisheries – Pearl - Conche diving - Ancient Knowledge ofOcean -KnowledgeSpecificSociety.

UNIT V SCIENTIFIC TAMIL & TAMIL COMPUTING 3

Development of Scientific Tamil - Tamil computing – Digitalization of Tamil Books – Development of Tamil Software – Tamil Virtual Academy – Tamil Digital Library – Online Tamil Dictionaries – Sorkuvai Project.

TOTAL : 15 PERIODS

TEXT-CUM-REFERENCEBOOKS

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும்

   கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils – The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi – 'Sangam City C ivilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Publishedby: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

MA23C06 **PARTIAL DIFFERENTIAL EQUATIONS AND COMPLEX FUNCTIONS**

L	T	P	C
3	1	0	4

OBJECTIVES:

- To familiarize the students to solve of partial differential equations.
- To familiarize the students in solving boundary value problems.
- To understand the concepts of Complex functions.
- To familiarize complex mappings and its property.
- To familiarize the students with integration of complex functions.

UNIT I PARTIAL DIFFERENTIAL EQUATIONS 9+3

Formation – Solutions of first order equations – Standard types and Equations reducible to standard types – Lagrange's Linear equation – Solution of linear equations of higher order with constant coefficients – Linear non-homogeneous partial differential equations.

UNIT II APPLICATIONS OF FOURIER SERIES TO PARTIAL DIFFERENTIAL EQUATION 9+3

Classification of partial differential equations- Method of separation of variables – Solutions of one dimensional wave equation and one-dimensional heat equation – Steady state solution of two dimensional heat equation – Fourier series solutions in Cartesian coordinates.

UNIT III ANALYTIC FUNCTIONS 9+3

Limit, Continuity and Differentiation of Complex functions - Analytic functions – Necessary and sufficient conditions for analyticity - Properties of analytic functions – Harmonic conjugates – Construction of analytic function – elementary analytic functions (exponential, trigonometric, logarithm) and their properties.

UNIT IV CONFORMAL MAPPING 9+3

Introduction to complex mapping - Conformal mapping – Condition for conformality – Standard mappings: a+z, az, az+b, $\frac{1}{z}, z^2, e^z$ - Bilinear transformations – Physical applications: Fluid flow and heat flow problems.

UNIT V INTEGRATION OF COMPLEX FUNCTIONS 9+3

Line integral - Cauchy's integral theorem – Cauchy's integral formula – Taylor's and Laurent's series – Singularities – Residues – Cauchy's Residue theorem – Application of residue theorem for evaluation of real integrals – Use of circular contour and semicircular contours (excluding poles on real lines).

TOTAL: 60 PERIODS

Laboratory based exercises / assignments / assessments will be given to students from the content of the course wherever applicable.

Branch specific / General Engineering applications based on the content of each units will be introduced to students wherever possible.

Suggested Laboratory based exercises / assignments / assessments :

1. Symbolic computation of solution to PDE using PDE Solver

2. Conformal mapping can be done by plotting the curves and surfaces

OUTCOMES:

CO1 :Understand the concepts of partial differential equations in practical situations.
CO2 :Obtain the solutions of the partial differential equations using Fourier series.
CO3 :Understand the Concepts of complex functions in practical situations.
CO4 :Understand the conformal mapping and its applications.
CO5 :Apply the complex integrations in engineering problems.

TEXT BOOKS:

1. Erwin Kreyszig "Advanced Engineering Mathematics", John Wiley & Sons., New Delhi, 2015.
2. Wylie C. R. and Barrett L. C "Advanced Engineering Mathematics", Tata McGraw-Hill., New Delhi, 2019.
3. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, 44th Edition, New Delhi, 2017.

REFERENCES:

1. Mathews J. H. and Howell R. W "Complex Analysis for Mathematics and Engineering", Narosa Publishing House. New Delhi, 2012.
2. Peter V.O Neil "Advanced Engineering Mathematics", Cengage., New Delhi, 2016.
3. Dennis G Zill "Advanced Engineering Mathematics", Jones & Bartlett India P Ltd., New Delhi, 2017.
4. Dean G Duffy "Advanced Engineering Mathematics with MATLAB", CRC., USA, 2010.
5. Spiegel, M.R., Theory and Problems of Complex Variables and its Application (Schaum's Outline Series), McGraw Hill Book Co., Singapore (1981).

CO – PO Mapping:

Course Outcomes	PROGRAMME OUTCOMES											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	P12
CO1 :	3	3	2	3	1	2	1	1	1	1	1	3
CO2 :	3	3	2	3	1	2	1	1	1	1	1	3
CO3 :	3	3	2	3	1	2	1	1	1	1	1	3
CO4 :	3	3	2	3	1	2	1	1	1	1	1	3
CO5 :	3	3	2	3	1	2	1	1	1	1	1	3

ME23C11 KINEMATICS AND DYNAMICS OF MACHINERY

L	T	P	C
3	0	2	4

COURSE OBJECTIVES:

The main learning objective of this course is:

1 To understand the principles in the formation of mechanisms and their kinematics.
2 To learn the basic concepts of toothed gearing and kinematics of gear trains.
3 To study the effect of friction in different machine elements.
4 To analyze the forces and torque acting on simple mechanical systems.
5 To understand the importance of balancing and vibration.

UNIT – I KINEMATIC ANALYSIS IN SIMPLE MECHANISMS AND CAMS 9

Mechanisms – Terminology and definitions – kinematics inversions and analysis of 4 bar and slide crank chain – velocity and acceleration polygons – Cams – classifications – displacement diagrams-layout of plate cam profiles.

PRACTICALS

1. Cams – Cam profile drawing and Motion curves

UNIT – II TOOTHED GEARING AND GEAR TRAINS 9

Gear terminology – law of toothed gearing – involute gearing – Gear tooth action - Interference and undercutting – gear trains – parallel axis gear trains – epicyclic gear trains.

PRACTICALS

1. Study of gear parameters: Experimental study of velocity ratios of simple, compound, epicyclic and differential gear trains.

UNIT – III FRICTION ASPECTS IN MACHINE COMPONENTS 9

Surface contacts – Sliding and Rolling friction – Friction drives – Friction in screw threads – Friction clutches – Belt drives – Friction aspects in brakes.

UNIT – IV STATIC AND DYNAMIC FORCE ANALYSIS 9

Applied and Constrained Forces – Free body diagrams – Static equilibrium conditions – Static Force analysis in simple mechanisms – Dynamic Force Analysis in simple machine members – Inertia Forces and Inertia Torque – D'Alembert's principle.

UNIT – V BALANCING OF ROTATING MASSES AND VIBRATION 9

Static and Dynamic balancing – Balancing of revolving masses – Balancing machines – Free vibrations – natural Frequency – Damped Vibration – Critical speed of simple shafts – Forced vibration – Harmonic forcing – Vibration isolation.

PRACTICALS

1. Single degree of freedom Spring Mass System – Determination of natural Frequency and verification of Laws of springs
2. Determination of torsional natural frequency of single undamped rotor system
3. Whirling of shafts – Determination of critical speeds of shafts with concentrated loads.
4. Determination of Mass moment of inertia of Fly wheel and Axle system.
5. Determination of Mass Moment of Inertia of axisymmetric bodies using Turn table apparatus.
6. Motorized gyroscope – Study of gyroscopic effect and couple.

7. Governor - Determination of range sensitivity and effort for Watts, Porter, Proell, and Hartnell Governors.

TOTAL : 45L+30P =75 PERIODS

COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

1. Design the linkages and the cam mechanisms for specified output motions.
2. Determine the gear parameters of toothed gearing and speeds of gear trains in various applications.
3. Evaluate the frictional torque in screw threads, clutches, brakes and belt drives and to determine mass moment of inertia of flywheel and axle system and axisymmetric bodies.
4. Determine the forces on members of mechanisms during static and dynamic equilibrium conditions and to determine gyroscopic couple and various parameters of governors
5. Determine the balancing masses on rotating machineries and the natural frequencies of free and forced vibratory systems.

TEXT BOOKS

1. Uicker, J.J., Pennock G.R and Shigley, J.E., “Theory of Machines and Mechanisms”, Oxford University Press, 2017.

REFERENCES

1. Cleghorn. W. L., Nikolai Dechev, “Mechanisms of Machines”, Oxford University Press, 2015.
2. Rao.J.S. and Dukkipati.R.V. “Mechanism and Machine Theory”, New Age International Pvt. Ltd., 2006.
3. Rattan, S.S, “Theory of Machines”, McGraw-Hill Education Pvt. Ltd., 2014
4. Robert L. Norton, Kinematics and Dynamics of Machinery, Tata McGraw-Hill, 2017.
5. Thomas Bevan, “The Theory of Machines”, Pearson Education Ltd., 2010.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	2	3	2	2	2	3	1	1	1	2	3	1	
2	3	3	3	3	2	3	2	3	1	1	1	2	3	1	
3	3	3	3	3	2	3	2	3	1	1	1	2	3	1	
4	3	3	3	3	2	2	2	2	1	1	1	2	3	1	
5	3	3	3	3	2	2	2	2	1	1	1	2	3	1	

ME23C08 **ENGINEERING THERMODYNAMICS**

L	T	P	C
3	0	0	3

COURSE OBJECTIVE:

To impart knowledge on various forms of energy, energy transfer and energy interactions.

UNIT I FIRST LAW OF THERMODYNAMICS 9

Thermodynamic systems, Properties and processes Thermodynamic Equilibrium - Displacement work - P-V diagram. Thermal equilibrium - Zeroth law – Concept of temperature and Temperature Scales. First law – application to closed and open systems – steady and unsteady flow processes.

UNIT II SECOND LAW AND CONCEPT OF ENTROPY 9

Heat Engine – Refrigerator - Heat pump. Statements of second law and their equivalence & corollaries. Carnot cycle - Reversed Carnot cycle - Performance - Clausius inequality. Concept of entropy - T-s diagram - Tds Equations - Entropy change for a pure substance, Principle of increase in entropy.

UNIT III EXERGY ANALYSIS 9

High and low grade energy, Exergy and Anergy, Availability and Irreversibility for open and closed system processes - I and II law Efficiency, Applications of II Law.

UNIT IV PROPERIES OF PURE SUBSTANCES, Ideal AND REAL GASES 9

Steam - formation and its thermodynamic properties - p-v, p-T, T-v, T-s, h-s diagrams. PVT surface. Determination of dryness fraction of wet and very wet steam. Calculation of work done and heat transfer in non-flow and flow processes using Steam Table and Mollier Chart.

Properties of Ideal gas, real gas - comparison. Equations of state for ideal gas. Real Gas, Vander Waal's relation - Reduced properties - Compressibility factor - Principle of Corresponding states - Generalized Compressibility Chart.

UNIT V GAS MIXTURES AND THERMODYNAMIC RELATIONS 9

Gas mixtures, Maxwell relations - Tds Equations - heat capacities relations - Energy equation, Joule-Thomson experiment - Clausius- Clapeyron equation.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

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

CO1: Understand and carry out various thermodynamic system analysis
CO2: Apply the second law of thermodynamics to various thermal systems
CO3: Determine the availability and perform the exergy analysis of thermal systems
CO4: Evaluate the properties of pure substance and real gases
CO5: Explain the thermodynamic relations and compute properties of gas mixtures

TEXTBOOKS:

1. Nag.P.K., “Engineering Thermodynamics”, 6th Edition, Tata McGraw Hill (2017), New Delhi
2. Cengel, Y and M. Boles, Thermodynamics - An Engineering Approach, Tata McGraw Hill,8th Edition, 2015

REFERENCES:

1. Rathakrishnan, E., “Fundamentals of Engineering Thermodynamics”, 2nd Edition, Prentice Hall of India Pvt. Ltd, 2006.
2. E. Natarajan, Engineering Thermodynamics-Fundamentals and Applications, First Edition 2019, ISBN: 93-1568-61-3, Anuragam Publication.
3. Chattopadhyay, P, “Engineering Thermodynamics”, 2nd Edition Oxford University Press, 2016
4. Claus Borgnakke and Richard E. Sonntag, “Fundamentals of Thermodynamics”, 7th Edition, Wiley Eastern, 2009.
5. Venkatesh. A, “Basic Engineering Thermodynamics”, Universities Press (India) Limited, 2007
6. Moran & Shapiro, “Principles of Engineering Thermodynamics”, 8th Edition, Wiley Eastern,

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	3	2	1	-	-	1	-	-	-	-	1	2	1	2
2	2	3	2	1	-	-	1	-	-	-	-	1	3	1	2
3	2	3	2	1	1	-	1	-	-	-	-	1	3	2	2
4	2	3	2	1	-	1		-	-	-	-	1	2	2	2
5	2	3	2	1	-	1		-	-	-	-	1	2	1	2
Avg	2	3	2	1	1	1	1	-	-	-	-	1	2.4	1.4	2

ME23301	MANUFACTURING TECHNOLOGY	L	T	P	C
		3	0	2	4

COURSE OBJECTIVE:

- To impart knowledge on metal casting, joining, and forming processes

UNIT I METAL CASTING PROCESSES 9

Sand Casting – Sand Mould – Type of patterns - Pattern Materials – Pattern allowances – Types of sand- sand properties and testing – Cores –Types and applications Basics of gating system – Molding machines – Melting furnaces – Principle of special casting processes- Shell, investment – Ceramic mould–Pressure die casting–Centrifugal Casting-CO_2 casting process Defects in Sand casting process Stir casting– Squeeze casting –Full Moulding –magnetic Moulding- Micro casting -Casting techniques for single crystal components -Casting defects.

PRACTICALS

1. Green sand mould preparation with single piece and split patterns.
2. Estimation of green sand properties.
3. Casting of aluminum components through green sand, full mould process.

UNIT II METAL JOINING PROCESSES 9

Fusion welding processes–Type of Gas welding–Flame characteristics–Filler and Flux materials Arc welding, Electrodes, Coating and specifications–Principles and types of Resistance welding– Gas Tungsten arc welding- Gas metal arc welding –Cold metal Transfer-Wire arc additive Manufacturing–Thermal spraying- Submerged arc welding – Electro slag welding – Plasma arc welding – Thermit Welding –Electron beam welding -Laser beam welding-Ultrasonic Welding –Friction welding–Friction stir welding–Diffusion bonding Weld defects - Brazing and soldering –– Adhesive bonding.

PRACTICALS

Microstructural examination of weldments.

UNIT III BULK DEFORMATION PROCESSES 9

Hot working and cold working of metals – Forging processes – Open, impression and closed die forging–Characteristics of the processes–Typical forging operations–rolling of metals–Types of Rolling – Flat strip rolling –contour roll forming- shape rolling operations – Defects in rolled parts – Principle of rod and wire drawing–Tube drawing–Principles of Extrusion–Types–Hot and Cold extrusion.

UNIT IV SHEET METAL PROCESSES 9

Sheet metal characteristics–Typical shearing bending and drawing operations– Stretch forming operations – Formability of sheet metal – Test methods –special forming processes – Working principle and applications–Hydro forming–Rubber pad forming–Multi-point Die Forming– Warm/Hot Forming – Solid Granular Medium Forming –Metals pinning-Introduction of Explosive forming magnetic pulse forming, peen-forming, Super plastic-forming –Micro-forming–Incremental forming.

PRACTICALS

1. Estimation of formability of sheet metals.
2. Fabrication of simple sheet metal components.

UNIT V MANUFACTURE OF PLASTIC COMPONENTS 9

Types and characteristics of plastics – Molding of thermoplastics – working principles and typical applications – injection molding – Plunger and screw machines – Compression molding transfer molding –Typical industrial applications–introduction to blow-molding–Rotational-molding–Film-blowing – Extrusion – Vacuum bag Forming- Thermo-forming–Bonding of Thermo-plastics.

TOTAL: 45 L +30 P = 75 PERIODS

COURSE OUTCOMES:

Upon completion of this course the students will be able to:

1. Explain the working principles of various metal casting processes.
2. Categorize and select the appropriate metal joining process.
3. Compare the working principles of bulk deformation of metals.
4. Suggest suitable sheet metal forming processes for production of Engineering Components.
5. Explain the manufacturing of plastic components.

TEXTBOOKS:

1. Kalpakjian.S, “Manufacturing Engineering and Technology”, Pearson Education India Edition,8th edition 2020.
2. Rao.P.N., Manufacturing Technology Foundry, Forming and Welding, 5thEdition, Tata McGraw Hill, 2018.

REFERENCES:

1. Gowri. S, P. Hariharan, A.Suresh Babu, Manufacturing Technology, Pearson Education, 2008.
2. R.K.Jain Production Technology Manufacturing Systems Vol –I K.hanna Publishers
3. PaulDegarmaE.,BlackJ.T.and Ronald A.Kosher, Materials and Processes, in Manufacturing, Eight Edition, Prentice Hall of India,1997.
4. Sharma,P.C.,A Textbook of Production Technology, S.ChandandCo.Ltd.,2006.
5. Roy.A.Lindberg, Processes and materials of manufacture, PHI / Pearson Education,2006.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	2	2	-	-	2	1	-	-	-	1	3	2	3
2	3	3	2	2	-	-	2	1	-	-	-	1	3	2	3
3	3	3	2	2	-	-	2	1	-	-	-	1	3	2	3
4	3	3	2	2	-	-	2	1	-	-	-	1	3	2	3
5	3	3	2	2	-	-	2	1	-	-	-	1	3	2	3
Avg	3	3	2	2	-	-	2	1	-	-	-	1	3	2	3

MS23C01 ENGINEERING MATERIALS AND METALLURGY

L	T	P	C
3	0	0	3

COURSE OBJECTIVE:

To impart knowledge on phase diagram constructions, Heat treatments of metals and alloys, and selection of ferrous & non-ferrous materials for suitable engineering applications

UNIT I CONSTITUTION OF ALLOYS AND PHASE DIAGRAMS 9

Constitution of alloys – Solid solutions, substitutional and interstitial – phase diagrams, Isomorphous, eutectic, eutectoid, peritectic, and peritectoid reactions, application of lever rule for phase calculation; Iron – Iron carbide equilibrium diagram. Classification of steel and cast Iron microstructure, properties and application.

UNIT II HEAT TREATMENT 9

Phase transformation- Pearlite, bainite and martensite formation mechanism; Diffusion-Fick's first and second Law-Homogenous and heterogeneous nucleation- critical radius of Nucleation-Full annealing, stress relief, spheroidising –normalizing, hardening and tempering of steel. TTT diagram – continuous cooling Transformation (CCT) diagram – Austempering, Martempering – Hardenability, Jominy end quench test –recrystallisation.

Case hardening, carburizing, Nitriding, cyaniding, carbonitriding – Flame and Induction hardening – Vacuum and Plasma hardening – Thermo-mechanical treatments

UNIT III FERROUS AND NON-FERROUS ALLOYS 9

Effect of alloying additions on steel (Mn, Si, Cr, Mo, V Ti & W) – stainless and tool steels – HSLA - Maraging steels-TRIP steel, PH steels – Grey, white, malleable, spheroidal – alloy cast irons, Copper and its alloys – Brass, Bronze and Cupronickel – Aluminium and its alloys; Al-Cu – precipitation strengthening treatment – Titanium
alloys, Mg-alloys, Ni-based super alloys – shape memory alloys- Properties and Applications

UNIT IV POWDER METALLRGY 9

PM process- Powder preparation, powder characterization, powder compaction, sintering-stages of sintering-mechanism of sintering, different sintering techniques- case studies on cemented carbide and cermet tool making.

UNIT V MECHANICAL BEHAVIOUR OF MATERIALS 9

Mechanisms of plastic deformation, slip and twinning – Types of fracture – fracture mechanics- Griffith's theory- Testing of materials under tension, compression, and shear loads – Hardness tests (Brinell, Vickers and Rockwell), Micro and nano- hardness tests, Impact test- Izod and charpy, fatigue and creep failure mechanisms, fatigue-creep interaction-case studies on different failures.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

CO1 Construct the iron-iron carbide phase diagram and estimate the phases present in the micro-structure.

CO2 Design a suitable heat treatment process for ferrous alloys based on the requirements.

CO3 Suggest suitable ferrous and non-ferrous alloys for specific engineering applications

CO4 Use the PM techniques to produce Engineering components
CO5 Describe testing procedures and failure mechanisms

TEXT BOOK

1. Williams D Callister, “Material Science and Engineering” Wiley India Pvt Ltd, Revised Indian edition 2007.
2. Sydney H.Avner, “Introduction to Physical Metallurgy”, McGraw Hill Book Company, 1994

REFERENCE BOOKS:

1. G.S. Upadhyay and Anish Upadhyay, “Materials Science and Engineering”, Viva Books Pvt.Ltd, New Delhi, 2006.
2. Raghavan.V, “Materials Science and Engineering”, Prentice Hall of India Pvt.Ltd. 1999.
3. Kenneth G.Budinski and Michael K. Budinski, “Engineering Materials”, Prentice Hall of India Private Limited, 4th Indian Reprint 2002.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	2	2	-	1	-	-	-	-	-	1	2	1	2
2	3	2	3	2	-	-	2	-	-	-	-	2	2	1	2
3	3	-	2		-	1	-	-	-	-	-	2	2	1	2
4	3	-	2	2	-	1	-	-	-	-	-	3	2	1	2
5	3	3	2	1	-	-	-	-	-	-	-	2	2	1	2
AVG	3	2.7	2.2	1.8		1	2	-	-	-	-	2	2	1	2

CE23C01 **MECHANICS OF MATERIALS** **L T P C**
3 0 2 4

COURSE OBJECTIVES:

1. To develop the understanding of the principle concepts of stress, strain and deformation of solids for various engineering applications.
2. To analyse the flexural and shear stresses induced in beams due to different loading conditions
3. To analyse the effect of torsion on shafts and springs.
4. To understand and analyse the deflection of beams for different support and loading conditions
5. To examine the stresses induced in thin and thick shells.

UNIT I STRESS, STRAIN AND DEFORMATION OF SOLIDS 9

Rigid bodies and deformable solids –Stresses and strains: Tension, Compression and Shear - Elastic constants – Relationships – Compound bars – Thermal stresses –Volumetric strains – Stress on inclined planes – Principal stresses and principal planes – Mohr’s circle of stress.

PRACTICALS

1. Tension test on mild steel rod

UNIT II TRANSVERSE LOADING ON BEAMS AND STRESSES IN BEAM 9

Beams – Types - Transverse loading on beams – Shear force and bending moment in beams – Cantilevers – Simply supported beams and over hanging beams - Theory of simple bending – Bending stress distribution - Load carrying capacity - Proportioning of sections –Flitched beams –Carriage springs – Shear stress distribution- Shear Centre.

PRACTICALS

1. Deflection test on carriage spring

UNIT III TORSION 9

Theory of Pure Torsion- Stresses and deformation in circular and hollows shafts – Transmission of power through hollow & solid shafts – Stepped shafts –Shafts fixed at the both ends – Stresses in helical springs – Deflection of helical springs.

PRACTICALS

1. Torsion test on mild steel rod

UNIT IV DEFLECTION OF BEAMS 9

Double Integration method – Macaulay’s method – Area moment method - Conjugate beam method - Strain energy method - computation of slopes and deflections in beams- Maxwell’s reciprocal theorem.

PRACTICALS

Compression test on helical spring

UNIT V THIN &THICK SHELLS, THEORIES OF FAILURE 9

Stresses and deformations in thin cylindrical shells and spherical shells subjected to internal pressure – Stresses in thick cylinders – Lame's theory – Application of theories of failure- Euler's buckling theory.

PRACTICALS

Hardness test on metal beam
(Rockwell and Brinell hardness test)

TOTAL: 45L+30P =75 PERIODS

COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

CO1	Have thorough understanding of the fundamental concepts of stress and strains and understand the mechanical behaviour of materials such as tension, compression and hardness.
CO2	Understand the bending and shear stress distribution in beams.
CO3	Have sufficient knowledge on designing shafts to transmit power and understand the behaviour of helical springs
CO4	Have the ability to determine the deflection of beams and carriage springs
CO5	Have the knowledge of behaviour of cylindrical and spherical shells.

TEXT BOOKS:

1. Bansal, R.K., Strength of Materials, Laxmi Publications (P) Ltd., 2018
2. Rajput, R.K., Strength of Materials, S Chand And Company Ltd., New Delhi, 2018

REFERENCES:

1.) Strength of Materials Laboratory Manual, Anna University, Chennai - 600025.
2.) IS 432 (art I) -1992, Specification for mild steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement.
3.) Egor. P.Popov"Engineering Mechanics of Solids" Prentice Hall of India, New Delhi, 2015.
4.) Ferdinand P. Beer, Russell Johnson, Jr. and John J. Dewole Mechanics of Materials, 7 th Edition, Tata McGraw Hill publishing 'co. Ltd., New Delhi, 2014.
5.) Hibbeler, R.C., Mechanics of Materials, Pearson Education, 10th Edition, 2022.
6.) Subramanian R., Strength of Materials, Oxford University Press, Oxford Higher Education Series, 2007

CO-PO-PSO MAPPING: MECHANICS OF MATERIALS

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	3	2	3	2	2	2	3	3	1	1	2	3	3	2
2	3	3	3	3	2	3	2	3	1	1	1	2	3	2	2
3	3	3	3	3	2	3	2	3	3	1	1	2	3	3	2
4	3	3	3	3	2	2	2	2	3	1	1	2	3	2	2
5	3	3	3	3	2	3	2	3	1	1	1	2	3	3	2
Avg.	**3**	**3**	**3**	**3**	**2**	**3**	**2**	**3**	**3**	**1**	**1**	**2**	**3**	**3**	**2**

ME23401	METAL CUTTING AND MACHINE TOOLS	L	T	P	C
		3	0	2	4

COURSE OBJECTIVE:

To Impart Knowledge on science of metal cutting through the application of mechanics of machining, material properties, and other relevant engineering knowledge.

UNIT I THEORY OF METAL CUTTING 15

Need for metal cutting, Classification of metal cutting processes, Mechanics of orthogonal and oblique cutting, forces in machining, Shear stress and shear strain in metal cutting, Types of chip, Nomenclature of single point cutting tool, Material factors – work piece materials and cutting tool materials, Tribological aspects in metal cutting - friction at the tool-chip interface, cutting fluids, thermal aspects - cutting temperatures, their measurement and heat transfer models, effect of process parameters, tool wear and mechanisms, tool life, surface integrity - surface roughness, machining induced microstructural changes, Machinability

PRACTICALS

1. Study the effect of workpiece material property on machinability
2. Analysis of chip morphology in machining
3. Measurement of tool wear in machining
4. Measurement of machining temperature using thermocouple and IR thermography

UNIT II TURNING MACHINES 15

Centre lathe, constructional features, specification, Specification of cutting tool inserts and tool holders as per ISO standard, operations – taper turning methods, thread cutting methods, special attachments, machining time and power estimation. Capstan and turret lathes - tool layout – automatic lathes: semi-automatic – single spindle: Swiss type, automatic screw type – multi spindle.

PRACTICALS

1. Perform basic lathe operations – Plain turning, taper turning, thread cutting.
2. Economics of machining – effect of process parameters on machining time
3. Estimation of machining power in turning using power quality analyser
4. Measurement of cutting forces in Turning using dynamometer

UNIT III ROTATING CUTTING TOOLS, GEAR CUTTING AND BROACHING 15

Drilling - geometry of helical drills, special modifications to improve drill performance, Allied operations - reaming, boring, tapping, Milling - Classification - Horizontal vs Vertical and Conventional vs Climb milling - types of milling cutters - Surface finish in milling – machining time calculations - Gear cutting, gear hobbing and gear shaping – gear finishing methods; broaching machines: broach construction – push, pull, surface broaching.

PRACTICALS

1. Drilling and reaming of a hole using a vertical milling machine
2. Contour milling by using a vertical milling machine
3. Cutting of spur gear using a milling machine
4. Gear generation by using a gear hobber and gear shaper
5. Broaching of components using a broaching machine

UNIT IV ABRASIVE PROCESSES 15

Grinding - Mechanics of grinding and specific energy in grinding, grinding wheel – specifications and selection, types of grinding process – cylindrical grinding, surface grinding, centreless grinding, internal grinding; Surface integrity in grinding - Traditional micro-/nano-finishing methods - Honing, Lapping, Superfinishing - Typical applications, Hybrid mass finishing of AM parts.

PRACTICALS

1. Grinding components using cylindrical, surface, and centerless grinding machine
2. Microfinishing using abrasive machining processes

UNIT V COMPUTER NUMERICAL CONTROL MACHINE TOOLS 9

Computer Numerical Control (CNC) machine tools – Need, types, constructional details, special features - ball screws, ATC, sensors, machining centre, part programming fundamentals – G-codes and M-codes, manual part programming and computer assisted part programming.

PRACTICALS

1. Manual part programming using CNC Machining Center
2. Manual part programming using CNC Turning Center

TOTAL : 45 PERIODS

COURSE OUTCOMES:

CO1 Analyze the variables governing metal cutting process and the mechanics behind metal cutting.

CO2 Determine the machining parameters of turning process and select appropriate automates.

CO3 Explain the need for milling & hole making processes and various gear cutting methods.

CO4 Analyze the process parameters and the physics of grinding, and explain the commonly used abrasive finishing processes

CO5 Develop CNC part programs for machining and turning centers.

TEXT BOOKS:

1. Kalpakjian. S, “Manufacturing Engineering and Technology”, Pearson Education India Edition, 2009.
2. Roy. A. Lindberg, Processes and materials of manufacture, PHI / Pearson education, 2006.

REFERENCES:

1. Geofrey Boothroyd, “Fundamentals of Metal Machining and Machine Tools”, McGraw Hill, 1984.
2. HMT – “Production Technology”, Tata McGraw Hill, 1998.
3. Richerd R Kibbe, John E. Neely, Roland O.Merges and Warren J.White “Machine Tool Practices”, Prentice Hall of India, 1998.
4. Rao. P.N “Manufacturing Technology,” Metal Cutting and Machine Tools, Tata McGraw-Hill, New Delhi, 2003.
5. Stephen Malkin, Grinding Technology: Theory and Applications of Machining with Abrasives, Industrial Press, 2nd Edition, 2008
6. Michael Fitzpatrick, Machining and CNC Technology, McGraw-Hill Education; 3rd edition, 2013.

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	2	3	3	2	2	2	-	-	-	2	3	3	1
2	3	3	2	3	-	-	-	-	-	-	-	-	3	2	-
3	3	3	2	3	-	-	-	-	-	-	-	-	3	1	-
4	3	3	2	3	2	-	-	-	-	-	-	-	3	3	-
5	3	3	3	3	3	-	-	-	-	-	-	2	3	3	1
Avg	3	3	2.2	3	2.7	2	2	2	-	-	-	2	3	2.4	1

ME23402	THERMAL ENGINEERING - I	L T P C
		3 0 2 4

COURSE OBJECTIVES:

The main learning objective of this course is to prepare the students for:

1. Applying the concepts and laws of thermodynamics to predict the operation of thermodynamic cycles.
2. Understanding working of steam power cycle and analyzing its performance improvements.
3. Understanding the working of IC engines and determining its performance
4. Understanding the IC engine auxiliary systems
5. Understanding the theory of air craft propulsion and its operating cycle

UNIT I THERMODYNAMIC CYCLES 9

Air Standard Cycles – Carnot, Otto, Diesel, Dual – Cycle Analysis, Comparison of Otto, Diesel and Dual Cycle, Atkinson, Stirling, Ericsson, Lenoir cycles.

UNIT II VAPOUR POWER CYCLE 9

Carnot Cycle, Basic Rankine Cycle, Comparison, Rankine cycle Improvements- Reheat, Regenerative Cycle, Kalina Cycle, Concept of Cogeneration, Combined cycle power generation

UNIT III INTERNAL COMBUSTION ENGINES 9

IC engine – Classification, working, components and their functions. Ideal and actual : Valve and port timing diagrams, P-V diagrams- two stroke & four stroke, and SI & CI engines – comparison. Comparison of SI and CI engines. Combustion in SI & CI Engines – Abnormal combustion- Knocking and detonation. Measurement of Performance parameters, Performance calculations. Morse and Heat Balance tests

PRACTICALS

1. Valve timing diagram and Port timing diagram
2. Determination of p-θ diagram
3. Performance test on Petrol & Diesel engine
4. Determination of frictional power for multi-cylinder petrol engine
5. Heat balance test on Diesel Engine

UNIT IV INTERNAL COMBUSTION ENGINES AUXILIARY SYSTEM 9

Simple Carburettor, Fuel Injector, Multipoint Fuel Injection (MPFI), Gasoline Direct Injection (GDI) and Common Rail Direct Injection (CRDI) systems, Electronic fuel Injection. Ignition system, Lubrication and Cooling systems. Concepts of Supercharging and Turbocharging,

UNIT V GAS TURBINES AND JET PROPULSION 9

Gas turbine cycle analysis – open and closed cycle. Performance and its improvement - Regenerative, Intercooled, Reheated cycles and their combination, Principle of Jet Propulsion, ICengine driven Propulsion, Gas turbine Propulsion, Turbojet, Turboprop, Turbofan engines, Analysis of Turbojet cycle.

TOTAL = 45 L+ 30 P = 75 PERIODS

COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

1. Choose an appropriate gas power cycle and operate with optimum efficiency
2. Evaluate performance of different vapour power cycles
3. Test, measure, and analyse IC engine performance
4. Identify and utilize the different auxiliaries of IC engines
5. Compare and analyse the various aircraft engines based on their performance parameters

TEXT BOOKS:

1. Mahesh. M. Rathore, "Thermal Engineering", 1st Edition, Tata McGraw Hill, 2010.
2. Ganesan.V , " Internal Combustion Engines" 4th Edition, Tata McGraw Hill, 2012.

REFERENCES:

1. Ballaney. P, "Thermal Engineering", 25th Edition, Khanna Publishers, 2017.
2. Domkundwar, Kothandaraman, & Domkundwar, " A Course in Thermal Engineering", 6th Edition, Dhanpat Rai& Sons, 2011.
3. Gupta H.N, "Fundamentals of Internal Combustion Engines", 2nd Edition Prentice Hall of India, 2013.
4. Mathur M.L and Mehta F.S., "Thermal Science and Engineering", 3rd Edition, Jain Brothers Pvt. Ltd, 2017.
5. Soman. K, "Thermal Engineering", 2nd Edition, Prentice Hall of India, 2011.

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

CE23C02 **FLUID MECHANICS AND MACHINERY** **L T P C**

3 0 2 4

UNIT I FLUID PROPERTIES AND FLOW CHARACTERISTICS 10

Definitions of fluid - Properties of fluids –Fluid pressure and its measurements – Forces on plane and curved surfaces - Buoyancy and floatation - Flow characteristics - Eulerian and Lagrangian Principle of fluid flow– concept of control volume and system – Continuity equation, energy equation and momentum equation - Applications.

PRACTICALS

Calibration of Venturimeter

UNIT II FLOW THROUGH PIPES AND BOUNDARY LAYER 9

Reynold's Experiment- Laminar flow through circular conduits- Hagen Poiseuille equation -Darcy Weisbach equation – friction factor- Moody diagram- minor losses- Hydraulic gradient and total energy gradient – Pipes in series and parallel - Boundary layer concepts – types of boundary layer thickness.

PRACTICALS

1. Determination of friction factor for flow through pipes

UNIT III DIMENSIONAL ANALYSIS AND MODEL STUDIES 7

Fundamental dimensions - Dimensional homogeneity - Rayleigh's method and Buckingham Pi theorem - Dimensionless parameters - Similitude and model studies - Distorted and undistorted models.

UNIT IV TURBINES 10

Impact of jets - Velocity triangles - Theory of rotodynamic machines - Classification of turbines – Pelton wheel, Francis turbine and Kaplan turbine- Working principles - Work done by water on the runner - Efficiencies – Draft tube - Specific speed - Performance curves for turbines

PRACTICALS

1. Characteristics of Pelton wheel turbine

UNIT V PUMPS 9

Classification of pumps- Centrifugal pumps – Working principle - Heads and efficiencies– Work done by the impeller - NPSH – Minimum speed to start the pump - Pumps connected in series and parallel - Performance curves - Reciprocating pump working principle – Indicator diagram and its variations – Air vessels - Work saved by air vessels.

PRACTICALS

1. Characteristics of centrifugal pumps
2. Characteristics of reciprocating pump

TOTAL: 45 L + 30 P = 75 PERIODS

COURSE OUTCOMES:

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

CO1 Understand the difference between solid and fluid, its properties and behaviour in static conditions along with the conservation laws applicable to fluid flow and its application through fluid kinematics and dynamics. Verify and apply Bernoulli's equation for flow measurement like Orifice/ Venturimeter.

CO2 Estimate losses in pipelines for both laminar and turbulent conditions and analysis of pipes connected in series and parallel and to understand the concept of boundary layer theory. Measure friction factor in pipes and compare with Moody diagram.

CO3 Formulate the relationship among the parameters involved in the given fluid phenomenon and to predict the performances of prototype by model studies.

CO4 Design of Pelton wheel, Francis and Kaplan turbines and explain the working Principles of each turbine with draft tube theory for reaction turbines. Determine the performance characteristics of Pelton wheels.

CO5 Differentiate pumps and explain the working principle with characteristic curves and design of centrifugal and reciprocating pumps. Determine the performance characteristics of centrifugal and reciprocating pump.

TEXT BOOKS:

1. Modi P.N. and Seth S.M., Hydraulics and Fluid Mechanics including Hydraulics Machines, 22nd Ed., Standard Book House. New Delhi, 2019.
2. Jain A. K. Fluid Mechanics including Hydraulic Machines, Khanna Publishers, New Delhi, 2014.

REFERENCES:

1. Kumar K.L, Engineering Fluid Mechanics, (8th Ed.) S. Chand Publishing (India) Pvt. Ltd., New Delhi, 2016.
2. Som S.K. Gautam Biswas and Chakraborty S, Introduction to Fluid Mechanics and Fluid Machines, Tata McGraw Hill Education Pvt. Ltd., 2017.
3. Subramanya, K. Fluid Mechanics and Hydraulic Machines,2nd Ed., Tata McGraw- Hill Pub. Co., New Delhi, 2018.
4. Yunus A. Cengel ; John M. Cimbala, Fluid Mechanics,4th Ed., McGraw Hill Education Pvt. Ltd.,2019.
5. Streeter, V. L. and Wylie E. B., Fluid Mechanics, McGraw Hill Publishing Co.,1998.
6. Hydraulic Laboratory Manual, Centre for Water Resources, Anna University, 2023.

MAPPING OF CO'S WITH PO'S

PO/PSO		Course Outcome					Overall Correlation of COs to POs
		CO 1	CO2	CO3	CO4	CO5	
PO1	Knowledge of Engineering Sciences	3	3	3	3	3	3
PO2	Problem analysis	2	3	3	3	3	3

PO3	Design / development of solutions	1	3	3	3	3	3
PO4	Investigation	1	1	2	2	2	2
PO5	Modern Tool Usage	1	1	1	1	1	1
PO6	Individual and Team work	1	1	1	1	1	1
PO7	Communication	1	1	1	1	1	1
PO8	Engineer and Society	2	2	2	3	3	2
PO9	Ethics	1	1	1	1	1	1
PO10	Environment and Sustainability	1	1	1	1	1	1
PO11	Project Management and Finance	1	1	1	1	1	1
PO12	Life Long Learning	2	2	2	3	3	2
PSO1	Knowledge of Civil Engineering discipline	3	3	3	3	3	3
PSO2	Critical analysis of Civil Engineering problems and innovation	2	3	3	3	3	3
PSO3	Conceptualization and evaluation of engineering solutions to Civil Engineering Issues	2	3	2	3	3	3

ME23C15 **DESIGN OF MACHINE ELEMENTS** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

The main learning objective of this course is to prepare the students for familiarizing the various steps involved in the design process using standard practices and standard data, evaluating the design parameters of a component to satisfy functional and strength requirements.

UNIT I FUNDAMENTAL CONCEPTS IN DESIGN 9

Introduction to the design process - factors influencing machine design, selection of materials based on mechanical properties - Preferred numbers- Direct, Bending, and torsional loading- Modes of failure - Factor of safety – Combined loads – Principal stresses curved beams – crane hook and 'C' frame- theories of failure – Design based on strength and stiffness – stress concentration – Fluctuating stresses – Endurance limit –Design for finite and infinite life under variable loading - Exposure to standards.

UNIT II DESIGN OF SHAFTS AND COUPLINGS 9

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

UNIT III DESIGN OF JOINTSAND POWER SCREWS 9

Threaded fasteners - Bolted joints – Simple and eccentrically loaded bolted joints- Welded joints – Butt, Fillet and parallel transverse fillet welds – welded joints subjected to bending, torsional
Terminology of Power Screw- Torque Requirement- Self-Locking screw- Efficiency of Screws- Collar Friction Torque.

UNIT IV DESIGN OF SPRINGSAND PIPE JOINTS 9

Types of springs, design of helical and concentric springs–Surge in springs, Design of laminated springs Introduction to pipe joints and fittings- soldered fittings-screwed connections - pipe connections- oval type flanged pipe joint

UNIT V DESIGN OF BEARINGS 9

Sliding contact and rolling contact bearings - Hydrodynamic journal bearings, Sommerfeld Number, Raimondi & Boyd graphs - Selection of Rolling Contact bearings
- Seals and Gaskets.

TOTAL : 45 PERIODS

Note: Use of approved design data book is permitted.

COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

CO1 Design machine members subjected to static and variable loads.
CO2 Design shafts and couplings for various applications.
CO3 Design bolted, welded joints and power screws for various kinds of loads.
CO4 Design helical, leaf springs, and pipe joints for various applications.
CO5 Design sliding and rolling contact bearings

TEXT BOOKS:

1. Bhandari V B, "Design of Machine Elements", 4th Edition, Tata McGraw-Hill Book Co, 2016
2. Joseph Shigley, Richard G. Budynas and J. Keith Nisbett "Mechanical Engineering Design" 10th Edition, Tata McGraw-Hill, 2015.

REFERENCES:

1. Ansel C Ugural, "Mechanical Design – An Integral Approach", 1st Edition, Tata McGraw-Hill Book Co, 2004.
2. Design Data Hand Book", PSG College of Technology, Coimbatore, 2013.
3. Merhyle Franklin Spotts, Terry E. Shoup, and Lee EmreyHornberger, "Design of Machine Elements" 8th Edition, Printice Hall, 2004.
4. Robert C. Juvinall and Kurt M. Marshek, "Fundamentals of Machine Component Design",6th Edition, Wiley, 2017.
5. Sundararajamoorthy T. V. and Shanmugam. N, "Machine Design", Anuradha Publications, Chennai, 2003.

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

ME23403	FLUID POWER AUTOMATION	L	T	P	C
		3	0	2	4

COURSE OBJECTIVES:

1. To make students conversant with the fluid power principles, and different types of hydraulic pumps.
2. To impart knowledge about the various types of hydraulic actuators and control components.
3. To inculcate the skills to design and develop hydraulic circuits and systems.
4. To familiarize the students with the design of pneumatic circuits.
5. To provide the knowledge of trouble shooting methods in fluid power systems.

UNIT – I FLUID POWER PRINICIPLES AND HYDRAULIC PUMPS 9

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

PRACTICALS

1. Study and simulation of basic structure of Fluid power systems and its components.
2. Selection of hydraulic pumps and motors and simulation using Automation software.

UNIT – II HYDRAULIC ACTUATORS AND CONTROL COMPONENTS 9

Hydraulic Actuators: Cylinders – Types and construction, Application, Hydraulic cushioning – Rotary Actuators – Hydraulic motors - Control components: Direction Control, Flow control and pressure control valves – Types, Construction and Operation – Accessories: Accumulators, Pressure Intensifiers, Reservoirs, Pressure Switches – Filters –types and selection- Applications – Fluid Power ANSI Symbols – Problems.

PRACTICALS

1. Simulation of single and double actuators with different direction control actuating systems

UNIT – III HYDRAULIC CIRCUITS AND SYSTEMS 9

Industrial hydraulic circuits – Regenerative, Pump Unloading, Double Pump, Air-over oil, Sequence, Reciprocation, Synchronization, Fail-Safe, Speed Control, Deceleration circuits, Sizing of hydraulic systems, Hydrostatic transmission, Electro hydraulic circuits – Servo and Proportional valves – Applications – Mechanical, hydraulic servo systems, Case Studies.

PRACTICALS

1. Study and Simulation of regenerative, synchronization and metering circuits.
2. Design and simulation of hydraulic sequencing circuits using hydraulic sequencing valve.
3. Design and simulation of hydraulic counter balance and unloading circuits.

UNIT – IV PNEUMATIC AND ELECTRO PNEUMATIC SYSTEMS 9

Properties of air – Air preparation and distribution – Filters, Regulator, Lubricator, Muffler, Air control Valves, Quick Exhaust Valves, Pneumatic actuators, Design of Pneumatic circuit – classification single cylinder and multi cylinder circuits – Cascade method – Integration of fringe circuits, Electro Pneumatic System – Elements – Relay ladder diagram – timer circuits – Problems, PLC – Logic ladder diagram – Controlling Fluid power actuators, Case Studies.

PRACTICALS

1. Design and simulation of pneumatic single and double acting cylinder circuits.
2. Design and simulation of electropneumatic single and double acting cylinder circuits
3. Development of ladder diagram for fluid power problems and simulation with PLC hardware and Automation software

UNIT – V TROUBLE SHOOTING AND APPLICATIONS 9

Installation, Selection, Maintenance, Trouble Shooting and Remedies in Hydraulic and Pneumatic systems, Conditioning of hydraulic fluids Design of hydraulic circuits for Drilling, Planning, Shaping, Surface grinding, Press and Forklift applications. Design of Pneumatic circuits for metal working, handling, clamping counter and timer circuits – Low cost Automation – Hydraulic and Pneumatic power packs, Case Studies.

PRACTICALS

1. Design and study of hydraulic circuits of Drilling, Planning, Shaping, Surface grinding machines and Presses using Automation software
2. Design and simulation of cascade method of sequencial circuits using Automation studio software

TOTAL:45 L +30 P = 75 PERIODS

COURSE OUTCOMES:

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

1. Apply the principles of fluid power systems, and select relevant hydraulic pumps for the fluid power applications.
2. Select necessary control components and hydraulic actuators for the fluid power applications.
3. Design and develop hydraulic circuits and systems.
4. Design and develop pneumatic circuits and systems.
5. Solve problems and troubles in fluid power systems.

TEXT BOOKS:

1. Anthony Esposito, “Fluid Power with Applications”, Prentice Hall, 2009
2. James A. Sullivan, “Fluid Power Theory and Applications”, Prentice Hall, 1997

REFERENCES:

1. Shanmugasundaram.K., “Hydraulic and Pneumatic Controls”. Chand & Co, 2006.
2. Jagadeesha. T., “Pneumatics Concepts, Design and Applications “, Universities Press, 2015.
3. Joshi.P., Pneumatic Control”, Wiley India, 2008.
4. Srinivasan.R., “Hydraulic and Pneumatic Controls”, Vijay Nicole Imprints, 2008.
5. Majumdar, S.R., “Oil Hydraulics Systems – Principles and Maintenance”, Tata McGraw Hill, 2001.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	1	1	1	-	-	-	-	-	-	-	1	3	1	3
2	3	1	1	1	-	-	-	-	-	-	-	1	3	1	3
3	3	3	3	3	-	-	-	-	-	-	-	1	3	1	3
4	3	3	3	3	-	-	-	-	-	-	-	1	3	1	3

ME23404 **PRODUCT DESIGN AND DEVELOPMENT**

L	T	P	C
2	0	2	3

COURSE OBJECTIVES:

1. To understand and apply the principles of generic development process; and understanding the organization structure for new product development.
2. To understand and conduct customer need analysis; and to design and set product specification for new product development.
3. To generate, select, and test the concepts for new product development
4. To understand and apply principles of product architecture and industrial design for new product development.
5. To understand and apply the principles in design for manufacturing and prototyping for new product development.

UNIT I INTRODUCTION TO PRODUCT DEVELOPMENT 9

Introduction – Characteristics of Successful Product Development – Product Development Team – Challenges of Product Development – Duration and Cost of Product Development – Product Development Process – Concept Development: The Front-End Process – Adapting the Generic Product Development Process – Product Development Process Flows – Product Development Organizations

UNIT II CUSTOMER NEEDS IDENTIFICATION & PRODUCT SPECIFICATION 9

Identifying Customer Needs – Importance of Latent Needs – Process of Identifying Customer Needs – Definition of Specifications – Time to Establish Specification – Establishing Target Specifications – Setting the Final Specifications.

UNIT III PRODUCT CONCEPT GENERATION, SELECTION & TESTING 9

Activity of Concept Generation – Concept Selection – Concept Screening – Concept Scoring – Caveats – Concept Testing.

UNIT IV PRODUCT ARCHITECTURE & INDUSTRIAL DESIGN 9

Product Architecture – Definition – Implications – Establishing the Architecture – Delayed Differentiation – Platform Planning – Related System-Level Design Issues – Industrial Design – Assessing the Need for Industrial Design – Impact of Industrial Design – Industrial Design Process – Management of the Industrial Design Process – Assessing the Quality of Industrial Design.

UNIT V DESIGN FOR MANUFACTURING & PROTOTYPING 9

Design for Manufacturing – DFM Process: Estimate the Manufacturing Costs – Reduce the Costs of Components – Reduce the Costs of Assembly – Reduce the Costs of Supporting Production – Consider the Impact of DFM Decisions on Other Factors – Prototyping – Principles of Prototyping – Prototyping Technologies – Planning for Prototypes.

TOTAL: 45 PERIODS

LABORATORY

The main objective of this laboratory is to understand and apply the principles and concepts in Product Design and Development for Innovative Product with hands on training.

Each student group (not more than three) have to develop digital and physical prototype models of a new product / existing product with enhanced feature involving the following areas:

- Automotive / Aerospace / Medical / Industrial components.

- Machining / Forming / Casting tool, fixtures, and supplementary components.
- Consumer products

The fabricated models may be in the form of RP models, clay models, sheet metal models or cardboard models etc. The design and development of the product will be reviewed in two stages for awarding internal marks. The end semester examination mark will be based on the project report (Introduction; Literature survey; Methodology; Simulation; Experimentation; Analysis and Discussion; and Conclusion) and their demonstration followed by oral examination of their new product by internal examiner.

TOTAL : 60 PERIODS

COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

CO1 Apply the principles of generic development process; and understanding the organization structure for new product development.

CO2 Conduct customer need analysis; and to design and set product specification for new product development.

CO3 Generate, select, and test the concepts for new product development

CO4 Apply principles of product architecture and industrial design for new product development.

CO5 Apply the principles in design for manufacturing and prototyping for new product development.

TEXT BOOKS:

1. Ulrich K.T., Eppinger S. D. and Anita Goyal, “Product Design and Development “McGraw-Hill Education; 7 edition, 2020.

REFERNCE BOOKS:

1. Belz A., 36-Hour Course: “Product Development” McGraw-Hill, 2010.
2. Rosenthal S.,“Effective Product Design and Development”, Business One Orwin,Homewood,1992,ISBN1-55623-603-4.
3. Pugh.S,“Total Design Integrated Methods for Successful Product Engineering”, Addison Wesley Publishing,1991,ISBN0-202-41639-5.
4. Chitale, A. K. and Gupta, R. C., Product Design and Manufacturing, PHI Learning, 2013.
5. Jamnia, A., Introduction to Product Design and Development for Engineers, CRC Press, 2018.

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

UC23U01 **UNIVERSAL HUMAN VALUES** **L T P C**
1 0 2 2

COURSE OBJECTIVE:

The objective of the course is four-fold:

1. Development of a holistic perspective based on self-exploration about themselves (human being), family, society and nature/existence.
2. Understanding (or developing clarity) of the harmony in the human being, family, society and nature/existence
3. Strengthening of self-reflection.
4. Development of commitment and courage to act.

MODULE I: INTRODUCTION **(3L,6P)**

Purpose and motivation for the course, recapitulation from Universal Human Values-I, Self-Exploration– Its content and process; 'Natural acceptance' and Experiential Validation- as the process for self-exploration Continuous Happiness and Prosperity- A look at basic Human Aspirations Right understanding, Relationship and Physical Facility- the basic requirements for fulfilment of aspirations of every human being with their correct priority Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario, Method to fulfil the above human aspirations: understanding and living in harmony at various levels.

Practical Session: *Include sessions to discuss natural acceptance in human being as the innate acceptance for living with responsibility (living in relationship, harmony and co-existence) rather than as arbitrariness in choice based on liking-disliking*

MODULE II: HARMONY IN THE HUMAN BEING **(3L,6P)**

Understanding human being as a co-existence of the sentient 'I' and the material 'Body', Understanding the needs of Self ('I') and 'Body' - happiness and physical facility, Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer), Understanding the characteristics and activities of 'I' and harmony in 'I', Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail, Programs to ensure Sanyam and Health.

Practical Session: *Include sessions to discuss the role others have played in making material goods available to me. Identifying from one's own life. Differentiate between prosperity and accumulation. Discuss program for ensuring health vs dealing with disease.*

MODULE III: HARMONY IN THE FAMILY AND SOCIETY **(3L,6P)**

Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfilment to ensure mutual happiness; Trust and Respect as the foundational values of relationship, Understanding the meaning of Trust; Difference between intention and competence, Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship, Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals, Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family.

Practical Session*: Include sessions to reflect on relationships in family, hostel and institute as extended family, real life examples, teacher-student relationship, goal of education etc. Gratitude* *as a universal value in relationships. Discuss with scenarios. Elicit examples from students' lives*

MODULE IV: HARMONY IN THE NATURE AND EXISTENCE (3L,6P)

Understanding the harmony in the Nature, Interconnectedness and mutual fulfilment among the four orders of nature- recyclability and self regulation in nature, Understanding Existence as Co-existence of mutually interacting units in all- pervasive space, Holistic perception of harmony at all levels of existence.

Practical Session: *Include sessions to discuss human being as cause of imbalance in nature (film "Home" can be used), pollution, depletion of resources and role of technology etc.*

MODULE V: IMPLICATIONS OF HARMONY ON PROFESSIONAL ETHICS (3L,6P)

Natural acceptance of human values, Definitiveness of Ethical Human Conduct, Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order, Competence in professional ethics: a. Ability to utilize the professional competence for augmenting universal human order b. Ability to identify the scope and characteristics of people friendly and eco-friendly production systems, c. Ability to identify and develop appropriate technologies and management patterns for above production systems. Case studies of typical holistic technologies, management models and production systems, Strategy for transition from the present state to Universal Human Order: a. At the level of individual: as socially and ecologically responsible engineers, technologists and managers b. At the level of society: as mutually enriching institutions and organizations, Sum up.

Practical Session: *Include Exercises and Case Studies will be taken up in Sessions E.g. To discuss the conduct as an engineer or scientist etc.*

TOTAL: 45 (15 Lectures + 30 Practicals) PERIODS

COURSE OUTCOME:

By the end of the course, the students will be able to:

1. Become more aware of themselves, and their surroundings (family, society, nature);
2. Have more responsible in life, and in handling problems with sustainable solutions, while keeping human relationships and human nature in mind.
3. Have better critical ability.
4. Become sensitive to their commitment towards what they have understood (human values, human relationship and human society).
5. Apply what they have learnt to their own self in different day-to-day settings in real life, at least a beginning would be made in this direction.

REFERENCES:

1. Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, 3rd revised edition, 2023.
2. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
3. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
4. The Story of Stuff (Book).

5. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi
6. Small is Beautiful - E. F Schumacher.
7. Slow is Beautiful - Cecile Andrews.
8. Economy of Permanence - J C Kumarappa
9. Bharat Mein Angreji Raj - PanditSunderlal
10. Rediscovering India - by Dharampal
11. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi
12. India Wins Freedom - Maulana Abdul Kalam Azad
13. Vivekananda - Romain Rolland (English)
14. Gandhi - Romain Rolland (English)

Web URLs:

1. Class preparations: https://fdp-si.aicte-india.org/UHV-II%20Class%20Note.php
2. Lecture presentations: https://fdp-si.aicte-india.org/UHV-II_Lectures_PPTs.php
3. Practice and Tutorial Sessions: https://fdp-si.aicte-india.org/UHV-II%20Practice%20Sessions.php

Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1						1	1	1	3			3
CO2						1	1	1	3			3
CO3						3	3	2	3		1	3
CO4						3	3	2	3		1	3
CO5						3	3	3	3		2	3

ME23405	COMPUTER AIDED MACHINE DRAWING	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES:

The main learning objective of this course is to provide hands on training to the students in:

1. Applying standard drawing practices using fits and tolerances.
2. Modeling orthogonal views of machine components.
3. Modeling orthogonal views of assembled components.
4. Preparing standard drawing layout for modeled parts or assemblies with BoM.
5. Gaining practical experience in handling 2D drafting software systems.

PART – I DRAWING STANDARDS & FITS AND TOLERANCES 4

Code of practice for Engineering Drawing, BIS specifications – Welding symbols, riveted joints, keys, fasteners – Reference to hand book for the selection of standard components like bolts, nuts, screws, keys etc. - Limits, Fits – Tolerancing of individual dimensions – Specification of Fits – Preparation of production drawings and reading of part and assembly drawings, basic principles of Geometric Dimensioning & Tolerancing.

PART– II 2D DRAFTING 56

Drawing, Editing, Dimensioning, Layering, Hatching, Block, Array, Detailing, Detailed Drawing.

1. Bearings – Bush Bearing
2. Valves – Safety and Non-return Valves.
3. Couplings – Flange, Oldham's, Muff, Gear couplings.
4. Joints – Universal, Knuckle, Gib & Cotter, Strap, Sleeve &Cotter joints.
5. Engine parts – Piston, Connecting Rod, Crosshead (vertical and horizontal), Stuffing box, Multi-plate clutch.
6. Machine Components – Screw Jack, Machine Vice, LatheTail Stock, Lathe Chuck, Plummer Block, Vane and Gear pumps.

Total: 20% of classes for theory classes and 80% of classes for practice

Note: 25% of assembly drawings must be done manually and remaining 75% of assembly drawings must be done by using any CAD software. The above tasks can be performed manually and using standard commercial 2D CAD software.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On Completion of the course, the students will be able to

CO1 Practice drawing standards using fits and tolerances.

CO2 Model orthogonal views of machine components

CO3 Model orthogonalviews of assembled components.

CO4 Prepare standard drawing layout for modeled parts or assemblies with BoM.

CO5 Create standard drawing for modeled parts or assemblies using modeling software.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3		3	-	-	1-	1	2	1	3	2	-	2
2	3	3	3		3	-	-	1	1	2	1	3	2	-	2
3	3	3	3		3	-	-	1	1	2	1	3	2	-	2
4	3	3	3		3	-	-	1	1	2	1	3	2	-	2
5	3	3	3		3	-	-	1	1	2	1	3	2	-	2

ME23501	METROLOGY AND MEASUREMENTS	L	T	P	C
		3	0	2	4

COURSE OBJECTIVE:

To impart knowledge on dimensional, form and surface finish measurement in manufacturing

UNIT I BASICS OF METROLOGY 15

Measurement – Need, Process, Role in quality control; Factors affecting measurement - SWIPE; Errors in Measurements – Types – Control – Measurement uncertainty – Types, Estimation using GUM approach and Monte Carlo method, Problems on Estimation of Uncertainty, Statistical analysis of measurement data, Measurement system analysis, Estimation of Gage R&R using Range and average method and ANOVA, Calibration of measuring instruments, ISO standards, Metrological requirements for accredited laboratories.

PRACTICALS

1. Calibration of linear measuring instruments – Vernier caliper, micrometer, Vernier height gauge using gauge blocks and reporting the calibration uncertainty
2. Perform gauge repeatability and reproducibility analysis

UNIT II MEASUREMENT OF LINEAR AND ANGULAR DIMENSIONS 15

Linear Measuring Instruments – Vernier caliper, Micrometer, Vernier height gauge, Depth Micrometer, Bore gauge, Telescoping gauge; Gauge blocks – Use and precautions, Comparators – Working and advantages; Optical measurements - measuring microscope and profile projector for dimensional measurements, Displacement measurement sensors for inline quality control - laser displacement sensor, chromatic confocal distance sensor and laser optical micrometer - Angular measuring instruments – Bevel protractor, Clinometer, Angle gauges, Precision level, Electronic level, Sine bar, Autocollimator, Angle dekkor, Alignment telescope.

PRACTICALS

1. Measurement of external and internal linear dimensions in the given component using vernier caliper, micrometer, vernier height gauge, depth micrometer, bore gauge and telescopic gauge.
2. Measurement of angles using bevel protractor and sine bar.
3. Non-contact (Optical) measurement using measuring microscope, profile projector and video measurement system
4. Measurement of dimensions using laser scan micrometer

UNIT III TOLERANCE ANALYSIS 15

Sources of Variation, Tolerancing – Interchangeability, Selective assembly, Tolerance representation, Terminology, Limits and Fits, Design of Limit gauges. Tolerance analysis in manufacturing, Process capability, tolerance stackup analysis – Worst case analysis and root sum of squares analysis, tolerance charting.

PRACTICALS

1. Use of mechanical and pneumatic comparators to check the dimensions in a component and variation from the given standard.
2. Process capability analysis of a given machining process
3. Tolerance stackup analysis in a given assembly

UNIT IV METROLOGY OF SURFACES 15

Fundamentals of GD & T - Conventional vs Geometric tolerance, Interpretation of GD&T Symbols in engineering drawings, Datums, Inspection of geometric parameters like straightness, flatness, roundness, perpendicularity, parallelism, symmetry, runout. Material conditions - concept of bonus tolerance, Simple problems. Measurement of Surface finish – Functionality of surfaces, Parameters, Surface roughness representation in engineering drawings, Comparative, Stylus based and Optical Measurement techniques, Filters – Selection of cut-off length, Introduction to 3D surface metrology-Parameters.

PRACTICALS

1. Measurement of geometric parameters – Roundness, runout, parallelism, perpendicularity, symmetry – in the given components using V-block / Bench center / Height gauge / roundness tester.
2. Measurement of surface roughness in components manufactured using various processes (turning, milling, grinding, etc.,) using stylus-based instruments.

UNIT V ADVANCES IN METROLOGY 15

Lasers in metrology - Advantages of lasers – Laser interferometers – Applications – Straightness, Alignment; Ball bar tests, Computer Aided Metrology - Basic concept of CMM – Types of CMM – Constructional features – Probes – Accessories – Software – Applications – Multi-sensor CMMs – Articulated CMMs. Machine Vision - Basic concepts of Machine Vision System – Elements – Applications - On-line and in-process monitoring in production; Digital Metrology solutions – X ray Computed tomography; White light Scanners / Structured light scanners; Metrology for e-mobility; Role of Metrology in I4.0 / Smart Manufacturing, Requirements for Metrology for I4.0.

PRACTICALS

1. Measurement of features in a prismatic component using Coordinate Measuring Machine (CMM) and offline Programming of CNC Coordinate Measuring Machines for repeated measurements of identical components
2. Surface defect inspection and reverse engineering using 3D digitalization with 3D scanner
3. Machine tool Metrology – Geometrical / Alignment tests on lathes / milling machines and measurement of straightness using autocollimator / electronic level.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1 To describe the importance of measurements in engineering and the factors affecting measurements and to estimate measurement uncertainty.

CO2 To describe the working principle and applications of various linear and angular contact and non-contact measuring instruments.

CO3 To analyse the effect of tolerance in manufacturing, interpret the various tolerance symbols given in engineering drawings to choose the appropriate manufacturing process.

CO4 To describe the principles and methods of form and surface metrology.

CO5 To describe the advances in measurements for quality control in manufacturing Industries.

TEXT BOOKS:

1. Dotson Connie, “Fundamentals of Dimensional Metrology”, Cengage Learning, Sixth edition, 2016.
2. Mark Curtis, Francis T. Farago, “Handbook of Dimensional Measurement”, Industrial Press, Fifth edition, 2013

REFERENCES:

1. Ammar Grous, J “Applied Metrology for Manufacturing Engineering”, Wiley-ISTE, 2011.
2. Galyer, J.F.W. Charles Reginald Shotbolt, “Metrology for Engineers”, Cengage Learning EMEA; 5th revised edition, 1990.
3. Raghavendra N.V. and Krishnamurthy, L., Engineering Metrology and Measurements, Oxford University Press, 2013.
4. Venkateshan, S. P. “Mechanical Measurements”, Second edition, John Wiley & Sons, 2015.
5. NPL Measurement good practice guides relevant to the syllabus – No. 40, No. 41, No. 42, No. 43, No. 80, No. 118, No. 130, No. 131.

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2		2		3	3	2	2			1	3	2	1
2	2		3	2	3				2	2			3	3	
3	2	2	2	2			2	2					3	2	
4		3		3	2								3	3	
5				3	3								3	3	
Avg	2.3	2.3	2.5	2.4	2.7	3	2.5	2	2	2	-	1	3	2.6	1

ME23502 THERMAL ENGINEERING- II

L	T	P	C
3	0	2	4

COURSE OBJECTIVES:

The main learning objective of this course is to prepare the students for:
1. Evaluating the fuel properties and performance of boiler.
2. Analyzing the performance of steam nozzle and turbine
3. Assessing the performance of an air compressor.
4. Comprehending the working principle of various refrigeration systems
5. Determining the different psychrometric properties and heat load

UNIT I FUELS AND COMBUSTION 9

Fuels - Types and Characteristics - Determination of Properties of Fuels – Basic Combustion Chemistry- determination air-fuel ratio- Calorific Value -Gross & Net Calorific Values – Flue gas Analysis- Calorimeter, Boiler Performance and Heat balance calculations.

PRACTICALS
1. Determination of flash/fire point
2. Determination of calorific value of given fuels.

UNIT II STEAM NOZZLES AND STEAM TURBINES 9

Types and Shapes of nozzles, Flow of steam through nozzles, Critical pressure ratio, Variation of mass flow rate with pressure ratio. Effect of friction. Metastable flow. Steam Turbine - Types, Impulse and reaction principles, Velocity diagrams, Work done and efficiency – optimal operating conditions. Multi-staging, compounding and governing.

PRACTICALS
1. Performance and Energy Balance test on steam generator
2. Performance and Energy Balance on Steam Turbine

UNIT III AIR COMPRESSORS 9

Classification and comparison, working principle, work of compressor - with and without clearance, Volumetric efficiency, Isothermal efficiency and Isentropic efficiency. Multistage air compressor, Intercooling and after cooling, Rotary compressors, working principle and types, comparison

PRACTICALS
1. Performance evaluation of reciprocating multi-stage compressor

UNIT IV REFRIGERATION SYSTEMS 9

Types, Bell-Coleman cycle, Air refrigeration, Vapour compression refrigeration cycle, Effect of Superheat and Sub-cooling, Refrigerant types and properties, ODP and GWP, Performance calculations, vapour absorption system, and Thermoelectric refrigeration.

PRACTICALS

1. Determination of atmospheric air properties using dry and wet bulb temperature
2. Determination of COP of a given vapour compression refrigeration system

UNIT V PSYCHROMETRY AND AIR-CONDITIONING 9

Psychrometric processes – adiabatic saturation, sensible heating and cooling, humidification, dehumidification, evaporative cooling and adiabatic mixing. Psychrometric properties – Property calculations using Psychrometric chart and expressions Air conditioning systems – summer, winter and year round, concept of RSHF, GSHF and ESHF, Cooling load calculations. Cooling towers – concept and types.

PRACTICALS

1. Determination of COP of air-conditioning system

TOTAL = 45 L+30P = 75 PERIODS

COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

1. Determine the fuel properties and analyze the performance of different boilers.
2. Design the steam nozzle and calculate performance of steam turbine.
3. Assess the performance of air compressors under different operating conditions
4. Assess the performance of refrigeration systems and estimate their COP.
5. Compute psychrometric properties and design suitable air conditioning systems.

TEXT BOOKS:

1. Mahesh. M. Rathore, "Thermal Engineering", 1st Edition, Tata McGraw Hill, 2010.
2. Ballaney. P, " Thermal Engineering", 25th Edition, Khanna Publishers, 2017

REFERENCES:

1. Ananthanarayanan P.N, " Basic Refrigeration and Air-Conditioning", 4th Edition, Tata McGraw Hill, 2013.
2. Arora, " Refrigeration and Air-Conditioning", 2nd Edition, Prentice Hall of India, 2010.
3. Mathur M.L and Mehta F.S., "Thermal Science and Engineering", 3rd Edition, Jain Brothers Pvt. Ltd, 2017.
4. Nag P.K, " Basic and Applied Thermodynamics", 2nd Edition, Tata McGraw Hill, 2010
5. Soman. K, "Thermal Engineering", 2nd Edition, Prentice Hall of India, 2011

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	2	2	2							1	2	2	1
2	3	2	2	2	2							1	2	2	1
3	3	2	2	2	2							1	2	2	1
4	3	2	2	2	2							1	2	2	1
5	3	2par	2	2	2							1	2	2	1

ME23503 PROJECT AND FINANCIAL MANAGEMENT

L	T	P	C
3	0	0	3

OBJECTIVES:

The main learning objective of this course is to prepare the students to understand, relate and apply the various project and financial management principles and tools for efficient management of engineering projects and its finance.

THEORY

UNIT I PROJECT MANAGEMENT (PM): PHILOSOPHY, CONCEPTS, SYSTEM DEVELOPMENT & PROJECT LIFECYCLE 9

Introduction to PM – What is PM? – Systems Approach to PM – Project Lifecycle and Project Conception – Project Definition & System Definition – Project Execution and Project Closeout.

UNIT II PROJECT MANAGEMENT (PM): SYSTEM AND PROCEDURE FOR PROJECT PLANNING I 9

Basic Project Planning Technique – Problems in Line Balancing – Project Schedule Planning and Networks – Advanced Project Network Analysis and Scheduling – Problems in Network Diagrams; CPM; PERT.

UNIT III PROJECT MANAGEMENT (PM): SYSTEM AND PROCEDURE FOR PROJECT PLANNING II 9

Project Cost Estimation & Budgeting – Problems in Cost Estimation – Project Quality Management – Project Risk Management – Project Procurement Management & Contracting – Project Monitoring & Control – Agile & Lean PM.

UNIT IV FINANCIAL MANAGEMENT (FM): INTRODUCTION & ACCOUNTING 9

Introduction to FM – Understanding Financial Statements – Analyzing Company Financial Data – Accounting Basics.

UNIT V FINANCIAL MANAGEMENT (FM): PROJECT COST, FORECASTING & EVALUATION 9

Project Level Cost Control – Problems – Forecasting Financial Needs – Problems – Time Value of Money and Evaluating investments – Problems.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

1. Understand the principles of design thinking and it approaches.
2. Apply empathy and its tools in ideation techniques in human-centered design problems.
3. Apply the design thinking techniques for Define and Ideation Phase of the design thinking context.
4. Build the prototype, analyze and test it in a design thinking context.
5. Apply design thinking tools toward innovative ideas.

TEXT BOOK:

1. John M. Nicholas and Herman Steyn, "Project management for Engineering, Business and Technology", 6th Ed., Routledge Pub., NY, USA, 2021.
2. Daniel W. Halpin and Bolivar A. Senior, "Financial Management & Accounting Fundamentals for Construction", John Wiley & Sons Inc., 2009.

REFERENCES:

1. Kuster J., Huber E., Lippmann R., Schmid A., Schneider E., Witschi U. and Wust R., "Project Management Handbook", Springer, UK, 2011.
2. J. Michael Bennet and Danny S. K. Ho, "Project Management for Engineers", World Scientific Pub. Co. Pvt. Ltd., Singapore, 2014.
3. Neil G. Siegel, "Engineering Project Management", Wiley & Sons Ltd., NJ, USA, 2019.
4. Peter C. Flynn, "Financial Management for Engineers", Pearson, USA, 2006.
5. F. K. Crundwel, "Finance for Engineers", Springer, UK, 2008.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1							3	3	2	2	1	3	2	1	2
2							3	3	2	2	1	3	2	1	2
3							3	3	2	2	1	3	2	1	2
4							3	3	2	2	1	3	2	1	2
5							3	3	2	2	1	3	2	1	2

ME23504	DESIGN OF TRANSMISSION SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

The main learning objective of this course is to prepare the students for designing mechanical power transmission elements.

UNIT I DESIGN OF FLEXIBLE ELEMENTS 9

Motor power capacity for various applications - Design of Flat belts and pulleys - Selection of V belts and sheaves – Selection of wire ropes and pulleys – Design of Transmission Chains and Sprocket.

UNIT II SPUR ANDHELICAL GEARS 9

Gear materials - Design of straight tooth spur & helical gears based on speed ratios, number of teeth, Fatigue strength, Factor of safety, strength, and wear considerations. Force analysis –Tooth stresses - Dynamic effects - Helical gears – Module - normal and transverse, Equivalent number of teeth – forces

.

UNIT III BEVEL AND WORM GEARS 9

Straight bevel gear: Gear materials - Tooth terminology, tooth forces, and stresses, equivalent number of teeth, estimation of dimensions of straight bevel gears. Worm Gear: Gear materials - Tooth terminology, Thermal capacity, forces and stresses, efficiency, estimation of dimensions of worm gear pair.

UNIT IV GEARBOXES 9

Need - Design of sliding and constant mesh gearboxes: Speed selection - Geometric progression - Standard step ratio - Ray diagram, kinematic layout – Determination of a number of teeth. Design of multi-speed gearbox for machine tool applications, Variable speed gearbox, Fluid Couplings, and Torque Converters for automotive applications.

UNIT V CLUTCHES AND BRAKES 9

Design of single and multi-plate clutches, cone clutches, internal expanding rim clutches, and Electromagnetic clutches. Design of brakes: External shoe brakes - Single and Double Shoe, Internal expanding shoe brakes, and Band brakes.

TOTAL : 45 PERIODS

Note: Use of approved design data book is permitted.

COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

CO1 Design flexible elements like belts, ropes, and chain drives for engineering applications.
CO2 Design spur and helical gear drives for power transmission.
CO3 Design bevel and worm drives for power transmission.
CO4 Design multi-speed gearbox for machine tools and automotive applications.
CO5 Design clutch and brake systems for engineering applications.

TEXT BOOKS:

1. Shigley. J., Mischke. C., Budynas, R., and Nisbett. K., “Mechanical Engineering Design”, 10thEdition, Tata McGraw-Hill,2014.
2. Sundararajamoorthy. T. V. and Shanmugam. N., “Machine Design”, 9th Edition, Anuradha

Publications, Chennai,2003
3. Bhandari V, “Design of Machine Elements”, 15th Reprint, Tata McGraw-Hill Book Co,2014

REFERENCES:

1. Bernard Hamrock, Steven Schmid, Bo Jacobson, “Fundamentals of Machine Elements”,2nd Edition, Tata McGraw Hill,2006
2. Sen and Bhattacharya, “Principles of Machine Tools”, New Central Book Agencies,1975.
3. C.S.Sharma, KamleshPurohit, “Design of Machine Elements”, Prentice Hall of India,Pvt. Ltd., 2003
4. Design Data Hand Book, PSG College of Technology, 2013-Coimbatore
5. GitinMaitra,L. Prasad “Handbook of Mechanical Design”, 2nd Edition, Tata McGraw- Hill,2001
6. Md. Jalaludeen , Machine Design, Volume II, Design of Transmission Systems, 4th edition, Anuradha Publications,2014
7. Prabhu. T.J., “Design of Transmission Elements”, Mani Offset, Chennai,2003
8. Robert C. Juvinall and Kurt M. Marshek, “Fundamentals of Machine component Design”,5th Edition, Wiley,2011.

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

ME23U02 PERSPECTIVES OF SUSTAINABLE DEVELOPMENT

L	T	P	C
2	0	2	3

MODULE I INTRODUCTION 6

Principles & Historical perspectives, Importance and need for sustainability in engineering and technology, impact and implications. United Nations Sustainability Development Goals (SDG), UN summit – Rio & outcome, Sustainability and development indicators.

MODULE II ENVIRONMENTAL SUSTAINABILITY 6

Climate change, Biodiversity loss, Pollution and waste management, Renewable vs. non-renewable resources, Water and energy conservation, Sustainable agriculture and forestry. National and international policies, Environmental regulations and compliance, Ecological Footprint Analysis

MODULE III SOCIAL & ECONOMIC SUSTAINABILITY 9

Equity and justice, Community development, Smart cities and sustainable infrastructure, Cultural heritage and sustainability, Ethical considerations in sustainable development.

Triple bottom line approach, Sustainable economic growth, Corporate social responsibility (CSR), Green marketing and sustainable product design, Circular economy and waste minimization, Green accounting and sustainability reporting.

MODULE IV SUSTAINABLE ENERGY TECHNOLOGIES 9

Smart and micro grid - energy storage - energy efficiency and conservation in Industrial process Electrification of Transport sector Hydrogen and Fuel cell for energy generation - Polygeneration technologies for rural and coastal communities - Carbon capture and storage.

MODULE V SUSTAINABILITY PRACTICES 30

- Energy efficiency – how to save energy (energy efficient equipment, energy saving behaviours).
- Chemical use and storage - the choice of chemicals being procured, the safe disposal of leftover chemicals, the impact of chemicals on the environment and long-term health impacts on humans.
- ECBC – Code Understanding
- Green building, green building materials, green building certification and rating: green rating for integrated habitat assessment (GRIHA), leadership in energy and environmental design (LEED)
- Tools for Sustainability - Environmental Management System (EMS), ISO14000, life cycle assessment (LCA)
- Ecological footprint assessment using the Global Footprint Network spreadsheet calculator
- National/Sub national Status of Sustainable Development Goals

TOTAL: 60 PERIODS

REFERENCES:

1. Allen, D., & Shonnard, D. R. (2011). Sustainable engineering: Concepts, design and case studies. Prentice Hall.
2. Munier, N. (2005). Introduction to sustainability (pp. 3558-6). Amsterdam, The Netherlands: Springer.
3. Blackburn, W. R. (2012). The sustainability handbook: The complete management guide to achieving social, economic and environmental responsibility. Routledge.
4. Clini, C., Musu, I., & Gullino, M. L. (2008). Sustainable development and environmental

management. Published by Springer, PO Box, 17, 3300.
5. Bennett, M., James, P., & Klinkers, L. (Eds.). (2017). Sustainable measures: Evaluation and reporting of environmental and social performance. Routledge.
6. Seliger, G. (2012). Sustainable manufacturing for global value creation (pp. 3-8). Springer Berlin Heidelberg.
7. Stark, R., Seliger, G., & Bonvoisin, J. (2017). Sustainable manufacturing: Challenges, solutions and implementation perspectives. Springer Nature.
8. Davim, J. P. (Ed.). (2013). Sustainable manufacturing. John Wiley & Sons
9. Ibrahim Dincer and Calin Zamfirescu, Sustainable Energy Systems and Applications, Springer, 2021

ME23U01 STANDARDS - MECHANICAL ENGINEERING

L	T	P	C
1	0	0	1

MODULE I OVERVIEW OF STANDARDS 6

Basic concepts of standardization; Purpose of Standardization, marking and certification of articles and processes; Importance of standards to industry, policy makers, trade, sustainability and innovation. Objectives, roles and functions of BIS, Bureau of Indian Standards Act, ISO/IEC Directives; WTO Good Practices for Standardization. Important Indian and International Standards.

MODULE II IMPORTANT STANDARDS RELEVANT TO MECHANICAL ENGINEERS 9

Overview of Quality Management Systems (as per IS/ISO 9001), Environmental Management Systems (as per IS/ISO 14001), Occupational Health & Safety Management Systems (as per IS/ISO 45001), Laboratory Quality Management Systems (as per IS/ISO/IEC 17025), Energy Management System (as per IS/ISO 50001).

Overview of Indian standards for 1. Engineering Drawing 2. Mechanical Testing of metals (Tensile test, Hardness, Impact test) 3. Non-destructive testing of metals 4. Safety of machinery (IS 16819) 5. Refrigeration and Air Conditioning.

ME23C12 **MECHATRONICS AND IOT** **L T P C**

3 0 2 4

COURSE OBJECTIVE:

To impart knowledge on the principles of sensors, actuators, micro-controllers, Programmable Logic control, Arduino, Raspberry Pi and IOT.

UNIT – I SENSORS AND ACTUATORS **9**

Introduction to Mechatronics - Modular Approach, Sensors and Transducers: Static and Dynamic Characteristics, Transducers - Resistive, Capacitive, Inductive and Resonant, Optical Sensors – Photodetectors - Vision Systems – Laser - Fibre optic - Non-fibre Optic, Solid State Sensors, Piezoelectric and Ultrasonic Sensors. Actuators – Brushless Permanent Magnet DC Motor – PM, VR and Hybrid Stepper motors – DC and AC Servo Motors.

PRACTICALS

1. Modeling and Analysis of Hydraulic, Pneumatic, Electro-Hydraulic and Electro-Pneumatic Circuits by using simulation software.
2. Actuation of double acting cylinder by using Electro-Hydraulic and Electro- Pneumatic circuits.

UNIT – II SIGNAL CONDITIONING CIRCUITS AND PLC **9**

Operational Amplifiers – Inverting and Non-Inverting Amplifier – Wheatstone bridge – Instrumentation Amplifier – PID Controller, Protection Circuits, Filtering Circuits, Multiplexer, Data Logger and Data Acquisition System, Switching Loads by Power Semiconductor Devices Circuits – Thyristors – TRIAC – Darlington Pair – MOSFET and Relays. PLC – Architecture – Input / Output Processing – Logic Ladder Programming – Functional Block Programming using Timers and Counters – Applications.

PRACTICALS

1. Data Acquisition System – Measurement of Physical Quantities
2. PLC Automation with Timers and Counters.

UNIT – III FUNDAMENTALS OF IoT AND EMBEDDED SYSTEMS **9**

The Internet of Things (IoT) - Introduction to the IoT Framework – IoT Enabling Technologies- The Effective Implementation of IoT: The Detailed Procedure. Embedded Systems: An Introduction - Single-Chip Microcontroller Systems - Single- Board Microcontroller Systems - Single-Board Computer Systems - Embedded Systems: Peripherals - Software Considerations.

PRACTICALS

1. Automation of material handling application by Six-Axis Articulated Robot.

UNIT – IV ARDUINO AND RASPBERRY Pi **9**

Arduino: The Arduino Boards - Arduino Peripherals- Arduino IDE – ESP8266 Wi-Fi module. Raspberry Pi: The Raspberry Pi Boards - The Raspberry Pi Peripherals - The Raspberry Pi Operating System. Interfacing and Controlling I/O devices by Arduino and Raspberry Pi: LEDs - Push buttons - Light intensity sensor - Ultrasonic distance sensor – Temperature sensor-Humidity sensor - Sensor and Actuator interactions

PRACTICALS

1. Automating the actuation of cylinder sequence by using Microcontroller.
2. Speed and Direction control of Stepper and Servo motors.
3. Speed and Direction control of DC and AC drives.

UNIT – V MECHATRONICS AND IoT CASE STUDIES 9

Mechatronics systems: Aerial drone actuation and Control - Autonomous Robot with Vision System, Automotive Mechatronics: Electronic Ignition System - ABS - EBD - Adaptive Cruise Control. IoT case studies: Remote Monitoring Systems- Remotely Operated Autonomous Systems - Centralized Water Management System - IoT Enabled Robotic Camera Dolly - Portable, Wireless, Interactive IoT Sensors for Agriculture - IoT Vehicle Management System with Network Selection.

PRACTICALS

1. Vision based image acquisition and processing technique for inspection and classification.
2. Remote data acquisition by using IoT.
3. IoT based Home Automation.
4. IoT enabled Robot.

TOTAL: 45L+ 30 P = 75 PERIODS

COURSE OUTCOMES:

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

1. Select suitable sensors and actuators to develop mechatronics systems
2. Devise proper signal conditioning circuit for mechatronics systems, and also able to implement PLC as a controller for an automated system.
3. Elucidate the fundamentals of IoT and Embedded Systems.
4. Implement Arduino and Raspberry Pi as controllers for automated systems.
5. Design and develop an apt mechatronics/IoT based system for the given real- time application.

TEXT BOOKS:

1. Bradley D.A., Burd N.C., Dawson D., Loader A.J., “Mechatronics: Electronics in Products and Processes”, Routledge, 2017.
2. Sami S.H and Kisheen Rao G, “The Internet of Mechanical Things: The IoT Framework for Mechanical Engineers”, CRC Press, 2022.

REFERENCES:

1. John Billingsley, “Essentials of Mechatronics”, Wiley, 2006.
2. David H., Gonzalo S., Patrick G.,Rob B. and Jerome H.,“IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things”, Pearson Education, 2018.
3. Nitin G and Sharad S, “Internet of Things: Robotic and Drone Technology”, CRC Press, 2022.
4. Newton C. Braga, “Mechatronics For The Evil Genius”, McGraw Hill, 2005.
5. Bell C., “Beginning Sensor Networks with Arduino and Raspberry Pi”, Apress, 2013.
6. Bolton W., “Mechatronics”, Pearson Education, 2019.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	1	1	1	-	-	-	-	-	-	2	1	2	3
2	3	3	3	1	2	-	-	-	-	-	-	2	1	2	3
3	3	1	2	1	2	-	-	-	-	-	-	2	1	2	3
4	3	3	3	3	3	2	-	-	-	-	-	2	1	2	3
5	3	3	3	3	3	2	-	-	-	-	2	2	1	2	3
Av g	3	2.4	2.4	1.8	2.2	2	-	-	-	-	2	2	1	2	3

ME23C09 FINITE ELEMENT ANALYSIS L T P C
3 0 0 3

COURSE OBJECTIVE:

To apply the concepts of the finite element analysis to solve multi-dimensional problems in engineering.

:

UNIT I INTRODUCTION 9

Historical Background – Mathematical Modeling of field problems in Engineering – Governing Equations – Discrete and continuous models – Boundary, Initial and Eigen Value problems– Weighted Residual Methods – Variational Formulation of Boundary Value Problems – Ritz Technique – Basic concepts of the Finite Element Method.

UNIT II ONE-DIMENSIONAL PROBLEMS 9

One Dimensional Second Order Equations – Discretization – Element types- Linear and Higher order Elements – Derivation of Shape functions and Stiffness matrices and force vectors- Assembly of Matrices - Solution of problems from solid mechanics including thermal stresses-heat transfer. Natural frequencies of longitudinal vibration and mode shapes. Fourth Order Beam Equation – Transverse deflections and Transverse Natural frequencies of beams.

UNIT III TWO DIMENSIONAL SCALAR VARIABLE PROBLEMS 9

Second Order 2D Equations involving Scalar Variable Functions – Variational formulation – Finite Element formulation – Triangular elements and Quadrilateral elements- Shape functions and element matrices and vectors. Application to Field Problems - Thermal problems – Torsion of Non-circular shafts.

UNIT IV TWO DIMENSIONAL VECTOR VARIABLE PROBLEMS 9

Equations of elasticity – Plane stress, plane strain and axisymmetric problems – Constitutive matrices and Strain displacement matrices – Stiffness matrix – Stress calculations - Plate and shell elements.

UNIT V ISOPARAMETRIC FORMULATION AND ADVANCED TOPICS 9

Natural co-ordinate systems – Isoparametric elements – Shape functions for isoparametric elements– One and two dimensions – Serendipity elements – Numerical integration - Meshing techniques - Introduction to Analysis Software-Introduction to Non Linearity.

TOTAL:45 PERIODS

COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

CO1 Develop mathematical models for Boundary Value Problems and their numerical solution

CO2 Formulate the Finite Element methodology to solve the one-dimensional problems.

CO3 Estimate field variables for two-dimensional scalar variable problems

CO4 Determine field variables for two-dimensional vector variable problems

CO5 Apply the Iso-parametric transformation and use the numerical integration technique for engineering problems.

TEXTBOOKS:

1. Rao, S.S., “The Finite Element Method in Engineering”, 6th Edition, Butterworth-Heinemann,2018.

REFERENCES:

1. David Hutton, “Fundamentals of Finite Element Analysis”, Tata McGrawHill, 2005
2. Dhanaraj. R and Prabhakaran Nair. K, “Finite Element Analysis”, Oxford Publications, 2015.
3. Robert D. Cook, David S. Malkus, Michael E. Plesha, Robert J. Witt, “Concepts and Applications of Finite Element Analysis”, 4th Edition, Wiley Student Edition, 2004.
4. Seshu.P, “Text Book of Finite Element Analysis”, PHI Learning Pvt. Ltd., NewDelhi, 2012.
5. TirupathiR.Chandrupatla and Ashok D. Belegundu, “Introduction to Finite Elements in Engineering”, International Edition, Pearson Education Limited, 2014.

COs	POs												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	3	2	2	2	-	-	1	-	-	2	1	3	2	2
2	3	3	3	3	2	-	-	1	-	-	1	2	3	2	2
3	3	3	3	2	3	-	-	1	-	-	2	2	3	2	2
4	3	3	3	3	2	-	-	1	-	-	1	2	3	2	2
5	3	3	2	2	3	-	-	1	-	-	2	1	3	2	2
Avg	3	3	2.6	2.4	2.4	-	-		-	-	1.6	1.6	3	2	2

ME23701 HEAT AND MASS TRANSFER

L	T	P	C
3	0	2	4

COURSE OBJECTIVE:

- To impart knowledge on fundamentals of heat and mass transfer and develop problem solving skills in its applications.

UNIT I CONDUCTION 15

Heat Conduction Equation – Cartesian, Cylindrical and Spherical Coordinates with and without heat generation, Boundary Conditions, Thermal Contact Resistance, Critical radius of insulation.

Transient Heat Conduction – Plane wall, cylinder, sphere, Lumped systems, Semi-infinite solids, Heisler-Grobber charts.

PRACTICALS

1. Thermal conductivity measurement of pipe insulation using lagged pipe apparatus.
2. Determination of thermal conductivity of a composite wall / insulating powder.

UNIT II CONVECTION 15

Classification of fluid flows, Energy & Momentum equations, Velocity & Thermal Boundary layers

Free convection – Vertical, Horizontal, Inclined plates, Cylinders and Spheres.

Forced Convection – Entry region, heat transfer and pressure drop for fluid flow in tubes. Drag and heat transfer in External flow – flat plate, cylinders, spheres and tube banks.

PRACTICALS

1. Determination of heat transfer coefficient of air under natural and forced convection.
2. Determination of heat transfer coefficient from pin-fin under natural and forced convection.

UNIT III HEAT TRANSFER APPLICATIONS 15

Fin Design – Uniform and non-uniform cross sectional area, fin performance, overall surface efficiency.

Heat Exchangers – Overall heat transfer coefficient, LMTD, ε-NTU method, TEMA classification.

Boiling and Condensation – Physical mechanisms, Regimes and heat transfer calculations.

PRACTICALS

1. Pool boiling phenomena and measure the critical heat flux.
2. Determination of heat transfer coefficient of cold/hot fluid and effectiveness of a heat exchanger.
3. Determination of effectiveness of a cooling tower.

UNIT IV RADIATION 15

Fundamental concepts – Radiation intensity, Black body radiation, View factor, Surface emission. Kirchhoff's law, Radiation heat transfer between two surfaces. Radiation shields, Thermal radiation network

PRACTICALS

1. Determination of Stefan – Boltzmann constant.
2. Determination of emissivity of a metal surface.

UNIT V SIMULTANEOUS HEAT & MASS TRANSFER 15

Machine Learning in Heat Transfer – Introduction, Linear regression and Neural networks. Boundary conditions, Fick's law of diffusion, Rate equations, Convective Mass Transfer, Analogy between Friction, Heat and Mass transfer coefficients.

TOTAL : 75 PERIODS

LIST OF EQUIPMENTS:

1. Lagged pipe apparatus.
2. Composite wall, insulating powder apparatus.
3. Natural convection and forced convection test setup.
4. Pin-fin apparatus
5. Stefan – Boltzmann constant apparatus.
6. Emissivity measurement apparatus.
7. Pool boiling test setup
8. Tube-in-tube heat exchanger test setup.
9. Cooling tower test setup.
10. IAQ and Energy audit equipment's

COURSE OUTCOMES:

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

CO1 Apply the conduction equations for steady and transient conditions.
CO2 Solve problems involving free and forced convection heat transfer.
CO3 Estimate heat transfer in systems involving radiation heat transfer.
CO4 Analyse the heat transfer problems in real systems.
CO5 Relate heat and mass transfer processes.

TEXT BOOKS:

1. Yunus A. Çengel, Afshin J. Ghajar, Mehmet Kanoğlu, Heat and Mass Transfer:Fundamentals & Applications, McGraw Hill, 2019.
2. J. P. Holman, Heat Transfer, McGraw Hill, 2011.

REFERENCES:

1 Theodore L. Bergman, Adrienne S. Lavine, Frank P. Incropera, David P. DeWitt,Fundamentals of Heat and Mass Transfer, Wiley, 2020.
2 YVC Rao, Heat Transfer, Universities Press, 2001.
3 Frank Kreith, Raj M. Manglik, Principles of Heat Transfer, Cengage Learning, 2016.
4 C. Balaji, Balaji Srinivasan, Sateesh Gedupudi, Heat Transfer Engineering: Fundamentals and Techniques, Elsevier, 2020.
5 Charles H. Forsberg, Heat Transfer Principles and Applications, Elsevier, 2020.

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

ME23702	SIMULATION AND ANALYSIS LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVE:
The main objective of this course is to prepare the students for learning the basics of simulation and analysis tools.

SIMULATION **30**

1. Introduction to MATLAB, MATLAB basics, Dealing with matrices, Graphing-Functions of one variable and two variables
2. Simulation of Spring-mass system using MATLAB
3. Solving the simple problems in vibration
4. Simulation of the working principle of air conditioning system
5. Simulation of the working principle of hydraulic and pneumatic cylinder
6. Simulation of the working principle of cam and follower mechanism
7. Simulation of quick return mechanism

ANALYSIS **30**

LIST OF EXPERIMENTS
Use of any finite element analysis software for following problems:

1. Force and Stress analysis using link elements in Trusses, cables and bars.
2. Stress and deflection analysis in beams with different support conditions.
3. Stress analysis of flat plates and simple shells.
4. Stress analysis of axi – symmetric components.
5. Thermal stress and heat transfer analysis of fins, plates and cylinders.
6. Vibration analysis of spring-mass systems.
7. Modal analysis of Beams.
8. Harmonic, transient and spectrum analysis of simple systems

TOTAL: 60 PERIODS

COURSE OUTCOMES:
Upon completion of this course, the students will be able to:

CO1 Simulate and analyze the response of mechanical systems.
CO2 Analyze structural and thermal problems.
CO3 Perform dynamic analysis of mechanical components

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

ME23047 AUTOMOTIVE MATERIALS, COMPONENTS, DESIGN AND TESTING

L	T	P	C
3	0	0	3

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

UNIT – I 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 – II DESIGN OF CYLINDER AND PISTON COMPONENTS 9

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

UNIT – III 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 – IV 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 – V 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 = 45 PERIODS

OUTCOMES:

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

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

TEXT BOOKS:

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

REFERENCES:

1. Hiroshima Yamagata, “The science and technology of materials in automotive engines”, Woodhead Publishing Limited, Cambridge, England
2. Jain.R.K, “Machine Design”, Khanna Publishers, New Delhi, 2005.
3. Manufacturing Automotive Components from Sustainable Natural Fiber Composites (SpringerBriefs in Materials) by Lobna A. Elseify, Mohamad Midani, et al. | 9 August 2021
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
5. 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

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	3	2	2				1			1	3	3	2
2	3	2	3	2	2				1			1	3	3	2
3	3	2	3	2	2				1			1	3	3	2
4	3	2	3	2	2				1			1	3	3	2
5	3	2	3	2	2				1			1	3	3	2

Low (1) ; Medium (2) ; High (3)

ME23048	CONVENTIONAL AND FUTURISTIC VEHICLE TECHNOLOGY	L T P C 3 0 0 3

COURSE OBJECTIVES:

To impart knowledge on both conventional and futuristic vehicle technologies.

UNIT – I ADVANCED ENGINE TECHNOLOGY 9

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 – II COMBUSTION TECHNOLOGY 9

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 – III LOW CARBON FUEL TECHNOLOGY 9

Alcohol Fuels, Ammonia Fuel and Combustion, Methane Technology, Dimethyl Ether, Hydrogen Fuel Technology, Challenges, and way forward

UNIT – IV HYBRID AND ELECTRIC VEHICLE (BATTERY POWERED) 9

Conventional Hybrids (Conventional ICE + Battery), Modern Hybrids (RCCI/GDCI Engine + Battery), Pure Electric Vehicle Technology – Challenges and Way forward

UNIT – V FUEL CELL TECHNOLOGY 9

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 : 45 PERIODS

COURSE OUTCOMES

On Completion of the course the student will be able to

1. Understand the latest trends in engine technology
2. Explain the need for advanced combustion technologies and their impact on reducing carbon footprint on the environment.
3. Analyze the basic characteristics of low carbon fuels, their impact over conventional fuels, and in achieving sustainable development goals.
4. Understand the working and energy flow in various hybrid and electric configurations.
5. Analyze the need for fuel cell technology in automotive applications.

TEXT BOOKS

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

REFERENCES

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

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

ME23049 RENEWABLE POWERED OFF HIGHWAY VEHICLES AND EMISSION CONTROL TECHNOLOGY

L	T	P	C
3	0	0	3

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

UNIT – I LOW AND ZERO CARBON FUELS POWERED OFF-HIGHWAY VEHICLES 9

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 – II GREEN ENERGY POWERED OFF-HIGHWAY VEHICLES 9

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 – III FUEL CELL POWERED OFF-HIGHWAY VEHICLES 9

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 – IV IN-CYLINDER TREATMENT TECHNOLOGIES 9

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 – V AFTER TREATMENT TECHNOLOGIES 9

Diesel Oxidation Catalyst, Diesel Particulate Filter, Selective Catalytic Reduction, Ammonia slip / clean up catalyst. CO_2 absorption techniques, Waste Heat Recovery and Organic Rankine Cycle.

TOTAL : 45 PERIODS

COURSE OUTCOMES

On Completion of the course the student will be able to

Evaluate the availability, suitability, and its role in off-road vehicle categories in reducing the carbon footprint on the environment.

1. Gain the knowledge on various green energy production methods and its impact on meeting energy demand of off-road vehicle applications.
2. Develop the working of fuel cell, various fuel cell types, and its design for off-road vehicle applications.
3. Gain the knowledge on various in-cylinder low temperature combustion technologies and its key role in controlling the engine-out emissions.
4. Develop the working of various existing aftertreatment systems in controlling the engine out emissions.

TEXT BOOKS

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

REFERENCES

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.
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.

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	1				1			1	3	1	1
2	3	2	1	1	1				1			1	3	1	1
3	3	2	1	1	1				1			1	3	1	1
4	3	2	1	1	1				1			1	3	1	1
5	3	2	1	1	1				1			1	3	1	1
Low (1) ; Medium (2) ; High (3)															

ME23050	VEHICLE HEALTH MONITORING, MAINTENANCE AND SAFETY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1. To enable the student to understand the principles, functions and practices adapted in maintenance activities of vehicles.
2. To study the powertrain maintenance, fault diagnosis, maintenance of Batteries
3. To develop vehicle system maintenance and service of clutch, brake.
4. To study the concepts of vehicle safety and regulations.
5. To study and understand the simulation of safety concepts

UNIT – I 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 – II 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 – III 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 IV VEHICLE SAFETY 9

Concepts of vehicle safety -Seat belt, regulations, automatic seat belt tightener system, collapsible steering column, 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 – V 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:45 PERIODS

OUTCOMES:

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

- The students have the knowledge of vehicle health monitoring, maintenance and safety.
- The students able to maintenance of powertrain.
- The students can ability to maintenance of Vehicle system.
- Explain and awareness of vehicle safety.
- Explain the simulation of safety concepts.

TEXT BOOKS:

1. 5th Edition, “Advanced Automotive Fault Diagnosis Automotive Technology: Vehicle Maintenance and Repair” By Tom Denton
2. Safety Management System and Documentation Training Programme Handbook by S. V. Paul ISBN: 9788123923444

REFERENCES:

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, 5thEdition, 2012
4. William H. Crouse and Donald L. Anglin, “Automotive Mechanics”, Tata McGraw Hill,10th Edition, 2004.
5. Vehicle Service Manuals of Reputed Indian Manufacturers.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	2	1	1				1			1	3	2	2
2	3	2	2	1	1				1			1	3	2	2
3	3	2	2	1	1				1			1	3	2	2
4	3	2	2	1	1				1			1	3	2	2
5	3	2	2	1	1				1			1	3	2	2
Low (1) ; Medium (2) ; High (3)															

ME23051 GAS DYNAMICS AND JET PROPULSION

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

1. To study the fundamentals of compressible flow concepts and the use of gas tables.
2. To learn the compressible flow behaviour in constant area ducts.
3. To study the development of shock waves and its effects.
4. To study the types of jet engines and their performance parameters.
5. To learn the types of rocket engines and their performance parameters.

UNIT – I BASIC CONCEPTS AND ISENTROPIC FLOWS 9

Energy and momentum equations of compressible fluid flows, Concepts of compressible flow – Mach waves and Mach cone. Flow regimes, effect of Mach number on compressibility. Stagnation, static, critical properties and their interrelationship. Isentropic flow and its relations. Isentropic flow through variable area ducts – nozzles and diffusers. Use of Gas tables.

UNIT – II COMPRESSIBLE FLOW THROUGH DUCTS 9

Flows through constant area ducts with heat transfer (Rayleigh flow) and Friction (Fanno flow) – variation of flow properties. Choking. Isothermal flow with friction. Use of Gas tables.

UNIT – III NORMAL AND OBLIQUE SHOCKS 9

Governing equations - Rankine-Hugoniot Relation. Variation of flow parameters across the normal and oblique shocks. Prandtl – Meyer expansion and relation. Use of Gas tables.

UNIT – IV JET PROPULSION 9

Theory of jet propulsion – thrust equation – Performance parameters - thrust, power and efficiency. Operation, cycle analysis and performance of ram jet, turbojet, turbofan, turbo prop and pulse jet engines.

UNIT – V SPACE PROPULSION 9

Types of rocket engines and propellants. Characteristic velocity – thrust equation. Theory of single and multistage rocket propulsion. Liquid fuel feeding systems. Solid propellant geometries. Orbital and escape velocity. Rocket performance calculations.

TOTAL:45 PERIODS

OUTCOMES:

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

1. Apply the fundamentals of compressible flow concepts and the use of gas tables.
2. Analyze the compressible flow behaviour in constant area ducts.
3. Analyze the development of shock waves and its effects.
4. Explain the types of jet engines and their performance parameters.
5. Explain the types of rocket engines and their performance parameters.

TEXT BOOKS:

1. Anderson, J.D., "Modern Compressible flow", Third Edition, McGraw Hill, 2003.
2. S.M. Yahya, "Fundamentals of Compressible Flow with Aircraft and Rocket propulsion", New Age International (P) Limited, 4th Edition, 2012.

REFERENCES:

1. R. D. Zucker and O Biblarz, “Fundamentals of Gas Dynamics”, 2nd edition, Wiley, 2011.
2. Balachandran, P., “Fundamentals of Compressible Fluid Dynamics”, Prentice-Hall of India, 2007.
3. Radhakrishnan, E., “Gas Dynamics”, Printice Hall of India, 2006.
4. Hill and Peterson, “Mechanics and Thermodynamics of Propulsion”, Addison – Wesley, 19 65.
5. Babu, V., “Fundamentals of Compressible Flow”, CRC Press, 1st Edition, 2008.

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1					1			1	3	1	2
2	3	2	1	1					1			1	3	1	2
3	3	2	1	1					1			1	3	1	2
4	3	2	1	1					1			1	3	1	2
5	3	2	1	1					1			1	3	1	2
Low (1) ; Medium (2) ; High (3)															

ME23052	HYBRID AND ELECTRIC VEHICLE TECHNOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

To provide knowledge on the various hybrid electric powertrain configurations, electric vehicle controls, drives, and energy storage technologies.

UNIT – I INTRODUCTION TO HYBRID AND ELECTRIC VEHICLE 9

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, the impact of modern drive-trains on energy supplies.

UNIT – II HYBRID ELECTRIC DRIVE TRAINS 9

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 – III CONTROL OF AC & DC DRIVES 9

Introduction to electric components used in hybrid and electric vehicles, Configuration, and control -DC Motor drives, Induction Motor drives, Permanent Magnet Motor drives, and Switch Reluctance Motor drives, drive system efficiency.

UNIT – IV ENERGY STORAGE 9

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 – V DRIVE SIZING AND ENERGY MANAGEMENT STRATEGIES 9

Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting 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: 45 PERIODS

COURSE OUTCOMES:

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

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

TEXT BOOKS:

1 Iqbal Husain, Electric and Hybrid Vehicles: Design Fundamentals‖, Third Edition, 2021

2 James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003

REFERENCES:

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. Rand D.A.J, Woods, R & Dell RM Batteries for Electric vehicles, John Wiley & Sons, 1998
3. Hybrid, Electric and Fuel-Cell Vehicles, International Edition by Jack Erjavec | 6 June 2012
4. Energy Management in Hybrid Electric Vehicles using Co-Simulation by Christian Paar | 11 February 2011
5. Hybrid Electric Vehicle Design and Control: Intelligent Omnidirectional Hybrids (MECHANICAL ENGINEERING) by Yangsheng Xu , Jingyu Yan, et al. | 16 December 2013

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

ME23053 THERMAL MANAGEMENT OF BATTERIES AND CELLS

	L	T	P	C
	3	0	0	3

COURSE OBJECTIVE:

- To impart knowledge on the significance of battery thermal management and its impact on performance and safety

UNIT – I ADVANCED BATTERIES 9

Li-ion Batteries- chemistry, different formats, operating areas, efficiency, aging. Battery Management System- Configuration, Characteristics. Tesla Model S- 18650 Cell specifications, P85 Battery Pack mechanical structure, Texas Instruments BMS. Supercapacitors Vs batteries. Diamond battery concepts.

UNIT – II THERMAL MANAGEMENT IN BATTERIES 9

Thermal Management Systems- impact, Types- Air, Liquid, Direct refrigerant, Heat pipe, Thermo-Electric, Phase Change Material Cooling methods. Solid-liquid PCM Types- Organic, Inorganic, Eutectics. PCM Thermal Properties and applications. Tesla Model-S Battery Module- bonding techniques, thermal management.

UNIT – III BATTERY THERMAL MANAGEMENT ~~CASE STUDIES~~ 9

EV Battery Cooling- challenges and solutions. Heat Exchanger Design and Optimization Model for EV Batteries using PCMs- system set up, selection of PCMs. Chevrolet Volt Model Battery Thermal Management System- Case study. Modelling Liquid Cooling of a Li-Ion Battery Pack ~~with COMSOL~~ Multiphysics- simulation concepts.

UNIT – IV THERMAL MANAGEMENT IN FUEL CELLS 9

Fuel Cells- operating principle, hydrogen-air fuel cell system characteristics, other fuel cell technologies, polarization curves, applications. Fuel cell thermal management- basic model, energy balance, governing equations, characteristic curve, sizing, cooling methods, advantages, restrictions.

UNIT – V FUEL CELL THERMAL MANAGEMENT CASE STUDIES 9

Fuel cell system- balance of plant- components required. Fuel cell power plant sizing problems- Fuel Cell Electric Vehicle Fuel economy Calculations-Battery EVs Vs Fuel Cell EVs. Toyota Mirai FCV- Operating principle, High pressure hydrogen tank, Boost convertor, NiMH Battery, Internal circulation system, Hydrogen refueling- Case studies.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

1. Discuss the different Li-ion Batteries and Fuel Cell performances.
2. Design a Battery Pack with appropriate PCM.
3. Apply Cooling Models using Simulation
4. Estimate fuel economy.
5. Utilize different Thermal Management System approaches during real world usage.

TEXT BOOKS:

1 Ibrahim Dinçer, Halil S. Hamut, and Nader Javani, “Thermal Management of Electric Vehicle Battery Systems’’, Wiley, 2017.
2 Jiuchun Jiang and Caiping Zhang, “Fundamentals and applications of Lithium-Ion batteriesin Electric Drive Vehicles’’, Wiley, 2015.
3 Mehrdad Ehsani, Yimin Gao, Sebastien E. Gay and Ali Emadi, “Modern Electric, Hybrid Electric, and Fuel Cell Vehicles-Fundamentals, Theory, and Design’’, CRC Press, 2005.
4 John G. Hayes and G. Abas Goodarzi, “Electric Powertrain”, Wiley, 2018
Davide Andrea, “Battery Management Systems for Large Lithium-Ion Battery Packs” ARTECH House, 2010.

REFERENCES:

1 Nag.P.K, “Engineering Thermodynamics”, 5th Edition, Tata McGraw Hill Education, New Delhi, 2013.

2 “Vehicle thermal Management Systems Conference Proceedings”, 1st Edition; 2013, Coventry Techno centre, UK

3 Younes Shabany,” Heat Transfer: Thermal Management of Electronics Hardcover” 2010, CRC Press.

4 T. Yomi Obidi, “Thermal Management in Automotive applications”, 2015, SAE International.
Jerry Sergent, Al Krum, “Thermal Management Handbook: For Electronic Assemblies Hardcover”, 1998, Mc Graw- Hill.

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

ME23054 ADVANCED VEHICLE ENGINEERING

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

1. To introduce the basic concepts of electric vehicle and their characteristics
2. To introduce different types of motors and the selection of motor for vehicle applications.
3. To acquaint the student with different sensors and systems used in autonomous and connected vehicles.
4. To give an overview of networking with sensors and systems.
5. To introduce the modern methods of diagnosing on-board the vehicle troubles.

UNIT – I ELECTRIC VEHICLES 9

EV architectures, advantages and disadvantages, Electrical and mechanical energy storage technologies, battery management. Performance of Electric Vehicles, Tractive effort and Transmission requirement, Vehicle performance, Tractive effort in normal driving.

UNIT – II ELECTRIC VEHICLE MOTORS 9

Electric Propulsion basics, motor capacity determination, Induction motor, DC motor, Permanent Magnet Motor, Switch Reluctance Motor, Configuration, Characteristics, Performance and control of Drives.

UNIT – III AUTONOMOUS AND CONNECTED VEHICLES 9

Vehicle-to-Vehicle Technology, Vehicle to Road and Vehicle to Vehicle Infrastructure, Basic Control System, Surroundings Sensing Systems, Role of Wireless Data Networks, Advanced Driver Assistance Systems, Basics of Radar System, Ultrasonic Sonar Systems, Lidar System, Camera Technology, Basics of Wireless Technology, Receiver System.

UNIT – IV AUTOMOTIVE NETWORKING 9

Bus Systems – Classification, Applications in the vehicle, Coupling of networks, networked vehicles, Buses - CAN Bus, LIN Bus, MOST Bus, Bluetooth, Flex Ray, Diagnostic Interfaces.

UNIT – V ON-BOARD TESTING 9

Integration of Sensor Data to On-Board Control Systems (OBD), OBD requirements, certification, enforcement, systems, testing, Catalytic converter and Exhaust Gas Recirculation system monitoring, Introduction to Cyber-physical system.

TOTAL: 45 PERIODS

OUTCOMES:

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

1. Acquire an overview of electric vehicles and their importance in automotive.
2 Discuss the characteristics and the selection of traction motor.
3 Comprehend the vehicle-to-vehicle and autonomous technology.
4 Explain the networking of various modules in automotive systems, communication protocols and diagnostics of the sub systems.
5 Be familiar with on-board diagnostics systems.

TEXT BOOKS:

1 John G Hayes and G AbaasGoodarzi, Electric Powertrain -, 1st Edition, John Wiley & Sons Ltd., 2018

2 Hussain T Mouftah, Melike Erol-kantarci and Samesh Sorour, Connected and Autonomous Vehicles in Smart Cities,CRC Press, 1st Edition, 2020.

REFERENCES:

1 Dominique Paret, Multiplexed Networks for Embedded Systems, John Wiley & Sons Ltd., 2007.

2 Hong Cheng, —Autonomous Intelligent Vehicles: Theory, Algorithms & Implementation‖, Springer, 2011

3 Advanced Technology Vehicles Manufacturing (ATVM) Loan Program (Energy Science, Engineering and Technology: Congressional Policies, Practices and Procedures)by Andrew M Wright and Harrison R Scott | 5 September 2012

4 Advanced Vehicle Technology by Heinz Heisler MSc BSc FIMI MIRTE MCIT | 17 July 2002

5 Advanced Motorsport Engineering: Units for Study at Level 3by Andrew Livesey | 1 September 2011

CO	**PO**												**PSO**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	1	1			2		1			1	1	2	1
2	2	1	1	1			2		1			1	1	2	1
3	2	1	1	1			2		1			1	1	2	1
4	2	1	1	1			2		1			1	1	2	1
5	2	1	1	1			2		1			1	1	2	1
Low (1) ; Medium (2) ; High (3)															

ME23055 **HYDROGEN POWERED VEHICLES**

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

The main learning objective of this course is to:

1. Understand the properties of hydrogen and utilise it safely based on regulations, standards and codes.
2. Utilise the production of hydrogen under various techniques
3. Utilise the storage and transportion of hydrogen safely using modern techniques
4. Utilise hydrogen in a fuel cell to power different systems
5. Utilise hydrogen as a fuel in an IC engine

UNIT – I INTRODUCTION

Properties of hydrogen, safety and storage aspects of hydrogen, hydrogen leakage detection, regulation - codes – standards**.**

UNIT – II HYDROGEN PRODUCTION FROM DIFFERENT SOURCES

Gasification, Pyrolysis, reforming - steam reforming - partial oxidation – auto thermal reforming. Fundamentals of electrolysis of water, Types of electrolyzers, sizing of electrolyzers, electrolysis parameters – current density, pressure, operating temperature, hydrogen purity

UNIT – III HYDROGEN STORAGE AND TRANSPORTATION

compressed hydrogen tank types and design considerations, Novel materials for solid state hydrogen storage; liquid state hydrogen storage tanks, fundamentals of hydrogen storage in adsorption-based materials economics of storage; Long distance hydrogen transport via pipelines, ships and in form of LOHC; hydrogen transport via road; hydrogen refuelling stations

UNIT – IV UTILIZATION OF HYDROGEN IN FUEL CELL

Introduction to fuel cells, thermodynamics and electrochemical kinetics of fuel cells, Fuels cells for automotive applications – Sizing - Performance evaluation - Parameters affecting the efficiency

UNIT – V UTILIZATION OF HYDROGEN IN IC ENGINES

Merits and demerits of hydrogen as a fuel for IC engines, Strategies for using hydrogen as fuel in IC engines, hydrogen fuel supply system, Performance – combustion - emission characteristics

COURSE OUTCOMES

On Completion of the course the student will be able to

CO1 Utilise hydrogen safely based on regulations, standards and codes.
CO2 Apply various techniques of hydrogen production as per need.
CO3 Apply the safety principles and techniques for storing and transporting as per need.
CO4 Utilise hydrogen in a fuel cell for energy applications
CO5 Utilise hydrogen as a fuel in IC engines for mobility applications

TEXT BOOKS

1. Gupta, R. B., Hydrogen Fuel: Production, Transport and Storage, CRC Press, Taylor & Francis Group, 2009.
2. Ehsani, Mehrdad, et al. Modern electric, hybrid electric, and fuel cell vehicles. CRC press, 2017.

REFERENCES

1. Global Hydrogen Review 2021, IEA (2021), Paris, https://www.iea.org/reports/global-hydrogen-review-2021
2. AgataGodula-Jopek, Hydrogen Production by Electrolysis, Wiley-VCH, Germany, 2015
3. Tzimas, E., Filiou, C., Peteves, S.D., &Veyret, J.B. "Hydrogen storage: state-of-the-art and future perspective. Netherlands": European Communities, 2003.
4. Michael Hirscher, "Handbook of Hydrogen Storage", Wiley-VCH, 2010.
5. B. Viswanathan, M Aulice Scibioh – Fuel Cells : Principles and Applications
6. NPTEL :: Chemical Engineering - NOC:Hydrogen Energy: Production, Storage, Transportation and Safety

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	2	1	1							1	2	2	1
2	3	2	2	1	1							1	2	2	1
3	3	2	2	1	1							1	2	2	1
4	3	2	2	1	1							1	2	2	1
5	3	2	2	1	1							1	2	2	1

HYBRID ELECTRIC VEHICLE TECHNOLOGY ELECTIVE COURSES FOR MINOR SPECIALIZATION

ME23056 POWER ELECTRONICS FOR ELECTRIC VEHICLES

L	T	P	C
3	0	0	3

UNIT I POWER SEMICONDUCTOR DEVICES AND CHARACTERISTICS 9

Operating principle and switching Characteristics: Power diodes - Power BJT, Power MOSFET, IGBT, SCR, GTO, Power integrated circuits (PIC) – Drive and Protection circuits – SiC and GaN devices.

UNIT II CONTROLLED RECTIFIERS 9

Single phase – Three phase – Half controlled – Fully controlled rectifiers – Dual converters -Effect of source and load inductance, Performance parameters calculation.

UNIT III DC TO DC CONVERTERS 9

Step up and Step-down Chopper – Chopper classification - quadrant of operation – Switching mode Regulators – Buck, Boost, and Buck-Boost Regulators- Design of DC –DC Converters. Introduction to Dual Active Bridge Converters.

UNIT IV INVERTERS 9

Voltage source Inverters –1-PhaseHalf bridge and Full bridge –3-Phase Bridge Inverters – Voltage control –PWM Techniques – Current Source Inverters Multilevel Inverters- Types-Principle of Operation.

UNIT V RESONANT CONVERTERS 9

Review on Parallel and Series Resonant Switches-Soft Switching- Zero Current Switching – Zero Voltage Switching –Classification of Quasi resonant switches-Zero Current and Zero Voltage Switching of Quasi Resonant Buck converter- Zero Current and Zero Voltage Switching of Quasi Resonant Boost converter: Steady State analysis.

TOTAL : 45 PERIODS

COURSE OUTCOMES (COs)

On successful completion of the course, students will be able to:

CO 1 Explain and analyse operations, characteristics and protection of power semiconductor devices .

CO 2 Classify, analyze and design, Controlled rectifier .

CO 3 Classify, analyze and design of DC to DC converters.
CO 4 Understand the principle of soft switching and resonant converters.
CO 5 Design and analyze inverters.

TEXT BOOKS:

1. Rashid, M.H., "Power Electronics – Circuits, Devices and Applications", PHI, Fourth edition, 2014.
2. Mohan, Undeland and Robbins., "Power Electronics", John Wiley and Sons, New York, 3rd edition 2006.
3. Bimbhra, P.S., "Power Electronics", Khanna Publishers, 5th edition, 2012.

REFERENCE BOOKS:

1. John G. Kassakian, Martin F. Schlecht, George C. Verghese, "Principles of Power Electronics",Pearson, India, New Delhi, 2010.
2. Philip T Krein, "Elements of Power Electronics", Oxford University Press, 1998.
3. Ned Mohan, "Power Electronics: A first course", John Wiley, 2011.
4. Issa Batarseh, Ahmad Harb, "Power Electronics- Circuit Analysis and Design, Second edition, 2018.
5. Dehong Xu, Rui Li, Ning He, Jinyi Deng, Yuying Wu, Soft-Switching Technology for Three-phase Power Electronics Converters, IEEE Press, 2022.
6. Fang Lin Luo, Hong Ye, Power Electronics Advanced Conversion Technologies, Second edition, CRC Press, 2018.
7. Deshang Sha, Guo Xu, High-Frequency Isolated Bidirectional Dual Active Bridge DC–DC Converters with Wide Voltage Gain, Springer 2019.

ME23057 **APPLIED THERMODYNAMICS** **L T P C**
3 0 0 3

UNIT I BASICS, ZEROTH AND FIRST LAW 9

Basics Concepts – Thermodynamic systems, Properties and processes Thermodynamic Equilibrium - Displacement work - P-V diagram. Thermal equilibrium - Zeroth law. First law – application to closed and open systems – steady and unsteady flow processes. Properties of Ideal gas- Ideal and real gas comparison.

UNIT II SECOND LAW AND ENTROPY 9

Heat Reservoir, source and sink. Heat Engine, Refrigerator, Heat pump. Statements of second law and its corollaries. Carnot cycle, Reversed Carnot cycle, Performance. Clausius inequality. Concept of entropy, Principle of increase in entropy.

UNIT III GAS AND STEAM POWER CYCLES 9

Air Standard Cycles - Otto, Diesel, Dual, Brayton Cycle, Basic layout of Open and closed cycle Gas turbine, Ideal Rankine cycle (Descriptive type).

UNIT IV INTERNAL COMBUSTION ENGINES AND COMBUSTION 9

IC engine – Classification, working, components and their functions, two stroke & four stroke, and SI & CI engines – working & comparison. Combustion in SI & CI Engines – Performance parameters and calculations.

UNIT V INTERNAL COMBUSTION ENGINE SYSTEMS 9

Carburetor, Spark Plug, Fuel Injection System, Multipoint Fuel Injection system and Common Rail Direct Injection systems. Ignition systems – Magneto, Battery and Electronic. Lubrication and Cooling systems. Concepts of Supercharging and Turbocharging – Emission Norms.

TOTAL = 45 PERIODS

TEXT BOOKS:

1. Nag.P.K., Basic and Applied Thermodynamics, 2ndh Edition, Tata McGraw Hill (2010), New Delhi
2. Mahesh Rathore ,Thermal Engineering, Tata Mc Graw Hill (2010), New Delhi

REFERENCES:

1. Cengel, Y and M. Boles, Thermodynamics - An Engineering Approach, Tata McGraw Hill,8th Edition, 2015.
2. Ganesan V, Internal Combustion Engines, Third Edition, Tata Mcgraw-Hill. (2012).
3. Rajput. R. K., Thermal Engineering, S.Chand Publishers (2017).
4. Kothandaraman.C.P., Domkundwar. S,Domkundwar. A.V., A course in thermal Engineering", Fifth Edition, Dhanpat Rai & sons (2016).
5. R.P. Mathur, M.L.Sharma, Internal Combustion Engines, Dhanpat Rai Publication (2005)

CO-PO MAPPING

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

ME23058 **ELECTRICAL MACHINES AND DRIVES** **L T P C**
3 0 0 3

UNIT I DC MACHINES AND TRANSFORMERS 9

DC Generator: Principle of operation -EMF equation - Characteristics DC- Motor working principle- Torque Equation-Characteristics - Starters - Speed Control-Applications of DC machines.
Transformer - Principle - Theory of ideal transformer - EMF equation - Construction -- Equivalent circuit –Performance

UNIT II AC MACHINES 9

Three phase Induction motor: -Types and principle of operation - toque-slip characteristics- Starting and speed control
Alternators: Principle of operation, Voltage regulation - Synchronous motor: Principle of operation-Starting.

UNIT III SPECIAL MACHINES 9

Doubly fed Induction Machine-Permanent magnet synchronous motor, Brushless DC motor, Switched reluctance motor Working principle-Governing equations and Control.

UNIT IV DC DRIVES 9

Modeling of drive elements – Equivalent circuit, transfer function of self, separately excited DC motors; Linear Transfer function model of power converters; Sensing and feeds back elements - Closed loop speed control – current and speed loops, P, PI and PID controllers

UNIT V AC DRIVES 9

Scalar Control of Induction motor, Characteristics. Reference frame theory: transformation of variables from stationary to arbitrary reference frame - variables observed from several frames of reference, Vector Control and Direct Torque control.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Fitzgerald A.E., Kingsley C., Umans, S. and Umans S.D., “Electric Machinery”, 6th Edition, McGraw-Hill, 2003.
2. Kothari, D.P., I.J. Nagrath, I.J.,“Electric Machines”, 5th edition, McGraw Hill Education,2017.
3. Paul C.Krause, Oleg Wasyzczuk, Scott S, Sudhoff, “Analysis of Electric Machinery and Drive Systems”, John Wiley, Second Edition, 2010.

4. Stephen Chapman, “Electric Machinery Fundamentals”, 4th edition, McGraw Hill Education. 2017.
5. Gopal K Dubey, “Power Semiconductor controlled Drives”, Prentice Hall Inc., NewYersy, 1989.
6. R.Krishnan, “Electric Motor Drives – Modeling, Analysis and Control”,Prentice-Hall of India Pvt. Ltd., New Delhi,2010.
7. Ashfaq Husain and Harroon Ashfaq., “Electric Machines”, 3rd edition, Dhanpat Rai & Co., 2016.

ME23059 CONTROL SYSTEM DESIGN FOR ELECTRIC VEHICLE APPLICATIONS

L	T	P	C
3	0	0	3

UNIT I MODELING OF LINEAR TIME INVARIANT SYSTEM (LTIV) 9

Control system: Open loop and Closed loop – Feedback control system characteristics – First principle modeling: Mechanical, Electrical and Electromechanical systems – Transfer function representations: Block diagram

UNIT II TIME DOMAIN AND FREQUENCY DOMAIN ANALYSIS 9

TIME DOMAIN ANALYSIS : Standard test inputs – Time responses – Time domain specifications – Stability analysis: Concept of stability

FREQUENCY DOMAIN ANALYSIS Bode plot, – Frequency domain specifications Introduction to closed loop Frequency Response. Effect of adding lag and lead compensators.

UNIT III DESIGN OF FEED BACK CONTROL SYSTEM 9

Design specifications – Lead, Lag and Lag-lead compensators using Root locus and Bode plot techniques –PID controller. - PID control in State Feedback form.

UNIT IV CONVERTER DYNAMICS 9

AC equivalent circuit analysis – State space averaging – Circuit averaging – Averaged switch modeling – Transfer function model for buck, boost, buck-boost and cuk converters – Input filters.

UNIT V CONTROLLER DESIGN 9

Review of P, PI, and PID control concepts – gain margin and phase margin – Bode plot based analysis – Design of controller for buck, boost and buck-boost converters.

TOTAL: 45 PERIODSS

TEXT BOOKS:

1. BenjaminC.Ku and Farid Golnaraghi,“Automatic Control Systems”,10th edition McGraw-Hill Education,2017.
2. Nagrath,I.J. and Gopal,M., “Control Systems Engineering”, 6th edition New Age International Publishers 2017.
3. Graham C.Goodwin, StefanF.Graebe, MarioE.Salgado, “Control System Design”, 2002.

REFERENCE BOOKS:

1. Hebertt Sira-Ramírez and Ramón Silva-Ortigoza,”Control Design Techniques in Power Electronics Devices “ Springer-Verlag London Limited 2006
2. Katsuhiko Ogata,“Modern Control Engineering”, PHI Learning Private Ltd, PEARSON, 5th Edition, 2015.
3. Robert W. Erickson & Dragon Maksimovic, ” Fundamentals of Power Electronics”, Second Edition, 2001 Springer science and Business media
4 Ned Mohan, “Power Electronics: A first course”, John Wiley,2012.
5 Marian K. Kazimierczuk and Agasthya Ayachit,”Laboratory Manual for Pulse-Width Modulated DC–DC Power Converters”, Wiley 2016

6 Farzin Asadi and Kei Eguchi, Morgan & Claypool,"Dynamics and Control of DC-DC Converters", 2018
7 Andre Kislovski, "Dynamic Analysis of Switching-Mode DC/DC Converters" ,Springer 1991

ME23060 **ELECTRIC VEHICLE ARCHITECTURE** **LT P C**
3 0 0 3

UNIT I VEHICLE ARCHITECTURE and SIZING (7+2 Skill) 9

Electric Vehicle History, and Evolution of Electric Vehicles, Hybrid vehicles and comparison. Series, Parallel and Series parallel and complex Architecture, Micro and Mild architectures. Mountain Bike - Motorcycle- Electric Cars and Heavy Duty EVs. -Details and Specifications.

UNIT II VEHICLE MECHANICS (7+2 Skill) 9

Vehicle mechanics- Roadway fundamentals, Laws of motion, Traction force, Vehicle Kinetics, Dynamics of vehicle motion, propulsion power, velocity and acceleration, Tire –Road mechanics, Propulsion System Design.

UNIT III POWER COMPONENTS AND BRAKES (7+2 Skill) 9

Power train Component sizing- Differential, Transmission and Vehicle Brakes. EV power train sizing, HEV Powertrain sizing, Design example.

UNIT IV HYBRID VEHICLE CONTROL STRATEGY (7+2 Skill) 9

Vehicle supervisory control, Mode selection strategy, Modal Control strategies.

UNIT V PLUG-IN HYBRID ELECTRIC VEHICLE (7+2 Skill) 9

Construction and working of PHEV-Block diagram and components-Charging mechanisms-Advantages of PHEVs-Introduction to V2G.

TOTAL : 45 PERIODS

SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation / Quiz/ Surprise Test / etc) Basics of MATLAB simulation 10

1. Variables and Expressions Formats, Vectors and Matrices,
2. Arrays, Vectors,
3. Matrices, Built-in functions, Trigonometric functions,
4. Data types and Plotting.
5. Simulation of drive cycles.

COURSE OUTCOMES:

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

CO1: Summarize the History and Evolution of EVs, Hybrid and Plug-In Hybrid EVs

CO2: Describe the various EV components

CO3: Describe the concepts related in the Plug-In Hybrid Electric Vehicles

CO4: Analyse the details and Specifications for the various EVs developed.

CO5: Describe the hybrid vehicle control strategy.

REFERENCES:

1. Mehrdad Ehsani, YiminGao, Sebastian E. Gay, Ali Emadi, 'Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design', CRC Press, 2004.
2. Build Your Own Electric Vehicle,Seth Leitman , Bob Brant, McGraw Hill, Third Edition 2013.
3. Advanced Electric Drive Vehicles, Ali Emadi, CRC Press, First edition 2017.
4. The Electric Vehicle Conversion Handbook: How to Convert Cars, Trucks, Motorcycles, and Bicycles -- Includes EV Components, Kits, and Project Vehicles Mark Warner, HP Books, 2011.
5. Heavy-duty Electric Vehicles from Concept to Reality, Shashank Arora, Alireza Tashakori Abkenar, Shantha Gamini Jayasinghe, Kari Tammi, Elsevier Science, 2021
6. Electric Vehicles Modern Technologies and Trends, Nil Patel, Akash Kumar Bhoi, Sanjeevikumar Padmanaban, Jens Bo Holm-Nielsen Springer, 2020
7. Hybrid Electric Vehicles: A Review of Existing Configurations and Thermodynamic Cycles, Rogelio León , Christian Montaleza , José Luis Maldonado , Marcos Tostado-Véliz and Francisco Jurado, Thermo, **2021**, 1, 134–150. https://doi.org/10.3390/thermo1020010.

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	-	2	-	-	-	-	1	-	-	-	2	-	-	-	-
CO2	3	-	2	-	-	-	-	1	-	-	-	2	-	-	-	-
CO3	3	-	2	-	-	-	-	1	-	-	-	2	-	-	-	-
CO4	3	-	2	-	-	-	-	1	-	-	-	2	-	-	-	-
CO5	3	-	3	3	3	-	-	1	-	-	-	2	-	-	-	-
Avg	3	-	2.2	3	3	-	-	1	-	-	-	2	-	-	-	-

ME23061 DESIGN OF HYBRID ELECTRIC VEHICLES

L	T	P	C
3	0	0	3

UNIT I INTRODUCTION TO HYBRID ELECTRIC VEHICLE 9

History of Hybrid Electric Vehicles, Architectures of HEVs, Interdisciplinary Nature of HEVs, State of the Art of HEVs, Challenges and Key Technology of HEVs. Basics of the EV, Basics of the HEV, Basics of Plug-In Hybrid Electric Vehicle (PHEV), Basics of Fuel Cell Vehicles (FCVs).

UNIT II POWER ELECTRONIC IN HYBRID ELECTRIC VEHICLE 9

hybrid Vehicle Model, Vehicle Performance, EV Powertrain Component Sizing, Series Hybrid Vehicle, Parallel Hybrid Vehicle, Wheel Slip Dynamics. Plug-in HEVs

Architectures, Fuel Economy of PHEVs, Power Management of PHEVs, Component Sizing of EREVs, Vehicle-to-Grid Technology.

Power electronics including switching, AC-DC, DC-AC conversion, electronic devices and circuits used for control and distribution of electric power, Thermal Management of HEV Power Electronics.

UNIT III BATTERIES, CAPACITORS, FUEL CELLS AND CONTROLS 9

Introduction to Batteries, capacitors, fuel cells and controls, Different types of batteries, Battery Characterization, Comparison of Different Energy Storage Technologies for HEVs, Battery Charging Control, Charge Management of Storage Devices, Flywheel Energy Storage System, Hydraulic Energy Storage System, Fuel Cells and Hybrid Fuel Cell Energy Storage System and Battery Management System.

UNIT IV ELECTRIC MACHINES AND DRIVES IN HEVS 9

Types of Motors- DC motors- AC motors, BLDC motors, Induction Motor Drives, Permanent Magnet Motor Drives, Switched Reluctance Motors, Doubly Salient Permanent Magnet Machines, Design and Sizing of Traction Motors, Thermal Analysis and Modelling of Traction Motors.

UNIT V MODELLING OF HEVs AND ENERGY MANAGEMENT STRATEGIES 9

Driving Cycles, Types of Driving Cycles, Range modeling for Battery Electric Vehicle, Hybrid (ICE & others), Fuel Cell EV, and Solar Powered Vehicles. Case study of 2 wheeler, 3 wheeler and 4 wheeler vehicles.
Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy management strategies.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1 Understand the history, architecture, challenges and key technologies of hybrid electric vehicles

CO2 Explain the role of power electronics in hybrid electric vehicles

CO3 Identify various energy source involved in HEVs like battery and fuel cell CO4 Select suitable electric motor for applications in hybrid electric vehicles.

CO5 Explain the HEVs modeling and study the energy management strategies for hybrid electric vehicles.

TEXT BOOKS:

1. Iqbal Husain, “Electric and Hybrid Vehicles-Design Fundamentals”, CRC Press,2003
2. Mehrdad Ehsani, “Modern Electric, Hybrid Electric and Fuel Cell Vehicles”, CRC Press,2005

REFERENCES:

1. James Larminie and John Lowry, “Electric Vehicle Technology Explained “John Wiley & Sons, 2003
2. Lino Guzzella, “Vehicle Propulsion System” Springer Publications, 2005
3. Ron HodKinson, “Light Weight Electric/ Hybrid Vehicle Design”, Butterworth Heinemann Publication,2005

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

ME23062 ENERGY STORAGE DEVICES FOR HYBRID ELECTRIC VEHICLES **L T P C**
3 0 0 3

UNIT I OVERVIEW OF ENERGY STORAGE TECHNOLOGIES 9

Introduction, Necessity for energy storage, Classification of energy storage systems, Overview of various energy storage technologies, Comparison of energy storage technologies

UNIT II THERMAL ENERGY STORAGE 9

Introduction, Types – Sensible, Latent and Thermochemical heat storage principle, Materials used in thermal energy storage systems – Organic, Inorganic and PCMs, Applications – Domestic, Industrial process heating and Solar thermal power plants, Advantages, and limitations.

UNIT III ELECTRICAL ENERGY STORAGE 9

Introduction, Types – Electrochemical and Capacitive systems, Working principle and characteristics of different batteries (lead-acid, lithium-ion and nickel-metal hydride) and capacitive storage systems (supercapacitors and electric double-layer capacitors), Applications - renewable energy integration, electric vehicles, and grid-scale energy storage systems, energy recovery systems, and power quality improvement.

UNIT IV CHEMICAL ENERGY STORAGE 9

Introduction, Fuel cells – Proton exchange membrane and Solid oxide fuel cells – Working principles and electrochemical reactions – Materials – Advantages and limitations – Applications, Hydrogen storage – Compressed, liquid and metal hydride storage – Working principle and storage mechanism – Materials – Advantages and limitations – Applications.

UNIT V *HYBRID ENERGY STORAGE SYSTEMS* 9

Overview, Types – Combined electrochemical and capacitive storage, thermal and electrochemical, Working principle and integration of different storage technologies, Advantages and limitations, Applications – Microgrids, electric vehicles, renewable energy integration.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able to understand

CO1 Understand the concept of energy storage and its importance in various fields.

CO2 Discuss the working and potential applications of thermal energy storage systems in various fields.

CO3 Elaborate the working and study the characteristics of different batteries.

CO4 Understand the working principle of fuel cell and hydrogen storage technologies.

CO5 Choose appropriate hybrid energy technology for various applications.

TEXT BOOKS:

1. R. Pendse, “Energy Storage Science and Technology”, SBS Publishers & Distributors Pvt. Ltd., New Delhi, 2011.
2. Ibrahim Dincer and Mark A. Rosen, “Thermal Energy Storage Systems and Applications”, John Wiley & Sons, 3rd Edition, 2021.

REFERENCES*:*

1. Ru-shi Liu, Lei Zhang and Xueliang sun, “Electrochemical technologies for energy storage and conversion”, Wiley publications, 2012.
2. Robert A. Huggins, “Energy Storage – Fundamentals, materials and applications”, Springer, 2nd Edition, 2016
3. A.G.Ter-Gazarian, “Energy Storage for Power Systems”, The Institution of Engineering and Technology (IET) Publication, UK, 2nd Edition, 2011.

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

ME23063 ELECTRIC VEHICLE CHARGING SYSTEMS **L T P C**
3 0 0 3

UNIT I ELECTRIC VEHICLES AND VEHICLE MECHANICS 9

Electric Vehicles (EV), Hybrid Electric Vehicles (HEV), Engine ratings- Comparisons of EV with internal combustion Engine vehicles- Fundamentals of vehicle mechanics.

UNIT II CHARGING STATIONS AND STANDARDS 9

Introduction-Charging technologies- Conductive charging, EV charging infrastructure, International standards and regulations - Inductive charging, need for inductive charging of EV, Modes and operating principle, Static and dynamic charging, Bidirectional power flow,. Types of commercial chargers, International standards and regulations.

UNIT III EV CHARGING USING RENEWABLE AND STORAGE SYSTEMS 9

Introduction- - EV charger topologies , EV charging/discharging strategies - Integration of EV charging-home solar PV system(HSP), Operation modes of EVC-HSP system , Control strategy of EVC-HSP system - fast-charging infrastructure with solar PV and energy storage.

UNIT IV WIRELESS POWER TRANSFER 9

Introduction - Inductive, Magnetic Resonance, Capacitive types. Wireless Chargers for Electric Vehicles - Types of Electric Vehicles - Battery Technology in EVs -Charging Modes in EVs - Benefits of WPT. - WPT Operation Modes - Standards for EV Wireless Chargers, SAE J2954, IEC 61980. ISO 19363.

UNIT V POWER FACTOR CORRECTION IN CHARGING SYSTEM 9

Need for power factor correction- Boost Converter for Power Factor Correction, Sizing the Boost Inductor, Average Currents in the Rectifier and calculation of power losses.

TOTAL :45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, students will be able to:
CO1: describe the concepts related with EV, HEV.
CO2: Understand the electric vehicle charging mechanism. .
CO3: Learn the concepts of Charging using renewable energy storage systems. .
CO4: explain the concepts related with wireless charging systems.
CO5: perform power factor correction in charging system.

REFERENCES:

1. Electric and Hybrid Vehicles, Design Fundamentals, Third Edition, Iqbal Husain, CRC Press, 2021.
2. Ali Emadi, Mehrdad Ehsani, John M.Miller, "Vehicular Electric Power Systems", Special Indian Edition, Marcel dekker, Inc 2003, 1st Edition.
3. Wie Liu, "Hybrid Electric Vehicle System Modeling and Control", Second Edition, John Wiley & Sons, 2017, 2nd Edition.
4. Mobile Electric Vehicles Online Charging and Discharging, Miao Wang Ran Zhang Xuemin (Sherman) Shen, Springer 2016, 1st Edition.
5. Alicia Triviño-Cabrera, José M. González-González, José A. Aguado, Wireless Power

Transferor Electric Vehicles: Foundations and Design Approach, Springer Publisher 1st Edition. 2020.

6. Nil Patel, Akash Kumar Bhoi, Sanjeevikumar Padmanaban, Jens Bo Holm-Nielsen, Electric Vehicles Modern Technologies and Trends. Springer Publisher 1st Edition, 2021.
7. Cable Based and Wireless Charging Systems for Electric Vehicles, Technology and control, management and grid integration, Rajiv Singh, Sanjeevikumar Padmanaban, Sanjeet Dwivedi, Marta Molinas and Frede Blaabjerg, IET 2021, 1st Edition.

MAPPING OF COs WITH POs AND PSOs

Os	*POs*												*PSOs*			
	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***	***PS O4***
CO1	3	3	3	3	3	-	-	-	1	2	-	2	-	-	-	-
CO2	3	3	3	3	3	-	-	-	1	3	-	2	-	-	-	-
CO3	3	3	3	3	3	-	3	-	1	2	-	2	-	-	-	-
CO4	3	3	3	3	3	-	3	-	1	2	-	2	-	-	-	-
CO5	3	3	3	3	3	-	3	-	1	2	-	2	-	-	-	-
Avg	3	3	3	3	3	-	3	-	1	2.3	-	2	-	-	-	-

ME23E01 INDUSTRIAL 5.0 AND IOT

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

The main learning objective of this course is to prepare the students for:

1. Understand the fundamental concepts, principles, and technologies underlying Industry 5.0 and IoT.
2. Acquire knowledge of automation and control systems, including sensors, actuators, PLCs, and SCADA systems.
3. Develop proficiency in industrial robotics, including robot anatomy, kinematics, programming, and material handling.
4. Gain expertise in IoT, including its architectures, applications in various sectors, sensor implementation, communication protocols, and security considerations.
5. Explore advanced topics and emerging trends in Industry 5.0 and IoT, such as AI, machine learning, edge computing, cloud integration, and cyber-physical systems.

UNIT – I INTRODUCTION TO AUTOMATION AND CONTROL SYSTEMS 9

Introduction to automated manufacturing systems, Sensors and actuators in automation, Pneumatic and hydraulic systems, Control using PLCs, Introduction to SCADA, Experiments: Logical circuits, pneumatic and electro-pneumatic circuits, study of PLC and PLC-based electro-pneumatic sequencing circuits,

UNIT – II INDUSTRIAL ROBOTICS AND MATERIAL HANDLING 9

Detroit Automation and material handling systems, Mechanization devices and parts handling, Parts feeding and sensing, Automated Guided Vehicles (AGVs), Industrial robotics: anatomy, drive systems, sensors, kinematics, End effectors and robot programming, Experiments: Visual inspection using computer vision technology, robot programming for pick and place, stacking of objects

UNIT – III INTERNET OF THINGS 9

Introduction to Industry 4.0 and IoT, Digitization and drivers of Industry 4.0, End-to-end digital integration in smart factories, Introduction to IoT and its architectures, IoT applications: smart cities, connected vehicles, healthcare, process monitoring, Experiments: Implementation of IoT for temperature-dependent cooling system, engine management system, machine condition monitoring, and healthcare monitoring

UNIT – IV IOT SENSORS AND COMMUNICATION 9

IoT sensors: RF and wireless sensor modules, power management, IoT communication protocols and networks, Data acquisition and transmission in IoT, Security and privacy considerations in IoT, Experiments: Implementation of IoT sensors and communication for specific applications,

UNIT – V ADVANCED TOPICS AND EMERGING TRENDS 9

Industry 5.0: evolution and key principles, Advanced automation technologies: AI, machine learning, and robotics, Edge computing and cloud integration in IoT, Cyber-physical systems and their applications, Emerging trends in Industry 5.0 and IoT, Experiments: Exploring advanced automation technologies and trends

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon successful completion of the course, students should be able to:

1. Demonstrate a comprehensive understanding of automation and control systems, including their components, operation, and applications in manufacturing systems.
2. Apply the principles of industrial robotics and material handling to design and implement efficient and reliable automated processes.
3. Design and implement Internet of Things (IoT) solutions, including sensor integration, data acquisition, communication protocols, and security considerations, for real-world applications.
4. Analyze and evaluate the impact of Industry 5.0 and IoT on various industries and sectors, including smart factories, connected vehicles, healthcare, and process monitoring.
5. Explore and assess advanced automation technologies and emerging trends in Industry 5.0 and IoT, such as AI, machine learning, edge computing, cloud integration, and cyber-physical systems.

TEXT BOOKS

1. Frank Lamb, "Industrial Automation: Hands-On", McGraw Hill, 2013.
2. William Bolton, "Programmable Logic Controllers", Elsevier Science, 2011. Elsevier Science, 2018.

REFERENCES

1. Stamatio, Nikolakopoulos, "Introduction to Industrial Automation", CRC Press, 2018.
2. B.R. Mehta, Y. Jaganmohan Reddy, "Industrial Process Automation Systems", Elsevier Science,2014.
3. John J. Craig, "Introduction to Robotics: Mechanics and Control", Pearson Education, 2014.
4. Bruno Siciliano and Lorenzo Sciavicco, "Robotics: Modelling, Planning and Control", Springer, 2010.
5. Grossetete, P., Hanes, D., Henry, J., Barton, R., Salgueiro, G., “IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things”, Pearson Education, 2017.

Mapping of COs with POs and PSOs

COs/POs & PSOs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	1	1	0	0	0	0	0	0	1	0	1	1	0	1
CO2	2	1	1	0	0	0	0	0	0	1	0	1	1	0	2
CO3	2	1	1	0	1	0	0	0	0	1	0	1	1	0	2
CO4	2	1	1	0	1	0	0	0	0	1	0	1	1	0	2
CO5	2	1	1	0	2	0	0	0	0	1	0	1	1	0	2
CO/PO & PSO Average	2.0	1.0	1.0	0	1.3	0	0	0	0	1.0	0	1.0	1.0	0	1.8
1 – Slight, 2 – Moderate, 3 – Substantial															

ME23E02	DIGITAL MANUFACTURING	L	T	P	C
		2	0	2	3

COURSE OBJECTIVES:

To study the various aspects of digital manufacturing, importance of DM in Product Life- cycle Management and Supply Chain Management in the digital work environment.

UNIT – I INTRODUCTION 6

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 – II DIGITAL LIFE CYCLE & SUPPLY CHAIN MANAGEMENT 6

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 – III SMART FACTORY 6

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

UNIT – IV INDUSTRY 4.0 6

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 – V STUDY OF DIGITAL TWIN 6

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: 45 PERIODS

DIGITAL MANUFACTURING AND IoT LABORATORY

Experiments

1. Measure the Distance Using Ultrasonic Sensor and Make Led Blink Using Arduino
2. Detect the Vibration of an Object Using Arduino
3. Sense a Finger When it is Placed on Board Using Arduino
4. Temperature Notification Using Arduino
5. Switch Light On and Off Based on the Input of User Using Raspberry Pi
6. Connect with the Available Wi-Fi Using Arduino

OUTCOMES:

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

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

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.

REFERENCES:

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 EmreCevikcan, “Industry 4.0: Managing The Digital Transformation”, Springer Series in Advanced Manufacturing., Switzerland, 2017
4. Ronald R. Yager and Jordan PascualEspada, “New Advances in the Internet of Things”, Springer., Switzerland, 2018.
5. Ronald R. Yager and Jordan PascualEspada, “New Advances in the Internet of Things”, Springer., Switzerland, 2018.

CO	**PO**												**PSO**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	-	1	1	3	3	-	1	2	2	-	2	3	2	1
2	3	2	3	1	3	3	2	2	2	2	-	2	3	2	3
3	3	-	3	1	3	3	2	-	3	2	-	2	3	2	3
4	3	2	2	2	3	3	2	2	2	2	2	2	3	2	3
5	3	-	2	-	1	3	-	2	2	2	-	2	3	2	2
Avg	3	2	2.2	1.2	2.6	3	3	1.7	2.2	2	2	2	3	2	2.4

ME23E03	TOPOLOGY OPTIMIZATION AND GENERATIVE DESIGN	L T P C 3 0 0 3

COURSE OBJECTIVES:

Upon completion of the scores the students are expected to:

1. Understand and appraise the importance of optimization in mechanical design
2. Evaluate the effectiveness of mathematical programming techniques for optimization
3. Analyze the application of topology optimization in mechanical systems
4. Evaluate the effectiveness of generative design principles and evolutionary algorithms
5. Analyze the impact of uncertainty on optimization outcomes in mechanical design

UNIT I: INTRODUCTION TO OPTIMIZATION IN MECHANICAL ENGINEERING 9

Overview of optimization techniques, Importance of optimization in mechanical design, Applications of topology optimization and generative design in mechanical engineering

UNIT II: MATHEMATICAL FOUNDATIONS OF OPTIMIZATION 9

Optimization problem formulations, Mathematical programming techniques (linear, nonlinear, and integer programming), Sensitivity analysis and gradient-based methods

UNIT III: INTRODUCTION TO TOPOLOGY OPTIMIZATION 9

Fundamentals of topology optimization, Optimization algorithms for topology optimization, Case studies and applications in mechanical systems

UNIT IV: GENERATIVE DESIGN TECHNIQUES 9

Overview of generative design principles, Evolutionary algorithms and their application in generative design, Integration of generative design with additive manufacturing processes

UNIT V: ADVANCED TOPICS IN TOPOLOGY OPTIMIZATION AND GENERATIVE DESIGN 9

Optimization under uncertainty, Multi-objective optimization in mechanical design, Future trends and challenges in topology optimization and generative design

TOTAL: 45 HOURS

COURSE OUTCOMES:

Upon completion of this course the students will be able to:

CO1: Critique the role of optimization in improving mechanical design outcomes

CO2: Assess the strengths and limitations of linear, nonlinear, and integer programming techniques in solving optimization problems

CO3: Justify the use of topology optimization in achieving optimal design solutions

CO4: Appraise the benefits and drawbacks of generative design in mechanical engineering applications

CO5: Critique the methods used to address uncertainty in topology optimization and generative design

TEXTBOOKS

1. Topology Optimization: Theory, Methods, and Applications" by Martin Philip Bendsoe and Ole Sigmund
2. Engineering Optimization: Methods and Applications" by Ravindra K. Ahuja, James B. Orlin, and Thomas L. Magnanti
3. Topology Optimization for Structural Design" by Martin Philip Bendsoe
4. Generative Design: Form Finding Techniques in Architecture" by Asterios Agkathidis
5. Topology Optimization: Theory, Methods, and Applications" by Martin Philip Bendsoe and Ole Sigmund

REFERENCE BOOKS

1. Optimization Concepts and Applications in Engineering" by Ashok D. Belegundu and Tirupathi R. Chandrupatla
2. Engineering Optimization: Methods and Applications" by Ravindra K. Ahuja, James B. Orlin, and Thomas L. Magnanti
3. Introduction to Optimization" by Edwin K. P. Chong and Stanislaw H. Zak
4. Convex Optimization" by Stephen Boyd and Lieven Vandenberghe
5. Topology Optimization in Structural Mechanics" by Rolf Steinbuch and Anthony J. H. F. van den Boogaard
6. Introduction to Structural Optimization" by D. M. Frangopol and H. Adeli
7. Generative Design: Visualize, Program, and Create with Processing" by Hartmut Bohnacker, Benedikt Gross, Julia Laub, and Claudius Lazzeroni
8. Generative Design: Visualize, Program, and Create with JavaScript in p5.js" by Benedikt Gross, Hartmut Bohnacker, Julia Laub, and Claudius Lazzeroni
9. Advanced Structural Optimization" by Hojjat Adeli

CO	P O												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	3	3							3	3	3	2
2	3	3	3	3	3							3	3	3	2
3	3	3	3	3	3							3	3	3	2
4	3	3	3	3	3							3	3	3	2
5	3	3	3	3	3							3	3	3	2
Avg	3	3	3	3	3							3	3	3	2

ME23E04	DIGITAL TWINS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

This course aims to impart knowledge on the basic elements and modeling of Digital Twin technology, its integration with other emerging technologies, the security aspects of Digital Twin, and its applications across various industries.

UNIT – I INTRODUCTION

Development and Concepts, Definition, Importance, Various types, characteristics and components of digital twins, Digital twin systems, Benefits, Challenges, Digital thread, Digital shadow, Resources necessary to Develop Digital Twins - Building the Infrastructure, Collecting the Data, Building the process and Attitude.

UNIT – II MODELLING OF DIGITAL TWIN

Design and Implementation of Digital Twin, Digital Twin Architecture, Three dimension digital twin, new requirements on digital twin, extended five dimension digital twin, application oriented three level digital twins, Key technologies for digital twin modeling, Eight rules for digital twin modeling, Hardware/Software requirement.

UNIT – III DIGITAL TWIN AND NEW TECHNOLOGIES

Digital Twin and Cloud, Fog, Edge Computing, Big data, Services, Virtual Reality and Augmented Reality/Mixed Reality, Artificial Intelligence for Digital Twin, Machine Learning, Internet of Things, Cyber Physical Systems.

UNIT – IV SECURITY IN DIGITAL TWIN

Internet of Things and information safety, Challenges in Interoperability with Digital Twins, Advanced Digital Transformation and Twins, Different Sides of Advanced Twin Security, Threats, Security by Design, Network Safety by solution, Knowledge Input – Engineer expertise, Field Information, DAF Twinning Framework – Creator, Computer Generated Environment, Simulation and replication, Monitoring, Device testing, Security and safety analysis, Behaviour Learning and Analysis, Management Client, Proof of Concept - Scenario Specification, Security Rule, Virtual Environment Generation, Simulation, Comparison of the Environment.

UNIT – V IMPLEMENTATION OF DIGITAL TWIN

Simulation of Physics, Digital Twin in - Process industries, Product life cycle management, Manufacturing industry, Automotive, Oil and gas industry, Energy, Shipping and Logistics, Fault Diagnosis and Prognostics of Mechanical systems, Digital Twin simulators, Experiments as Digital Twin – Case studies, Digital Twin standards.

COURSE OUTCOMES

On Completion of the course the student will be able to

CO1 Understand the basic concepts of Digital Twin technology.
CO2 Describe the architecture and modeling aspects of Digital Twin.
CO3 Appraise the concepts of integrating Digital Twin with other advanced technologies.

CO4 Discuss the security aspects of Digital Twin.
CO5 Apply the concepts of Digital Twin in industrial applications.

TEXT BOOKS

1. Borole, Yogini, Pradnya Borkar, Roshani Raut, Vijaya Parag Balpande, and Prasenjit Chatterjee. Digital Twins: Internet of Things, Machine Learning, and Smart Manufacturing. Vol. 8. Walter de Gruyter GmbH & Co KG, 2023.
2. Adam T. Drobot, Noel Crespi, Roberto Minerva. The Digital Twin. Germany: Springer International Publishing, 2023.

REFERENCES

1. Lyu, Zhihan, ed. Handbook of Digital Twins. CRC Press, 2024.
2. Chaudhary, Gopal, Manju Khari, and Mohamed Elhoseny, eds. Digital twin technology. CRC Press, 2021.
3. Tao, Fei, Meng Zhang, and Andrew Yeh Chris Nee. Digital twin driven smart manufacturing. Academic press, 2019.
4. Lv, Zhihan, and Elena Fersman, eds. Digital Twins: Basics and Applications. Springer International Publishing, 2022.

CO	**PO**												**PSO**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3												3		
2	3	2			1							3	3	3	
3	3	1	2		3		2					3	3	3	
4	3	1	2		3		2					3	3		
5	3	2	3		2		2					3	3		3

ME23E05	AUGMENTED REALITY & VIRTUAL REALITY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

The main learning objective of this course

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/VR 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.

UNIT – I 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 148 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 – II AUGMENTED REALITY 9

Introduction to Augmented Reality-Key Technology in AR, General solution for Calculating geometric and Illumination , Consistency in the Augmented environment, Computer vision for AR-Interaction-Modelling and Annotation Navigation-Wearable devices.

UNIT – III 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 – IV VR PROGRAMMING 9

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

UNIT – V 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.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On Completion of the course the student will be able to

CO1 Understand the basic concepts of AR and VR

CO2 Understand the tools and technologies related to AR/VR

CO3 Know the working principle of AR/VR related Sensor devices

CO4 Design of various models using modelling techniques

CO5 Develop AR/VR applications in different domains

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.
3. John Vince, “Introduction to Virtual Reality”, Springer-Verlag, 2004..
4. William R. Sherman, Alan B. Craig: Understanding Virtual Reality – Interface,
5. Application, Design”, Morgan Kaufmann, 2003

REFERENCES

1. Paul Mealy, Virtual and Augmented Reality for Dummies, For Dummies, 1st Edition, 2018.
2. Schmalstieg/Hollerer, Augmented Reality: Principles & Practice, Pearson Education India, 1 st Edition, 2016.
3. Alan B. Craig, Understanding Augmented Reality: Concepts and Applications, Morgan Kaufmann, 1st Edition, 2013.
4. Kelly S. Hale, Kay M. Stanney, Handbook of Virtual Environments: Design, Implementation, and Applications, September 10, 2014 by CRC Press.

CO	P O												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	2		3				2	2	1	2	2	1	2
2	3	2	2	1	3				3	2	2	3	3	1	2
3	3	3	2	2	3				3	2	1	2	3	2	2
4	3	3	3	2	3				3	2	2	3	3	2	2
5	3	3	3	3	3				3	3	3	3	3	3	3

ME23E06	SEMICONDUCTOR MANUFACTURING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To provide the students with a comprehensive understanding of the fundamental principles of semiconductor materials, devices and technology
2. To explore the operational principles of various semiconductor devices, processes involved in the fabrication, apply their knowledge in designing and analyzing basic semiconductor circuits and systems.

UNIT – I INTRODUCTION TO SEMICONDUCTOR MATERIALS 9

Definition and types, comparison with conductors and insulators; bonding and structure - crystal structure (diamond, zinc blende), covalent bonding in semiconductors; energy bands – energy band theory, conduction and valence bands, bandgap and its significance; carrier statistics – electrons and holes, effective mass, fermi level and its significance.

UNIT – II SEMICONDUCTOR DEVICES AND THEIR OPERATION 9

P-N junction – formation and properties, depletion region, forward and reverse bias characteristics; diodes – types and applications; bipolar junction transistors – structure and operation, current gain, common configurations; Field effect transistor – JFETs and MOSFETs, threshold voltage and I-V characteristics, applications.

UNIT – III FABRICATION TECHNIQUES 9

Crystal growth and wafer preparation – czochralski process, wafer slicing and polishing; oxidation – thermal oxidation process, properties of silicon dioxide; photolithography – photoresist application, exposure and development; etching and doping – wet and dry etching techniques, diffusion and ion implantation; thin film deposition – chemical vapor deposition and physical vapor deposition; fabrication for ceramic components – tapecasting, sintering, machining , challenges in processing ceramic materials, integration with semiconductor fabrication process.

UNIT – IV CHARACTERIZATION AND TESTING OF SEMICONDUCTORS 9

Electrical characteristics – I-V and C-V measurements, carrier lifetime and mobility; Optical characterization – photoluminescence and Raman spectroscopy, absorption and reflection measurements; structural characterization – x-ray diffraction, SEM, TEM; Reliability and Failure analysis – stress testing, common failure mechanisms, techniques for failure analysis; characterization of ceramic materials – mechanical testing, thermal properties, electrical properties

UNIT – V CERAMICS IN SEMICONDUCTOR TECHNOLOGY 9

Overview of applications in semiconductor devices and fabrication processes, comparison with other materials used in semiconductors; ceramic substrates – types of substrates, properties and advantages of ceramic substrates, applications in power electronics, RF components and high frequency devices; ceramic packaging – importance of packaging in semiconductor devices, types of ceramic packaging, advantages, thermal management and reliability; ceramic s in MEMs – role of ceramics in MEMs, common materials and applications; ceramic dielectrics – types of ceramic dielectric materials, properties and applications, role of high k dielectrics for advanced semiconductor devices

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course, the students will be able to

CO1 Explain the fundamental concepts of semiconductor physics

CO2 Demonstrate the ability to analyze and describe the operation of various semiconductor devices

CO3 Acquire knowledge of the key processes in semiconductor device fabrication

CO4 Use the various characterization and testing techniques to evaluate the properties and performance of semiconductor materials and devices

CO5 Aware of the current trends and future directions in the use of ceramics in semiconductor technology including advancements in materials and fabrication techniques

TEXTBOOKS:

1. Peter Y Yu, Manuel Cardona, "Fundamentals of Semiconductors: Physics and Material Properties",
2. Dieter K Schroder, "Semiconductor Material and Device Characterization"

REFERENCES:

1. Donald A Neamen, "Semiconductor Physics and Devices",
2. Adel S Sedra, Kenneth C Smith, "Microelectronic Circuits",
3. Ben G Streetman, Sanjay Banerjee, "Solid State Electronic Devices",
4. Stephen A Campbell, "The Science and Engineering of Microelectronic Fabrication",
5. Hong Xiao, "Introduction to Semiconductor Manufacturing Technology",
6. C Barry Carter, M Grant Norton, " Ceramic Materials: Science and Engineering"

COURSE ARTICULATION MATRIX

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	1	1	1	1	-	-	-	-	-	-	-	-	2	1	-
2	2	2	2	2	-	-	-	-	-	-	-	-	-	-	2
3	3	3	1	2	-	-	-	-	-	-	-	-	-	-	1
4	3	2	3	2	2	-	-	-	-	-	-	-	-	2	-
5	1	1	3	1	1	-	-	-	-	-	-	-	-	2	-
Avg	2	1.8	2	1.6	1.5	-	-	-	-	-	-	-	2	1.7	1.5

Correlation Levels: 1 – low, 2 – medium, 3 – high, ‗-‗ – no correlation

ME23901	BASIC AUTOMOBILE ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

The main learning objective of this course is to prepare the students for:

1. Classifying the types of chassis and identify different class of automobiles
2. Outline the hybrid vehicle system architecture and their merits and demerits.
3. Illustrating the functions of various transmission systems.
4. Imparting the working of different braking and steering systems.
5. Understanding the working of electrical and electronic components

UNIT – I INTRODUCTON 9

Types of automobiles, vehicle construction and different layouts, chassis, frame and body, Aerodynamic Drag, Specifications, Performance Parameters, Bharat New Vehicle Safety Assessment Program (BNVSAP) – Crash Test norms

UNIT – II HYBRID ELECTRIC VEHICLES 9

History and need for electric and hybrid vehicles, Concept of hybrid electric drive train, architecture of series and parallel hybrid electric drive train, merits and demerits, mild and full hybrids, plug-in hybrid electric vehicles and range extended hybrid electric vehicles, Fuel cell vehicles, comparison of diesel, petrol, electric and hybrid vehicles based on performance and emissions, limitations of electric vehicles and technical challenges

UNIT – III TRANSMISSION SYSTEMS 9

Clutch-types and construction, gear boxes, manual and automatic, propeller shaft, slip joints, universal joints, Differential, and rear axle.

UNIT – IV STEERING, BRAKES AND SUSPENSION SYSTEMS 9

Types of steering, Power Assisted Steering., Pneumatic and Hydraulic Braking Systems, Suspension Systems – Need & types

UNIT – V SAFETY AND COMFORT SYSTEMS 9

Passive Safety Systems – Airbags, Seatbelts, Crumple Zones, Active Safety Systems – Automatic Driver Assist Systems (ADAS), Antilock Braking System, Reverse parking system, Anti-collision system, Traction control system, Comfort Systems – Cruise control system, Heating, ventilation and Air-conditioning system (HVAC), Autonomous Driving Cars – Level of Driving Automation

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

1. Distinguish the different types of automobiles and chassis.
2. Interpret the various types of engines and their emission control.
3. Select the appropriate transmission systems.
4. Compare the braking and steering systems.
5. Infer the functions of different electrical and electronic components.

TEXT BOOKS

1. William H. Crouse and Donald L. Anglin, “Automotive Mechanics”,Tata McGraw Hill, 2004,10thEd
2. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, 2nd edition CRC Press, 2011

REFERENCES

1. Ganesan V, "Internal Combustion Engines", Tata McGraw Hill Book Co., 2003.
2. Ehsani, M, “Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals,
3. Theory and Design”, CRC Press, 2005
4. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
5. Bosch “Automotive Handbook”, Robert Bosch GmbH, Germany, 2008, Eighthth Edition

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	1	1										3		3
2	3	3	3										3		3
3	3	3	3										3		3
4	3	3	3										3		3
5	3	3	3										3		3
Avg	3	2.6	2.6										3		3

ME23902	PRODUCT DESIGN AND PROCESS DEVELOPMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

The main learning objective of this course is to prepare the students for:

1. Applying the principles of generic development process; and understanding the organization structure for new product design and development.
2. Identifying opportunity and planning for new product design and development.
3. Conducting customer need analysis; and setting product specification for new product design and development.
4. Generating, selecting, and screening the concepts for new product design and development.
5. Testing and prototyping the concepts to design and develop new products.

UNIT – I INTRODUCTION TO PRODUCT DESIGN & DEVELOPMENT 9

Introduction – Characteristics of Successful Product Development – People involved in Product Design and Development - Duration and Cost of Product Development - The Challenges of Product Development - The Product Development Process - Concept Development: The Front-End Process - Adapting the Generic Product Development Process - Product Development Process Flows - Product Development Organizations.

UNIT – II OPPORTUNITY DENTIFICATION & PRODUCT PLANNING 9

Opportunity Identification: Definition - Types of Opportunities - Tournament Structure of Opportunity Identification - Effective Opportunity Tournaments – Opportunity dentificationProcess - Product Planning: Four Types of Product Development Projects - The Process of Product Planning

UNIT – III IDENTIFYING CUSTOMER NEEDS & PRODUCT SPECIFICATIONS 9

Identifying Customer Needs: The Importance of Latent Needs - The Process of Identifying Customer Needs. Product Specifications: Definition - Time of Specifications Establishment - Establishing Target Specifications - Setting the Final Specifications.

UNIT – IV CONCEPT GENERATION & SELECTION 9

Concept Generation: Activity of Concept Generation - Structured Approach - Five step method of Concept Generation. Concept Selection: Methodology - Concept Screening and Concepts Scoring.

UNIT – V CONCEPT TESTING & PROTOTYPING 9

Concept Testing: Seven Step activities of concept testing. Prototyping – Principles of Prototyping – Prototyping Technologies – Planning for Prototypes

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

1. Apply the principles of generic development process; and understand the organization structure for new p1roduct design and development.
2. Identify opportunity and plan for new product design and development.
3. Conduct customer need analysis; and set product specification for new product design and development.
4. Generate, select, and screen the concepts for new product design and development.
5. Test and prototype the concepts to design and develop new products.

TEXT BOOKS

1. Ulrich K.T., Eppinger S. D. and Anita Goyal, "Product Design and Development" McGraw-Hill Education; 7 edition,2020.

REFERENCES

1. Belz A., 36-Hour Course: "Product Development" McGraw-Hill,2010.
2. Rosenthal S., "Effective Product Design and Development", Business One Orwin, Home wood, 1992, ISBN 1-55623-603-4.
3. Stuart Pugh., "Total Design –Integrated Methods for Successful Product Engineering" Addison Wesley Publishing, 1991, ISBN 0-202-41639-5.
4. Chitale, A. K. and Gupta, R. C., Product Design and Manufacturing, PHI Learning, 2013.
5. Jamnia, A., Introduction to Product Design and Development for Engineers, CRC Press 2018.

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

ME23903	APPLICATIONS OF 3D PRINTING TECHNIQUES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To understand about concept of 3D printing
2. To appreciate the role of 3D printing in food technology
3. To appreciate the role of 3D printing in fashion technology
4. To appreciate the role of 3D printing in construction technology
5. To appreciate the role of 3D printing in healthcare Industry.

UNIT – I 3D PRINTING 9

History-Rapid Prototyping –ISO/ASTM 52915/21/- Additive Manufacturing- Process Steps in 3D printing-Classification of AM techniques- Advantages, Limitations.

UNIT – II 3D PRINTING IN FOOD TECHNOLOG 9

Printable food materials and properties, food product design- advantages & limitations, FOOD SAFETY LAWS AND REGULATION- Ethics- Software's, Advantages, Limitations, Future Aspects, case studies.

UNIT – III 3D PRINTING IN FASHION TECHNOLOGY 9

Printable materials and properties, Fashion & Apparel design, N-topology, Conductive textiles, Smart Wearable electronics, printed garments, Sportswear, software's, Advantages, Limitations, Future Aspects, case studies.

UNIT – IV 3D PRINTING IN CONSTRUCTION TECHNOLOGY 9

Printable materials and properties, Bio inspired designs, Advantages, Limitations, Future Aspects case studies.

UNIT – V 3D PRINTING IN HEALTHCARE TECHNOLOGY 9

Printable materials and properties, Bio-printing, Modelling, pharmacology, forensic, Future Aspects

TOTAL: 45 PERIODS

COURSE OUTCOMES

The students will able to
1. Remember the role modern healthcare machines
2. Apply the concept of 3D printing in food technology
3. Apply the concept of 3D printing in fashion technology
4. Apply the concept of 3D printing in construction technology
5. Apply the concept of 3D printing in healthcare technology

REFERENCES

1. Muralidhara HB, Soumitra Banarjee, 3D PRINTING TECHNOLOGY AND ITS DIVERSE APPLICATIONS, CRC Press, AAP, 2022, ISBN 9781771889780
2. Ben Redwood, Filemon Schöffer, Brian Garret, The 3D Printing Handbook: Technologies,

3. design and applications [1st ed.], 3D Hubs, 2017, ISBN 9789082748505.
4. Godoi, Fernanda C, Fundamentals of 3D food printing and applications, Elsevier Ltd. Academic Press, 2012, ISBN 9780128145647.
5. Carlos BAÑÓN, Félix RASPALL, 3D Printing Architecture: Workflows, Applications, and Trends [1st ed.], Springer Singapore, 2021, ISBN 9789811583872
6. Georgios Tsoulfas, Petros I. Bangeas, Jasjit S. Suri, 3D Printing: Applications in Medicine and Surgery [1 ed.], Elsevier, ISBN 9780323661645

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	1		3		2						3		3
2	3	2	1		3		2						3		3
3	3	2	1		3		2						3		3
4	3	2	1		3		2						3		3
5	3	2	1		3		2						3		3
Avg	3	2	1		3		2						3		3

ME23904 **FUEL CELLS** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

1. To introduce the basic knowledge and to impart the principles of fuel cells.
2. To outline the working principles and importance of various types of fuel cells.
3. To learn and discuss about the thermodynamics and reaction kinetic methods and techniques of fuel cells.
4. To address the construction, design, development and fabrication of the fuel cell device and to study their performance.
5. To understand the use of fuel cells in various fields and to gain knowledge on its future prospects.

UNIT – I INTRODUCTION 9

Fuel cell basics –Attractive features - Batteries and fuel cells – Principle and working of fuel cells - Types of fuel cells

UNIT – II CLASSIFICATION OF FUEL CELLS 9

Proton exchange membrane fuel cell (PEMFC) - Direct methanol fuel cell (DMFC) - Alkaline fuel cell (AFC) - Solid oxide fuel cells (SOFC) - Molten carbonate fuel cell (MCFC) – Bio fuel cell (BFC) – Enzymatic and Microbial

UNIT – III THERMODYNAMICS AND KINETICS 9

Basics of electrochemistry – Cyclic Voltammetry – Chronoamperometry – Chronocoulometry - Fuel cell thermodynamics - Efficiency of fuel cells -fuel cell electrochemistry - Nernst equation, Electrochemical Kinetics - Butler-Volmer equation

UNIT – IV CONSTRUCTION AND WORKING OF FUEL CELLS 9

Fuel cell design and components - Cell components, stack components, system components – Membrane electrode assembly (MEA) preparation - Fuel Cell Performance - Current density and Power density

UNIT – V APPLICATIONS OF FUEL CELLS 9

Hydrogen as Green energy – Energy sectors – Automobile and other industries

TOTAL: 45 PERIODS

COURSE OUTCOMES

. Upon completion of this course, the students will be able to:

1. Understand and appreciate the merits of fuel cell technology.
2. Gain knowledge on the need for development of various types of fuel cells and their scopes for different uses.
3. Apply the principles of thermodynamics and kinetics of fuel cells and make attempts to improve their efficiencies.
4. Acquire and accomplish the information on constructing and designing fuel cells.
5. Analyze the importance of hydrogen as a sustainable and green source of energy and their impact in a national and global context.

REFERENCES

1. J. Larminie and A. Dicks, Fuel Cell Systems Explained, 2nd Edition, Wiley (2003)
2. Xianguo Li, Principles of Fuel Cells, Taylor and Francis (2005)
3. B. Viswanathan and M. Aulice Scibioh, Fuel cells principles and applications, Universities Press (India) Pvt Ltd (2006)
4. Frano Barbir, PEM Fuel cells – Theory and Practice, Elsevier Academic Press (2005)
5. Suddhasatwa Basu, Recent trends in Fuel Cell Science and Technology, Anamaya Publishers (2007)

CO PO Mapping

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	1					3								
2	3	2	1				1								
3	3	3	1	3	3		1								1
4	3	3	2	2	2		1							3	1
5	3	1	1				3							2	3
Avg	3	2	1	1	1	0	3							1	1

ME23905	SUSTAINABLE ENERGY TECHNOLOGIES AND ASSESSMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To study and understand the global and Indian energy scenario
2. To identify the energy demand and bridge the gap with suitable technology for sustainable habitat
3. To learn how to design and conduct performance analysis in various energy systems
4. To get familiar with the energy technology, current status of research and find the ways to optimize a system as per the user requirement
5. To impart basic knowledge related to numerical simulation analysis

UNIT – I ENERGY SCENARIO STATUS AND POLICY 9

Indian and global energy scenario in various sectors – domestic, industrial, commercial, agriculture & transport – Current conventional and renewable energy status in India – Potential of renewable energy sources in India: Present status and future promise – Energy modelling, regression analysis and double moving average – Energy in economic development and social transformation

UNIT – II SOLAR THERMAL & PHOTO VOLTAIC TECHNOLOGY 9

Solar radiation – Measurements of solar radiation and sunshine – Solar thermal collectors and applications – Principle of working, types, design and operation of solar heating and cooling systems– Solar Desalination – Solar cooker – Solar Pond – Solar drying – Semiconductor – properties & energy levels – SPV system design & optimization – Standalone, hybrid, centralized, grid connected and decentralized SPV systems – SPV system maintenance, market analysis and economics.

UNIT – III WIND ENERGY, BIO ENERGY, OTEC & GEOTHERMAL ENERGY 9

Wind data assessment – Site selection for windfarms – Horizontal & vertical axis wind turbine – Environmental issues and applications – Biomass direct combustion – thermochemical & biochemical conversion – Biomass gasifier – Types of biomass gasifiers – Cogeneration & trigeneration – Biogas plants and digesters – Small hydro – Tidal energy – Wave energy – Open and closed cycle ocean thermal energy conversion (OTEC) – Geothermal energy sources – Types of geothermal power plants & Applications.

UNIT – IV ENERGY STORAGE TECHNOLOGIES 9

Necessity of energy storage – types of energy storage – comparison of energy storage technologies – Applications – Thermal storage types – Modelling of thermal storage units – Simple water and rock bed storage system – Fundamental concept of batteries & types, charging and discharging, storage & energy density and safety issues – Hydrogen storage – Flywheel, Super capacitors – Compressed air Energy storage & Concept of Hybrid Storage. TRYNSYS, PY SYST, TONATIUH, ANSYS & COMSOL.

UNIT – V ENERGY: NODAL AGENCIES, RESEARCH CENTRES & GOVERNMENT SHEMES 9

TNEB, TANGEDCO, TANTRANSCO & TEDA – MNRE ministry – NIWE, NISE & NIOT – Government of India initiatives – Green Energy Corridor – Net Metering Policy – International Solar Alliance – Surya Mitra Scheme – International Energy Agency (IEA) – NREL – Platforma Solar De Almeria.

TOTAL: 45 PERIODS

COURSE OUTCOMES

1. Analyze and compare energy scenarios in various sectors globally and in India, evaluate the impact of energy policies.
2. Evaluate solar thermal and photovoltaic systems, assess their market potential and economic viability.
3. Assess wind, bioenergy, OTEC, geothermal, and small hydro systems and evaluate their environmental impacts.
4. Understand and compare various energy storage technologies and model thermal storage units to assess their applications.
5. Identify and describe key energy institutions and policies and evaluate government initiatives and international energy organizations.

REFERENCES

1. Armstrong J.Scott (ed.), Principles of forecasting: a hand book for researchers and practitioners, Norwell, Massachusetts: Kluwer Academic Publishers.2001.
2. Godfrey Boyle, “Renewable Energy, Power for a Sustainable Future”, Oxford University Press, U.K., 2012.
3. Solar Energy International, Photovoltaic – Design and Installation Manual, New Society Publishers, 2006
4. Lovegrove K., Stein W., Concentrating Solar Power Technology, Woodhead Publishing Series in Energy, Elsevier, 1st Edition, 2012
5. John A. Duffie, William A. Beckman, Solar Engineering of Thermal Processes, John Wiley & Sons, 2013
6. Twidell, J.W. & Weir A., “Renewable Energy Resources”, EFNSpon Ltd., UK, 2015.
7. Rai.G.D., “Non-Conventional Energy Sources”, Khanna Publishers, New Delhi, 2014.
8. Ibrahim Dincer and Mark A. Rosen, Thermal Energy Storage Systems and Applications, John Wiley & Sons 2002.
9. Robert Huggins, Energy Storage: Fundamentals, Materials and Applications, 2nd edition, Springer, 2015
10. Ru-shiliu, Leizhang, Xueliang sun, Electrochemical technologies for energy storage and conversion, Wiley publications, 2012.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2			2									1	1	3
2	2	2	2										1	1	3
3	2	2					2						1	1	3
4	2	2					2						1	1	3
5													1	1	3
Avg	2	2	2	2			2						1	1	3

ME23906 MODERN HEALTHCARE MACHINES L T P C

3 0 0 3

COURSE OBJECTIVES:

1. To create awareness about over modern healthcare machines
2. To understand the basic equipment's/machines in Healthcare industry
3. To appreciate the application of Intelligent machines and applications of AI & ML in imaging
4. To recognise the role of maternal machines in future
5. To explain the role of Digital technologies in modern healthcare Industry

UNIT – I INTRODUCTION 9

Healthcare and hospitals, Need- Resilience in a crisis- past & present Technologies, contents of First-aid-kit-digital healthcare-AI in healthcare, -Barriers to digital transformation-strategic partnerships- global leaders in healthcare- Skills-sustainable systems-Emergency codes-Advantages and Limitations.

UNIT – II BASIC EQUIPMENT'S 9

History-Stethoscope- Thermometer-weigh scale-BP Machine-Air purifier- Blood glucose meter-Pulse-oximeter-Nebuliser-ECG- working – input data and output interpretation methodology- Inside ICU: Patient Monitor-ventilator-Role of Mobility solutions-Analytics and alarm management, case studies.

UNIT – III INTELLIGENT IMAGING MACHINES 9

Contrast Media-Fluoroscopy- Computer Tomography- Magnetic Resonance-Mammograpgy, Molecular Imaging, Radiography (X-Ray)-Dual Energy X-Ray Absorptiometry (DXA)-Ultrasound Imaging- Application of AI & ML in Imaging-Case studies

UNIT – IV MATERNAL MACHINES 9

CASA- Anaesthesia workstation- ICSI Equipments-Warmers- Incubation carestation- Resuscitation Systems-Phototherapy system - Fetal Monitors-Application of AI in Maternal Machines-Case studies

UNIT – V DIGITAL HEALTHCARE 9

Transformation history- Personalised Healthcare-3D printing-TeleHealthcare - Health 4.0-MIoT-Digital Twin in Healthcare-Societal and Ethical aspects- Case studies.

TOTAL: 45 PERIODS

COURSE OUTCOMES

The students will able to

1. Remember the role modern healthcare machines
2. Ability to understand and Interpret the results from basic healthcare equipment's
3. Appreciate the role of AI and ML in Medical Imaging
4. Understand the capability of Maternal Machines
5. Discover the role digital technologies in modern healthcare industry

.

REFERENCES

1. Geddes LA and Baker L.E Principals of Applied Biomedical Instrumentation, 3rd Edition, John Wiley and sons, New york 1989
2. Joseph J Carr and John Brown - Introduction to Biomedical equipment Technology- Pearson Education 4th edition New Delhi 2001.
3. Seeram Ramakrishna, Lingling Tian, Charlene Wang, Susan Liao, Wee Eong Teo, Medical Machines, 1st edition, Elseiver, 2015, ISBN: 9780081002896
4. Shivani Chandra, Ankur Saxena, Artificial Intelligence and Machine Learning in Healthcare, Springer Imprint, 2021
5. Abdulmotaleb El Saddik, Digital Twins for Healthcare, Elsevier Science, 2022, 97803239916

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	1	1											3
2	3	3	1	1											3
3	3	3	3	3	3									3	3
4	3	3	3	3	3									3	3
5	3	3	3	3	3									3	3
Avg	3	3	2.2	2.2	3									3	3

ME23907	ENERGY AUDITING AND CONSERVATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To understand the various methods of energy auditing and management.
2. To carryout energy accounting and balancing
3. To impart knowledge on the various energy conservation opportunities of utilities.

UNIT – I INTRODUCTION 9

Types & Forms of Energy - Primary / Secondary Energy Sources –EC Act 2003 - Energy Auditing: Types, classifications, deliverables, barriers – Benchmarking - Roles & Responsibility of Energy Managers and Auditors – Basic Instruments for Energy Auditing.

UNIT – II ENERGY COSTING AND ECONOMICS 9

Data & Information Analysis – Energy Accounting and Balancing - Energy ROI – Depreciation - Financial Analysis Techniques – Discount Rate, Payback Period, Internal Rate of Return, Net Present Value, Life Cycle Costing – ESCO concept – CUSUM Technique – ESCO Concept – ESCO Contracts.

UNIT – III ELECTRICAL SYSTEMS 9

TANGEDCO Billing – HT and LT supply - Transformers - Efficiency - Power Factor - Harmonics, Electric Motors - Motor Efficiency Computation, Energy Efficient Motors, Illumination – Lux, Lumens, Types of lighting, Efficacy, LED Lighting and scope of Encon in Illumination.

UNIT – IV THERMAL SYSTEMS 9

Stoichiometry, Combustion principles, Boilers, Furnaces and Thermic Fluid Heaters – Efficiency Computation and Encon Measures - Steam Traps - Cogeneration - Waste heat recovery devices.

UNIT – V ENERGY CONSERVATION IN MAJOR UTILITIES 9

Pumps, Fans, Blowers, Compressed Air Systems, Refrigeration and Air Conditioning Systems - Cooling Towers – D.G. sets.

TOTAL: 45 PERIODS

COURSE OUTCOMES

TEXT BOOKS

1. Energy Manager Training Manual (4 Volumes) available at https://beeindia.gov.in/content/energy-auditors, a website administered by Bureau of Energy Efficiency (BEE), a statutory body under Ministry of Power, Government of India, 2017.
2. Barney L. Capehart, Wayne C. Turner, and William J. Kennedy, Guide to Energy Management, Fifth Edition, The Fairmont Press, Inc., 2006

REFERENCES

1. L.C. Witte, P.S. Schmidt, D.R. Brown, “Industrial Energy Management and Utilisation” Hemisphere Publ, Washington, 1988.
2. Callaghn, P.W. “Design and Management for Energy Conservation”, Pergamon Press, Oxford,1981.
3. I.G.C. Dryden, “The Efficient Use of Energy” Butterworths, London, 1982
4. W.C. turner, “Energy Management Hand book” Wiley, New York, 1982
5. W.R. Murphy and G. McKay “Energy Management” Butterworths, London 1987
6. Ursala Eicker, “Solar Technologies for buildings”, Wiley publications, 2003
7. Eastop T.D & Croft D.R, Energy Efficiency for Engineers and Technologists,. Logman Scientific & Technical, ISBN-0-582-03184, 1990.

ME23908	FUTURE ENERGY RESOURCES AND MOBILITY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

The main objective of the course is to expose the students to various future energy resources and mobility

UNIT – I CURRENT AND FUTURISTIC ENERGY RESOURCES 9

High Carbon Fuels - Gasoline and Diesel Fuels. Low Carbon Fuels – Ethanol, Methanol, Isobutanol, Dimethyl Ether(DME), Polyoxymethylene Dimethyl Ether (PODE), Compressed and Liquified Natural Gas (CNG & LNG). Zero Carbon Fuels – Hydrogen and Ammonia Fuels. – Physiochemical Properties – Improvements in Fuel Quality as per BS Norms – Current and Future plans on storage and distribution infrastructures.

UNIT – II ALTERNATE ENERGY RESOURCES 9

Fuel Cell stacks – Types – Working, Batteries – Types – Working – Materials, Comparison of Fuel Cell and Battery. Future scopes in Fuel Cell and Batteries.

UNIT – III CURRENT AND FUTURE INTERNAL COMBUSTION ENGINES(ICE) FOR MOBILITY 9

BSVI Qualified ICE Powered Vehicles and Technologies, Conventional Hybrid Vehicle Technologies, Advanced Combustion Mode enabled ICEs and Hybrids, Hydrogen and Ammonia Fuelled ICEs, Flexi Fuel Engines. Low Carbon Fuelled ICEs. Decarbonisation and De-fossilization.

UNIT – IV ALTERNATE ENERGY RESOURCES POWERED MOBILITY 9

Fuel Cell Powered Vehicle Technologies, Battery Powered Electric Vehicle Technologies, Requirements of fuelling and charging Infrastructures, Comparison of Merits and Demerits, Life cycle analysis and Carbon credit gained between Alternate and Conventional Fuel powered mobility.

UNIT – V DATA ANALYSIS OF CURRENT AND FUTURE MOBILITY APPLICATIONS 9

Student should analyse and present the case study report by observing the market trends and predictions by reading reports, magazines, research articles, books, chapters, and online tools. **Evaluation of student case study report can be performed by Power Point Presentation or Correcting Hard Copy Reports.**

TOTAL: 45 PERIODS

COURSE OUTCOMES

CO1: Knowledge on impact of high and low carbon energy resource on mobility

CO2: Synergetic knowledge on fuel cells Battery energy sources

CO3: Knowledge on conventional and future propulsion system

CO4: Knowledge on alternate energy sources powered mobility

CO5: Capability to perform data analysis of conventional and future propulsion systems.

REFERENCES

1. Pundir B.P. I.C. Engines Combustion and Emission, 2010, Narosa Publishing House
2. Barclay F.J., Fuel Cells, Engines and Hydrogen, Wiley, 2009.
3. Bent Sorensen (Sørensen), Hydrogen and Fuel Cells: Emerging Technologies and Applications,
4. Elsevier, UK 2005.
5. HCCI Diesel Engines - Nptel - https://nptel.ac.in/courses/112104033/34
6. HCCI and CAI Engines – Nptel - https://nptel.ac.in/courses/112104033/33 CO PO PS
7. Rakesh_Kumar_Maurya Characteristics and Control of Low Temperature Combustion Engines,
8. Springer - ISSN 0941-5122 ISSN 2192-063X (electronic), Mechanical Engineering Series, ISBN
9. 978-3-319-68507-6 ISBN 978-3-319-68508-3 (eBook), https://doi.org/10.1007/978-3-319-
10. 68508-3.
11. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and
12. Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
13. Rand D.A.J, Woods, R & Dell RM Batteries for Electric vehicles, John Wiley & Sons 1998

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	1						1			1	3		2
2	3	2	1						1			1	3		2
3	2	3	2		1		2		2		2	1	3	1	2
4	3	2	1				1		1			1	3		2
5	2	2	2		2		2		1		1	1	3	1	2
Avg	2.6	2.2	1.2		1.2		1.6		1.2		1.2	1	3	1	2

ME23909	HYDROGEN AS A FUEL FOR POWERTRAINS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. The main learning objective of this course is to prepare the students:
2. To acquaint with the benefits, properties and availability of hydrogen as an energy source in many engineering applications
3. To develop an understanding of using hydrogen as a fuel for spark ignition (S.I.) internal combustion engines
4. To develop an understanding of using hydrogen as a fuel for compression ignition (C.I.) internal combustion engines
5. To acquaint with the basic principle of operation of hydrogen fuel cells and its environment impacts
6. To appreciate the application and limitations of using hydrogen fuel cells in vehicles

UNIT – I HYDROGEN AS ENERGY SOURCE 9

Hydrogen Production: Thermal Processes, Electrolytic Processes, Photolytic Processes - Hydrogen Distribution - Hydrogen Storage - Combustion Properties - Pollution - World and Indian Scenario

UNIT – II HYDROGEN IN S.I. ENGINE SYSTEM 9

Design modification of Engine, Combustion Characteristics - Dual Fueling, Direct Injection of Gaseous and Liquefied Hydrogen.

UNIT – III HYDROGEN IN C.I. ENGINE SYSTEM 9

Design modification of Engine, Combustion Characteristics - Dual Fueling, Direct Injection of Gaseous and Liquefied Hydrogen. Hydrogen enrichment

UNIT – IV FUEL CELLS 9

Fuel Cells: Description, working principle, anodic, cathodic and cell reactions - fabrication of electrodes and other components- applications - advantages, disadvantages and environmental aspects - Fuels for Fuel Cells: Hydrogen - Sources and preparation, reformation processes for hydrogen - clean up and storage of the fuels - use in cells, advantages and disadvantages of using hydrogen as fuel.

UNIT – V FUEL CELL FOR VEHICLES 9

Operating Principle - Fuel Cell Stack Assembly - Drive Train details- Safety Aspects of a Hydrogen Fuel Cell - FCVs vs BEVS vs ICE - Challenges Ahead for FCVs

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon successful completion of the course, students will be able to:

1. Understand the benefits, properties and availability of hydrogen as an energy source in many engineering applications
2. Analyse the hydrogen's performance as a fuel for spark ignition (S.I.) internal combustion engines
3. Analyse the hydrogen's performance as a fuel for compression ignition (C.I.) internal combustion engines

4. Understand the basic principle of operation of hydrogen fuel cells and its environment impacts
5. Appreciate the application and limitations of using hydrogen fuel cells in vehicles

REFERENCES

1. Johannes Topler and Jochen Lehmann, Hydrogen and Fuel Cell Technologies and Market Perspectives, Springer, 2016
2. Pasquale Corbo, Fortunato Migliardini and Ottorino Veneri, Hydrogen Fuel Cells for Road Vehicles (Green Energy and Technology), Spinger, 2011.
3. Alternative Fuels (A decade of success and Promise) edited by Reda Moh.Bata,SAE PT-48, ISBN 1-56091 – 593 – 5.
4. Hydrogen Fuel Cells for Road Vehicles, April 2010, Springer

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	1	1	1	1	2							3	3	3
2	3	3	3	3	1	2							3	3	3
3	3	1	3	3	3	2							3	3	3
4	3	3	3	3	3	2							3	3	3
5	3	3	3	3	3	2							3	3	3
Avg	3	2.2	2.6	2.6	2.2	2							3	3	3

ME23910	CONCEPTS OF COMPETITIVE MANUFACTURING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1 To explain the lean principles and the need to follow these principles in industries.
2 To give an overview of the various tools and techniques involved in lean manufacturing used in industries.
3 To learn the basics involved in Green manufacturing.
4 To give an understanding of the various tools used in a six sigma project for quality improvement.
5 To provide an overview of the DMAIC methodology in a six sigma project.

UNIT – I LEAN MANUFACTURING 9

Evolution of Mass production, Evolution of Toyota (Lean) Production System, Need for Lean production, 7 Wastes in Manufacturing, Principles of Lean production – Value, Value stream, Flow, Pull, Perfection.

UNIT – II LEAN MANUFACTURING – TOOLS AND TECHNIQUES 9

Lean Tools to eliminate waste - 5S, Standardised work, TPM, Poka Yoke, JIT, Kanban, Value stream mapping. Lean manufacturing in service industries

UNIT – III GREEN MANUFACTURING 9

Green manufacturing - Definition, motivation and barriers to green manufacturing - Environmental impact of manufacturing - Waste generation- Energy consumption - Strategies for green manufacturing – Green manufacturing by design – Life cycle assessment.

UNIT – IV SIX SIGMA – TOOLS AND TECHNIQUES 9

Cost of Quality – Conformance and Non-Conformance cost, Seven Basic Quality Control Tools, Seven Management tools, FMEA.

UNIT – V SIX SIGMA METHODOLOGY 9

Need for Six Sigma, Six Sigma Team, DMAIC Methodology - Define, Measure, Analyse, Improve and Control; Lean Six Sigma

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

1. Describe the importance and evolution of lean principles.
2. Apply the various tools, techniques and methodology of lean manufacturing to improve the efficiency of an organization.
3. Explain the need for green manufacturing techniques.
4. Explain the various tools and techniques needed for a six sigma project.
5. Apply six sigma methodology to improve quality in a given situation.

TEXT BOOKS

1. Issa Bass and Barbara Lawton, “Lean Six Sigma using Sigma XL and Minitab”, Tata McGraw Hill 2010.
2. Pascal Dennis, “Lean production Simplified: A plain language guide to the world’s most powerful Production system”, Productivity Press 2007

REFERENCES

1. Dornfield David, “Green Manufacturing”, Springer, 2012
2. James Womack and Daniel T. Jones, “Lean Thinking: Banish waste and create wealth in your organization”, Free Press 2003.
3. Donna C. S. Summers, “Six sigma: Basic tools and techniques”, Pearson / Prentice Hall 2007.
4. Mike Rother and Rother Shook, “Learning to See: Value-Stream Mapping to Create Value and Eliminate” Muda, The Lean Enterprise Institute 2003
5. Yasuhiro Monden, Toyota Production System: “An Integrated approach to Just-in-Time”, CRC Press 2012

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3			2					1		3		3
2	3	3	3			2					1		3		3
3	3	3	3			2					1		3		3
4	3	3	3			2					1		3		3
5	3	3	3			2					1		3		3
Avg	3	3	3			2					1		3		3

ME23911	SOLAR ENERGY TECHNOLOGIES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

The main objective of this course is to expose the students to various solar energy technologies

UNIT – I SOLAR DOMESTIC WATER HEATING **9**

Solar flat plate collector - evacuated tubular collectors - concentrator collectors – Components of collectors – Collector performance – System layouts and installation solar water heating systems- Reduction of fuel bills and pollution.

UNIT – II SOLAR LIGHTING **9**

Solar cell and its types – Working principle of a solar cell – Solar home lighting systems – Solar street lighting systems - Solar lanterns – Applications - Rural electrification process – standalone and grid connected PV systems

UNIT – III SOLAR COOKING **9**

Introduction – Types of solar cookers – Advantages and disadvantages - Box type – Parabolic dish cooker - Performance evaluation of solar cookers – Testing of a solar cooker – Applications of solar cooking - Solar Steam Cooking System

UNIT – IV SOLAR DRYING AND SOLAR DESALINATION **9**

Introduction – Need for solar drying - Basics of solar drying – Types of solar dryers – Applications- Performance evaluation.

Necessity for desalination - Basics of solar still – Components of solar still – Performance evaluation - Socioeconomic Benefits

UNIT – V SOLAR COOLING **9**

Solar Refrigeration and air conditioning – Absorption cooling – Adsorption cooling - Solar powered vapor compression system – Peltier cooling - Desiccant Cooling - Zero energy buildings.

TOTAL: 45 PERIODS

COURSE OUTCOMES

1. Explain the solar domestic water heating
2. Summarize the working of solar lighting
3. Describe the working, types, testing of solar cooking
4. Discuss the solar drying and desalination processes
5. Summarize the solar cooling process

TEXT BOOKS

REFERENCES

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1						1						1			
2	2	2	2			1	2				1	1	2		1
3	1	2	2			1	2				1	1	2		1
4	2	1	2			1	2				1	1	2		1
5	2	2				1	2				1	1	2		1

ME23S01 **FUNDAMENTALS OF PRACTICAL MANUFACTURING SKILLS** **L T P C**
0 0 2 1

OBJECTIVE

This course focuses on developing practical skills in key manufacturing processes, including welding, casting, rolling, and drawing.

Lab Exercise

1. **Introduction and Safety Protocols**
    - Introduction to manufacturing processes
    - Lab safety training
    - Overview of lab equipment and tools
2. **Basics of Gas Metal Arc Welding (GMAW) & GAS Tungsten Arc Welding (GTAW)**
    - Principles of GMAW & GTAW
    - Equipment setup and electrode selection
    - Basic welding practice
3. **Welding Techniques and Joint Fabrication**
    - Types of welding joints (butt, lap, T-joints)
    - Hands-on practice welding different joints
4. **Sand Casting**
    - Introduction to sand casting
    - Common casting defects
    - Inspection and testing methods
5. **Rolling Process Fundamentals**
    - Basics of rolling (hot vs. cold rolling)
    - Rolling machine setup and operation
    - Hands-on practice reducing plate thickness
6. **Drawing Process Fundamentals**
    - Fundamentals of wire and rod drawing
    - Drawing machine setup and operation
    - Hands-on practice with metal rods
7. **Integration of Manufacturing Processes**
    - Demonstrate different geometrical shapes using sheet metal
    - Fabricate any complicated structures using different welding processes.
    - Make various mould shapes for the sand casting process.

Lab Equipment and Materials:

- GMAW and GTAW machine
- Sand moulding equipment
- Stir casting machine
- Rolling machine
- Drawing machine
- Safety gear (gloves, goggles, aprons)

TOTAL: 30 PERIODS

OUTCOME

Upon completing of the course students will be able to:

- Demonstrate GMAW and GTAW process
- Analyse casting defects
- Apply Metal forming process

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	1			2		1	1	3		3	3	2	2	2
2	2	1			2		1	1	3		3	3	2	2	2
3	2	1			2		1	1	3		3	3	2	2	2
Avg	2	1			2		1	1	3		3	3	2	2	2

ME23S02 PRACTICAL PROFICIENCY IN MACHINING AND MEASUREMENT **L T P C**

OBJECTIVE **0 0 2 1**

This course's aim is to demonstrate various methods of machining, measurement, and assembly.

Lab Exercise

1. **Introduction and Safety Protocols**
   a. Introduction to precision machining
   b. Lab safety training
   c. Overview of lab equipment and tools
2. **Introduction to Machining**
   a. Mechanisms of Different Machines
   b. Selection of machine tools and materials
3. **Fastener Fabrication**
   a. Fabrication of bolts, nut using lathes and threading tools
   b. Machining of Splines, Keyways
   c. Hands-on practice: Make Nut & Bolt to specified dimensions
4. **Making Gears**
   a. Purpose and applications of Gears
   b. Hands on Practise : Machining Gears using different techniques
5. **Measurements**
   a. Need for Tolerances and measurements
   b. Geometrical and Form measurements – Basics
   c. Measurement of Thread and Gear Parameters
   d. Straightness and Flatness measurements
6. **Final Project: Integration of Machining Processes**
   a. Produce the system components as per the given dimensions and tolerances in the drawing.
   b. Design and Fabrication of Different Mechanisms used in lathe, Milling Machine, Shaper, Slotter, etc.
   c. Process planning and documentation

Lab Equipment and Materials:

- Vertical Milling machine
- Radial Drilling Machine
- Shaper
- Slotter
- Broaching Machine
- Gear Shaper
- Gear Hobbing Machine
- Lathes
- Measurement tools
- Safety gear (gloves, goggles, aprons)

TOTAL: 30 PERIODS

OUTCOME

Upon completing of the course students will be able to:

1. Demonstrate Proficiency in Machining Safety Protocols
2. Execute machining Operations
3. Fabricate High-Quality Fasteners
4. Demonstrate Different measuring methods
5. Integrate Multiple Machining Processes

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	1			2		1	1	3		3	3	2	2	2
2	2	1			2		1	1	3		3	3	2	2	2
3	2	1			2		1	1	3		3	3	2	2	2
4	2	1			2		1	1	3		3	3	2	2	2
5	2	1			2		1	1	3		3	3	2	2	2
Avg	2	1			2		1	1	3		3	3	2	2	2

ME23S03	TURNING -NUMERICAL CONTROL PROGRAMMING	L	T	P	C
		0	0	2	1

COURSE OBJECTIVES:

1. Understand CNC Technology Fundamentals
2. Learn CNC Controller Basics
3. Develop CNC Part Programming Skills
4. Master Turning Cycles and Milling Integration
5. Perform and Optimize Milling Program Simulations

UNIT – I Introduction to CNC 6

Principles of CNC Machines, components, tools, drives, feedback systems, coordinate systems

UNIT – II Introduction to CNC controller (808D) 6

Overview of CNC controllers, components, basic operations, operator panel, interface, I/O modules.

UNIT – III Introduction to CNC Part Programming 6

Fundamentals, G codes, M Codes, programming structure, blocks, sequences, functions, tool paths, coordinate systems, work offsets and tool offsets, tool selection and tool path generation.

UNIT – IV Standard Turning cycles for Turning functions 6

Introduction to turning cycles, syntax and parametrs, roughing, finishing, threading and grooving, optimizing turning operations.

UNIT – V Turning Program Simulation 6

Importance of program simulation, optimization of tools paths and cycle times, interpreting simulations results, practical exercises

TOTAL: 30 PERIODS1`

COURSE OUTCOMES

Upon successful completion of the course, students should be able to

1. Explain applications and advantages of CNC machines and technology.
2. Demonstrate and explain various CNC control Calculate technological data for CNC machining and part programming.
3. Understand the importance and use of PPE's.
4. Expose with CNC turning operation
5. Simulate the turning machine with program

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3		3									3	3
2	3	3	3		3									3	3
3	3	3	3		3									3	3
4	3	3	3		3									3	3
5	3	3	3		3									3	3
Avg	3	3	3		3									3	3

ME23S04 NON-DESTRUCTIVE EVALUATION L T P C

1 0 0 1

COURSE OBJECTIVES:

The main learning objective of this course is to prepare the students

1. Provide a thorough understanding of materials, destructive testing, and non-destructive testing (NDT) methods
2. Introduce the concept of NDE 4.0, predictive maintenance, IoT, AI, ML, and automated defect detection
3. Teach measurement uncertainties, statistical tools, and frameworks for evaluating the reliability of NDT methods
4. Familiarize students with non-conventional NDT methods like thermography, shearography, leak testing, and more.
5. Examine advanced NDT methods and their applications across various industries, along with certification standards.

UNIT – I Introduction 3

Materials - Destructive testing-Non-destructive testing- Basic methods of NDT under various societies- Advent of digital Radiography and Computed Tomography – Integration of Advanced Sensors and Robotics.

UNIT – II NDE 4.0 and Beyond 3

Introduction – Predictive Maintenance – Internet of Things (IoT) – Integration of Artificial intelligence (AI) and Machine Learning (ML) – Automated Defect Detection – Robotic Inspection – Swarms of Miniature Robots – Multi-Modal Sensors – Portable and Wireless Sensors – Real-Time Monitoring – Remaining Useful Life Estimation.

UNIT – III Reliability in NDE 3

Measurements and uncertainties - Definitions and statistical tools - Statistical indicators to evaluate reliability in NDE - The standard framework - General overview - Deterministic and statistical approaches - Details on the main reference documents and standards (RSEM, ASME-BPVC, DNV OS F101, MH1823A, ENIQ RP41).

UNIT – IV Non-Conventional NDT Methods 3

Thermography-Shearography-Leak Testing-Magnetic Flux Leakage-Microwave Testing-Neutron Radiographic Testing-Vibration Analysis.

UNIT – V Advanced NDT Methods Application on Various Industries and Certification 3

PAUT / TOFD / TFM- Eddy Current Array-Pulsed Eddy Current. Aviation-Marine-Oil & Gas-Mining-Automobiles-Petrochemical. Certification Levels-Standards

TOTAL: 15 PERIODS

COURSE OUTCOMES

Upon successful completion of the course, students should be able to

1. Demonstrate Knowledge of NDT Fundamentals
2. Apply of predictive maintenance through IoT, AI, and ML in NDT.

3. Use statistical tools to evaluate the reliability of NDT methods with standards.
4. Implement non-conventional NDT Methods.
5. Apply advanced NDT methods in industries like aviation, marine, oil & gas, mining, automobiles, and petrochemical sectors.

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	1	1	1	1								1		1
2	3	1	3	3	3								2		3
3	3	3	3	3	3								2		3
4	3	3	3	3	3								2		3
5	3	3	3	3	3								2		3
Avg	3	2.2	2.6	2.6	2.6								1.8		2.6

ME23S05 **PIPING DESIGN** **L T P C**

1 0 0 1

COURSE OBJECTIVES:

The main learning objective of this course is to prepare the students.

1. Understand Material Selection and Piping Basics
2. Comprehend Pipe and Pipe Fitting Components
3. Analyze Valves and Valve Actuators
4. Design and Implement Standard Piping Practices
5. Master Piping Elements and Support Systems

UNIT – I INTRODUCTION TO FUNDAMETALS OF PIPING 3

Material Selection, Types, Size, Schedule, Method of Joining, Drawing

UNIT – II PIPE AND PIPE FITTING 3

Types - Pipes, Bolts, Gaskets, Body, Bonnet, Trim, Disk & Seat, Stem, Actuator, Packing.

UNIT – III VALVES AND VALVE ACTUATOR 3

Valves and - types, selection criteria , construction . Valve actuator - types , selection criteria , construction

UNIT – IV STANDARD PIPING 3

Pipe Rack Spacing - Pipe Flexibility - Heat Expansion - Pipe Anchors - Pipe Insulation Shoes - Pipe Guides, Pipe Span, Pipe Support, Field Support, Dummy Support, Hanger Rods

UNIT – V PIPING ELEMENTS 3

Pipe Guides, Pipe Span, Pipe Support, Field Support, Dummy Support, Hanger Rods

TOTAL: 15 PERIODS

COURSE OUTCOMES

Upon successful completion of the course, students should be able to

1. Demonstrate Material Selection Proficiency
2. Explain Pipe and Fitting Components
3. Evaluate and Select Valves and Actuators
4. Design Standard Piping Systems
5. Implement Effective Piping Supports

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	1	3										3		3
2	3	1	3										3		3
3	3	3	3										3		3

4	3	3	3										3		3
5	3	3	3										3		3
Avg	3	2.2	3										3		3

ME23S06 Fundamentals of Practical Analysis Skills Using ANSYS **L T P C**
0 0 2 1

Course Overview:

This course provides undergraduate mechanical engineering students with essential practical analysis skills using ANSYS and emphasizing Finite Element Analysis (FEA).

Course Objectives:

The main learning objective of this course is to provide hands on training to the students in:

1. Demonstrating foundational knowledge of ANSYS software.
2. Applying geometric modeling techniques in practical scenarios.
3. Analyzing mesh types and settings to ensure accurate simulation results.
4. Conducting static and dynamic analyses to solve engineering problems.
5. Applying heat transfer principles in comprehensive projects.

Lab Exercise

1. **Getting Started with ANSYS**
   - Overview of ANSYS software
   - Installation and setup
   - Navigating the user interface
2. **Geometric Creation and import**
   - Geometric modeling in ANSYS
   - Importing external geometries
   - Editing and manipulating geometries
3. **Mesh Generation**
   - Introduction to meshing
   - Structured and unstructured mesh types
   - Mesh controls and settings
   - Boundary layer meshing
   - Tetrahedral and hexahedral meshing
   - Mesh quality and refinement
4. **Static Structural Analysis**
   - Setting up a static analysis
   - Applying loads and constraints
   - Solving and interpreting results
5. **Dynamic Analysis**
   - Introduction to dynamic analysis
   - Modal analysis
6. **Heat Transfer Analysis**
   - Conductive, convective, and radiative heat transfer
   - Thermal boundary conditions
   - Coupled fluid-thermal analysis
7. **Project Work and Advanced Topics**
   - Integrating learned concepts into a comprehensive project
   - Exploring advanced ANSYS features and capabilities
   - Applying troubleshooting techniques and best practices

TOTAL: 30 PERIODS

Course Outcomes:

Upon completion of this course, the students will be able to:

1. Analyze the concepts of Finite Element Analysis (FEA).
2. Apply structural and thermal analysis techniques with ANSYS.
3. Evaluate simulation results accurately.
4. Solve real-world engineering problems with simulation techniques.
5. Apply knowledge to develop and complete comprehensive projects.

CO's	PO's												PSO's		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	3	3		3			1	1	1		1	3	3	
2	3	3	3	2	3			1	1	1		1	3	3	
3	3	3	3	2	3			1	1	1		1	3	3	
4	3	3	3	2	3	2		1	1	1		1	3	3	2
5	3	3	3	2	3			1	2	1		1	3	3	1
Avg.	**3**	**3**	**3**	**2**	**3**	**2**		**1**	**1.2**			**1**	**3**	**3**	**1.5**

ME23S07 PHYSICAL MODELLING AND ANALYSIS OF MECHANICAL ENGINEERING SYSTEMS **L T P C**

OBJECTIVE **0 0 2 1**

To enable students to understand and analyze thermal and mechanical systems through physical modeling using MATLAB Simscape.

Lab Exercise

1. **Introduction to Physical Modelling in Engineering**
   - Understanding physical modelling and advantages with conventional analysis methods
   - Hands on experience with Simscape tools and functions
   - Overview of tutorials to be covered
2. **Modelling Simple Pendulum**
   - Formulation of mathematical model
   - Solution methods – Analytical and Numerical
   - Solution using SIMULINK
   - Solution using SIMSCAPE
3. **Modelling Spring-Mass Damper System**
   - Formulation of mathematical model
   - Solution methods – Analytical and Numerical
   - Solution using SIMULINK
   - Solution using SIMSCAPE
4. **Modelling Elastic Collision of Two Masses**
   - Formulation of mathematical model
   - Solution methods – Analytical and Numerical
   - Solution using SIMSCAPE
5. **Modelling Pressure Drop in a Flow Through Pipe**
   - Formulation of mathematical model
   - Solution methods – Analytical and Numerical
   - Solution using SIMSCAPE
6. **Modelling Steady-State Heat Conduction**
   - Formulation of mathematical model
   - Solution methods – Analytical and Numerical
   - Solution using SIMULINK
   - Solution using SIMSCAPE
7. **Modelling Transient Heat Conduction**
   - Formulation of mathematical model
   - Solution methods – Analytical and Numerical
   - Solution using SIMULINK
   - Solution using SIMSCAPE

Lab Equipment and Materials:

- Computer installed with MATLAB SIMULINK

TOTAL: 30 PERIODS

OUTCOME

Upon completing of the course students will be able to:

1. Mathematical modelling of a physical problem related to mechanical engineering domain
2. Choose relevant tool for the analysis of mathematical model
3. Proficiency in MATLAB SIMSCAPE in modelling and analysis of physical problem

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3			3				1		3	3	3	2	1
2	3	3			3				1		3	3	3	2	1
3	-	3			3				1		3	3	3	2	1
Avg	3	3			3				1		3	3	3	2	1

ME23S08 **VIRTUAL MODELLING AND ANALYSIS OF THERMAL POWER PLANTS** **L T P C 0 0 2 1**

OBJECTIVE

This skill development course focuses on developing practical skills in thermal power plant configuration, instrumentation, control system and other critical parameters.

Lab Exercise

1. **Thermal power plant introduction**
   - Introduction to thermal power plants
   - Thermal power cycles (Carnot, Rankine, Brayton, etc.,)
   - Components available
2. **Basics of thermal power plant**
   - Energy balancing
   - Analysis of saturation dome (Wet, dry, saturated & superheated steam)
   - Sub critical, critical, super critical & ultra-super critical technology
3. **Power plant operation**
   - Design, process Control and safety
   - Steam boiler, centrifugal pump, heat exchanger and furnace
   - Hands-on virtual practice
4. **Power generating unit**
   - Open and closed cycle system
   - Steam turbine
   - Gas turbine
   - Fuels used

Lab Equipment / software:

- Power plant simulation software package

TOTAL: 30 PERIODS

OUTCOME

Upon completing of the course students will be able to:

- Virtually design and analyse thermal power plant
- Operate the power plant under different power cycles
- Optimize the process parameters for sustainable power generation

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	1			2			1			3	3		3	1
2	2	1			2			1			3	3		3	1
3	2	1			2			1			3	3		3	1
4	2	1			2			1			3	3		3	1
5	2	1			2			1			3	3		3	1
Avg	2	1			2			1			3	3		3	1

ME23001	VALUE ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

The main Objective of the course is to understand and apply the fundamental concepts and principles of value engineering in product design, manufacturing and maintenance.

UNIT I INTRODUCTION TO VALUE ENGINEERING 9

Definition of Value, Value Analysis, Value Engineering, Value Management – Meaning of Value, Types of Value & their Effect in Cost Reduction – Value Analysis versus Value Engineering – Value Analysis versus Traditional Cost Reduction Techniques – Uses, Applications, Advantages and Limitations of Value Analysis. Symptoms to Apply Value Analysis – Coaching of Champion Concept. Reasons for Unnecessary Cost of Product – Peeling Cost: Onion Concept – Unsuspected Areas Responsible for Higher Cost - Value Analysis Zone – Attractive Features of Value Analysis – Value Analysis Procedure by Simulation.

UNIT II VALUE ENGINEERING & FUNCTIONAL COSTS 9

Definition: Function and Functional Cost – Rules for Functional Definition - Types of Functions: Primary and Secondary Functions using Verb and Noun – Function Evaluation Process, Methods of Function Evaluation – Evaluation of Function by Comparison – Evaluation of Interacting Functions – Evaluation of Function from Available Data – Matrix Technique – MISS Technique – Numerical Evaluation of Functional Relationships - Steps in problem setting System – Identification, Separation andGrouping of functions – Various Steps in Problem Solving.

UNIT III VALUE ENGINEERING JOB PLAN 9

Definition and Importance of Value Engineering Job Plan – Phases of Job Plan Proposed by Different Value Engineering Experts: Information Phase, Analysis Phase, Creative Phase, Judgement Phase, Development Planning Phase – Cost Reduction Programs – Criteria for Cost Reduction Program – Value Analysis Change Proposal.

UNIT IV VALUE ENGINEERING TECHNIQUES 9

Basic Value Engineering Techniques: Result Accelerators or New Value Engineering Techniques – Listing – Role of Techniques in Value Engineering – Details with Case Examples for Each of the Techniques. Advanced Value Engineering Techniques: Functional Analysis System Technique and Case Example – Value Analysis of Management Practice (VAMP):Steps in VAMP, Application of VAMP to Government, University, College, Hospitals, School Problems etc., (Service Type Problems).

Total Value Engineering: Concepts, Need, Methodology and Benefits

UNIT V APPLICATION OF VALUE ANALYSIS 9

Application of Value Analysis: Cost Reduction, Engineering Design, Manufacturing, Purchasing, Material Management, Quality Control, Sales Management, Marketing Management, Accounting, Appearance Design. Comparison of Approach of Value Analysis &Other Management Techniques.

TOTAL : 45PERIODS

COURSE OUTCOMES:

CO1 Apply the fundamental concepts and principles of value engineering in product design, manufacturing and maintenance.

CO2 Apply the principles of functional costing in value engineering in the product design, manufacturing and maintenance.

CO3 Apply the principles of job plan in value engineering in the product design, manufacturing and maintenance.

CO4 Apply the principles of various techniques in value engineering in the product design, manufacturing and maintenance.

CO5 Apply the principles of value analysis in the product design, manufacturing and maintenance.

TEXT BOOKS:

1. Anil Kumar Mukhopadhyaya, Value Engineering: Concepts, Techniques and Applications, Sage Pub., 2019.
2. Lawrence D. Miles, Techniques of Value Analysis and Engineering, Amazon Asia-Pacific Holding Pvt. Ltd., 3rd Ed., 2015.

REFERENCES:

1. Del Younker, Value Engineering Analysis and Methodology, Taylor & Francis, 2003.
2. G.Jagannathan, Getting More at Less Cost: The Value Engineering Way, Tata Mcgraw Hill Pub. Co., 1995.
3. Arther E Mudge, Value Engineering, McGraw Hill Book Co., 1981.
4. Edward D Heller, Value Management, Value Engineering and Cost Reduction, Addison Wesley Pub. Co., 1971.
5. Warren J Ridge, Value Analysis for Better Management, American Management Association Edition, 1969.

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

5	2	3	2	2	1	2	1	1	1	1	2	2	2	2	1
Avg	2	3	2	2	1	2	1	1	1	1	2	2	2	2	1

MF23C01	ADDITIVE MANUFACTURING	L	T	P	C
		2	0	2	3

COURSE OBJECTIVES:

- To introduce the development of Additive Manufacturing (AM), various software tools, processes, and techniques to create physical objects that satisfy product development/prototyping requirements.

UNIT I INTRODUCTION 6

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 II DESIGN FOR ADDITIVE MANUFACTURING (DfAM) 6

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

UNIT III VAT POLYMERIZATION AND DIRECTED ENERGY DEPOSITION 6

Photopolymerization: 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 IV POWDER BED FUSION AND MATERIAL EXTRUSION 6

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 V OTHER ADDITIVE MANUFACTURING PROCESSES 6

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.

30

ADDITIVE MANUFACTURING LABORATORY
Experiments

1. Modelling and converting CAD models into STL file.
2. Manipulation and error fixing of STL file.
3. Design and fabrication of parts by varying part orientation and support structures.
4. Fabrication of parts with material extrusion AM process.
5. Fabrication of parts with vat polymerization AM process.
6. Design and fabrication of topology optimized parts.

Equipment required - lab

1. Extrusion based AM machine
2. Resin based AM machine
3. Mechanical design software
4. Open-source AM software for STL editing manipulation and slicing.

30

TOTAL: 60

COURSE OUTCOMES:

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

CO1: Recognize the development of AM technology and how AM technology propagated into various businesses and developing opportunities.

CO2: Acquire knowledge on process of transforming a concept into the final product in AM technology.

CO3: Elaborate the vat polymerization and direct energy deposition processes and its applications.

CO4: Acquire knowledge on process and applications of powder bed fusion and material extrusion.

CO5: Evaluate the advantages, limitations, applications of binder jetting, material jetting and sheet lamination processes.

TEXT BOOKS:

1. Ian Gibson, David Rosen, Brent Stucker, MahyarKhorasani "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.

REFERENCES:

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.

COs	POs												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	1	3	1	2	-	-	1	-	2	-	2	3	1	-
2	3	1	2	1	2	-	-	1	-	2	-	2	3	1	-
3	3	1	3	1	2	-	-	1	-	2	-	2	3	1	-
4	3	2	2	1	2	-	-	1	-	-	-	2	3	1	-
5	3	3	2	2	2	-	-	1	-	-	-	2	3	1	-
Avg	3	1.6	2.4	1.2	2	-	-	1		-	-	2	3	1	-

IE23C04 PRODUCT LIFE CYCLE MANAGEMENT L T P C
3 0 0 3

COURSE OBJECTIVE:

The main objective of the course is to prepare the students for understanding and applying the fundamental concepts and principles behind PLM in Product Design & Development.

UNIT I INTRODUCTION TO PLM 9

Definition of PLM; PLM Initiative; PLM Paradigm – P, L and M of PLM – Scope of PLM – PLM Paradigm – Benefits of PLM – Spread of PLM – Overcoming Problems& Enabling Opportunities –PLM Environment – Issues in the Traditional Environment – Product Data Issues – A Complex, Changing Environment – Example from “Before PLM” – Product Pains: Aerospace Products; Power Plants; Automotive Products – Product Opportunities.

UNIT II PLM ENVIRONMENT: BUSINESS PROCESS 9

Business Processes in the PLM Environment – Relevance of Business Processes in PLM – Definitions & Introductions for Business Process – Business Process Reality in a Typical Company – Business Process Activities in the PLM Initiative – Learning from Experience with Business Process.

UNIT III PLM ENVIRONMENT: PRODUCT DATA 9

Product Data in the PLM Environment – Relevance of Product Data in PLM – Product Data Reality in a Typical Company – Product Data Activities in the PLM Initiative – Learning from Experience with Product Data.

UNIT IV PLM ENVIRONMENT: INFORMATION SYSTEMS 9

Information Systems in the PLM Environment – Relevance of Information Systems Applications in PLM – PLM Applications in the Product Lifecycle – Generic and Specific PLM Applications – PDM System: A Special Application – Importance of the PDM System in PLM – Reality in a Typical Company – Application Activities in the PLM Initiative – Best Practice PDM System Selection – Learning from Experience with Information Systems.

UNIT V PLM ENVIRONMENT: PROJECT MANAGEMENT 9

Project/Program Management in the PLM Environment – Skills and Relevance – Definitions and Introduction with Project Management – Project Management Reality in a Typical Company – Project Management Activities in the PLM Initiative – Learning from Experience with Project Management.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

CO1 Apply the fundamental concepts and principles behind PLM in Product Design & Development.

CO2 Apply the business process concept of PLM in Product Design & Development.

CO3 Apply the product data concept of PLM in Product Design & Development.

CO4 Apply the information systems concept of PLM in Product Design & Development.

CO5 Apply the project management concept of PLM in Product Design & Development

TEXT BOOKS:

1. John Stark, “Product Lifecycle Management: 21st Century Paradigm for Product Realisation”, Springer Publisher, 2011 (2nd Edition).
2. Michael Grieves, “Product Life Cycle Management”, Tata McGraw Hill, 2006.

REFERNCE BOOKS:

1. UthayanElangovan, Product Lifecycle Management (PLM): A Digital Journey Using Industrial Internet of Things (IIoT), CRC Press, 2020.
2. EudesCanuto, Bernd Daum and Michael Rodel, Product Development with SAP PLM, SAP Press, 2017.
3. John Stark, “Global Product: Strategy, Product Lifecycle Management and the Billion Customer Question”, Springer Publisher, 2007.
4. AnttiSaaksvuori andAnselmiImmonen, “Product Lifecycle Management, Springer Publisher, 3rd Ed., 2008.
5. IvicaCrnkovic, Ulf Asklund and AnnitaPerssonDahlqvist, “Implementing and Integrating Product Data Management and Software Configuration Management”, Artech House Publishers, 2003.

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	2	3	2	2	2	2	1	1	2	2	2	3	3	2
2	2	2	3	2	2	2	2	1	1	2	2	2	3	3	2
3	2	2	3	2	2	2	2	1	1	2	2	2	3	3	2
4	2	2	3	2	2	2	2	1	1	2	2	2	3	3	2
5	2	2	3	2	2	2	2	1	1	2	2	2	3	3	2
Avg	2	2	3	2	2	2	2	1	1	2	2	2	3	3	2

ME23002	DESIGN FOR X	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

The main learning objective of this course is to prepare the students for designing the components with the considerations of quality, reliability, safety, cost, environment, manufacturing and assembly.

UNIT I DESIGN FOR QUALITY 9

Quality Function Deployment -House of Quality-Objectives and Functions-Targets-Stakeholders- Measures and Matrices-Design of Experiments –design Process-Identification of control factors, noise factors, and performance metrics - developing the experimental plan- experimental design – testing noise factors- Running the experiments – Conducting the Analysis-Selecting and conforming factor-Set points-reflecting and repeating

UNIT II DESIGN FOR RELIABILITY AND SAFETY 9

Reliability – Definitions – Constant failure Rate – Weibull Frequency distribution – Reliability with variable failure rate – System reliability - Design strategy – Causes of unreliability – Minimizing Failure – Sources of reliability data – Cost of reliability – Failure Mode Effect Analysis – Defects and Failure Modes – Importance of Failure – Safety – Safe product – Design aspects of safety – Fail safe design – Potential dangers and safety hazards – Guidelines for design for safety – Warning Labels

UNIT III DESIGN FOR MANUFACTURE AND ASSEMBLY 9

Role of Manufacturing in design – Manufacturing functions - types of manufacturing process, process systems- Manufacturing process selection - Design for Manufacturability (DFM) – Design for Assembly (DFA) - Role of standardization in DFMA – Mistake Proofing.

UNIT IV DESIGN FOR ENVIRONMENT AND SERVICEABILITY 9

Design for Environment – Life cycle design – DFE Approach – DFE scoring methods. Human factors in design, ergonomics, user friendly design- Serviceability – Preventive Maintenance – Breakdown Maintenance – Testability – Role of reliability in maintenance and repair.

UNIT V DESIGN FOR COSTING 9

Categories of costing – Overhead cost – methods of developing cost estimates – Manufacturing cost – Product profit model – refinements to cost analysis methods – Design to cost – Value Analysis in costing – Life cycle costing

TOTAL :45 PERIODS

COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

CO1 Apply the quality concepts to develop a robust product.

CO2 Enforce methods to improve the reliability of a product and to ensure the safety of the product by use of standards and guidelines

CO3 Apply the principles of process selection and to design the components by considering the manufacturing and assembly guidelines.

CO4 Design the product for its environment and to improve its re-pairability.

CO5 Predict the product cost using strategies and to refine the cost by performing cost analysis.

TEXTBOOKS:

1. Dieter. G. N., Linda C. Schmidt, “Engineering Design”, McGraw Hill, 2013.
2. Horenstein, M. N., Design Concepts for Engineers, Prentice Hall, 2015.

REFERENCES:

1. Dhillon, B. S., Advanced Design Concepts for Engineers, Technomic Publishing Co., 1998.
2. Edward B. Magrab, Satyandra K. Gupta, F. Patrick McCluskey and Peter A. Sandborn, “Integrated Product and Process Design and Development”, CRC Press, 2009.
3. James Garratt, “Design and Technology”, Cambridge University Press, 1996.
4. Joseph E. Shigley, Charles R.Mische, and Richard G. Budynas, “Mechanical Engineering Design”, McGraw Hill Professional, 2003.
5. Sumesh Krishnan and MukulSukla, Concepts in Engineering Design, Notion Press, 2016.

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	2	1	2	2	1	-	-	-	2	3	2	2
2	3	3	3	2	1	2	3	1	-	-	-	2	3	2	2
3	3	3	3	2	1	2	2	1	-	-	-	2	3	2	2
4	3	3	3	2	1	2	3	1	-	-	-	2	3	2	2
5	3	3	3	2	1	2	2	1	-	-	-	2	3	2	2
Avg	3	3	3	2	1	2	2.4	1	-	-	-	2	3	2	2

ME23003	ERGONOMICS IN DESIGN	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

To introduce to industrial design with considerations of ergonomics, aesthetics and environmental aspects.

UNIT – I INTRODUCTION 9

An approach to industrial design, Elements of design structure for industrial design in engineering application in modern manufacturing systems- Ergonomics and Industrial Design: Introduction to Ergonomics, Communication system, general approach to the man-machine relationship, Human component of work system, Machine component of work system, Local environment-light, Heat, Sound.

UNIT – II ERGONOMICS AND PRODUCTION 9

Introduction, Anthropometric data and its applications in ergonomic, working postures, Body Movements, Work Station Design, Chair Design. Visual Effects of Line and Form: The mechanics of seeing, Psychology of seeing, Figure on ground effect, Gestalt's perceptions - Simplicity, Regularity, Proximity, Wholeness. Optical illusions, Influences of line and form.

UNIT – III DESIGN PRINCIPLES FOR DISPLAY AND CONTROLS 9

Displays: Design Principles of visual Displays, Classification, Quantitative displays, Qualitative displays, check readings, Situational awareness, Representative displays, Design of pointers, Signal and warning lights, colour coding of displays, Design of multiple displays Controls: Design considerations, Controls with little efforts – Push button, Switches, rotating Knobs. Controls with muscular effort – Hand wheel, Crank, Heavy lever, Pedals. Design of controls in automobiles, Machine Tools

UNIT – IV VISUAL ASPECTS 9

Colour: Colour and light, Colour and objects, Colour and the eye – after Image, Colour blindness, Colour constancy, Colour terms – Colour circles, Munsel colour notation, reactions to colour and colour combination – colour on engineering equipment, Colour coding, Psychological effects, colour and machine form, colour and style

UNIT – V AESTHETIC CONCEPTS 9

Concept of unity, Concept of order with variety, Concept of purpose, Style and environment, Aesthetic expressions - Symmetry, Balance, Contrast, Continuity, Proportion. Style - The components of style, House style, Style in capital good. Introduction to Ergonomic and plant layout software's, total layout design.

TOTAL: 45

COURSE OUTCOMES:

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

1. Appreciate ergonomics need in the industrial design.
2. Apply ergonomics in creation of manufacturing system
3. Discuss on design of controls and display.
4. Consider environmental factors in ergonomics design.
5. Report on importance of aesthetics to manufacturing system and product

TEXTBOOKS:

1. Benjamin W.Niebel, Motion and Time Study, Richard, D. Irwin Inc., 7thEdition, 2002
2. Brain Shakel,“Applied Ergonomics Hand Book”, Butterworth Scientific London 1988.

REFERENCES:

1. Bridger, R.C., Introduction to Ergonomics, 2ndEdition, 2003, McGraw Hill Publications.
2. Martin Helander, A Guide to human factors and Ergonomics, Taylor and Francis, 2006
3. Mayall W.H. “Industrial design for Engineers”, London Hiffee books Ltd., 198

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	1	3	-	2	2	3	1	-	-	-	1	2	--	2
2	3	1	3	-	2	2	3	1	-	-	-	1	2	-	2
3	3	1	3	-	2	2	3	1	-	-	-	1	2	-	2
4	3	1	3	-	2	2	3	1	-	-	-	1	2	-	2
5	3	1	3	-	2	2	3	1	-	-	-	1	2	-	2
Avg	3	1	3	-	2	2	3	1	-	-	-	1	2	-	2

ME23004 **CAD/CAM** **L T P C**
3 0 0 3

COURSE OBJECTIVE:

The main learning objectives of this course is to provide knowledge on Geometric modelling and CNC part programming.

UNIT I COMPUTER AIDED DESIGN **9**

Product cycle- Design process- sequential and concurrent engineering- Computer aided design – CAD system architecture- Computer graphics – co-ordinate systems- 2D and 3D transformations- homogeneous coordinates-Line drawing -Clipping- viewing transformation-visual realism.

UNIT II GEOMETRIC MODELLING **9**

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

storage –Data structures for interactive modeling- integration of design analysis and CAD- customization and design automation.

UNIT III CAD STANDARDS and CAD CAM INTERFACE **9**

Graphics and computing standards- Data exchange standards- IGES-STEP – communication standards- current trends in manufacturing engineering- Group technology- design for manufacture and assembly – process planning techniques – Total approach to product development – techniques of quality engineering – QFD and FMEA – Taguchi methods –Additive Manufacturing.

UNIT IV COMPUTER NUMERICAL CONTROL **9**

Fundamentals of Numerical control – CNC technology – CNC hardware basics- CNC Tooling and machine tools- Control systems – CNC Programming – Manual programming – Machining and Turning Centre Programming - Computer assisted part programming – APT language structure and commands.

UNIT V INFORMATION AND INTEGRATION OF MANUFACTURING SYSTEMS **9**

Information Requirements of Manufacturing - Group Technology and Computer Aided Process Planning- production planning and control- Integration of Manufacturing

Systems: Communications - Material-Handling Systems- Flexible Manufacturing Systems

- Computer Aided Quality Control - introduction to Computer Integrated Manufacturing-Future of CAD/CAM

TOTAL : 45

COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

CO1 Apply the fundamental concepts of computer graphics and its tools in a generic framework.

CO2 Create and manipulating geometric models using curves, surfaces and solids.

CO3 Apply standard CAD practices in engineering design and to understand the need for integration of CAD and CAM

CO4 Apply CNC manual and computer assisted part programming for various manufacturing process

CO5 Discriminate the problems in Production Planning and Control.

TEXTBOOKS:

1. Groover, M. P., CAD/CAM: Computer-Aided Design and Manufacturing, Pearson Education, 2008.

REFERENCES:

1. P.N.Rao “CAD/CAM Principles and Applications” Tata McGraw-Hill Publication Co. New
 Delhi – 2006.
2. Ibrahim Zeid “Mastering CAD CAM” Tata McGraw-Hill Publishing Co.2007.
3. Chris McMahon and Jimmie Browne “CAD/CAM Principles, practice and manufacturing
 management “Pearson Education Asia – 2001
4. Donald Hearn and M. Pauline Baker “Computer Graphics”’. Prentice Hall, Inc, 1992.

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	1	3	1	2	-	-	1	-	2	-	2	3	1	-
2	3	1	2	1	2	-	-	1	-	2	-	2	3	1	-
3	3	1	3	1	2	-	-	1	-	2	-	2	3	1	-
4	3	2	2	1	2	-	-	1	-	-	-	2	3	1	-
5	3	3	2	2	2	-	-	1	-	-	-	2	3	1	-
Avg	3	1.6	2.4	1.	2	-	-	1	-	2	-	2	3	2	-

ME23006 INTEGRATED PRODUCT DESIGN AND MANUFACTURING USING GD&T **L T P C**
3 0 0 3

COURSE OBJECTIVE:

To impart the knowledge on GD&T to interpret engineering drawings from the manufacturing perspective, and for cost effective manufacturing of products.

1. Explain why geometric tolerancing is superior to coordinate tolerancing
2. Interpret the symbols and material modifiers used in GD&T
3. Define the key terms used in GD&T
4. Interpret applications of datum targets, size datum features, and size datum features
5. Interpret the various types of tolerance (flatness, circularity, cylindricity, straightness, perpendicularity, parallelism, angularity, position, runout, and profile)

UNIT I NEED FOR GD&T AND BASIC CONCEPTS 9

Engineering drawings and tolerancing - Dimensioning, dimensioning standards and rules, Geometric properties of a surface - Coordinate tolerancing system and its shortcomings, Geometric dimensioning and tolerancing system - benefits, Symbols & terms as per ASME Y14.5M, rules and concepts, virtual condition and bonus tolerance.

UNIT II FORM, DATUMS, AND ORIENTATION CONTROLS 9

Flatness, Straightness, Circularity and Cylindricity control; Datums - Implied datums, Planar datums, datum targets, FOS datum features, FOS datum features applications RFS, at MMC and LMC, Orientation controls - Perpendicularity, Angularity and parallelism control of axis / midplane.

UNIT III POSITION, CONCENTRICITY, SYMMETRY, RUNOUT AND PROFILE CONTROLS 9

Tolerance of position - Position vs Coordinate conversion, Tolerance of position RFS, at MMC and LMC, TOP calculations, fixed and floating fastener calculations; Runout control - circular, total and runout calculations, Profile control - surface, line, Profile modifiers, Derived element controls - Straightness derived median line, Flatness derived median plane, Concentricity control, Symmetry control.

UNIT IV GD&T FOR INTEGRATED PRODUCT DESIGN AND MANUFACTURING - 1 **9**

Concurrent engineering in Y14.5M, Datum reference frames, Foundation of geometric control: interrelated features, the boundary concept, Taylor's principle, and refinement of controls; Application considerations, Product and process design - The six step methodology, Developing the tooling and gaging designs needed to create a producible product

UNIT V GD&T FOR INTEGRATED PRODUCT DESIGN AND MANUFACTURING - 2 **9**

Producibility design cycle, datum - specification, selection, qualification, and identification; Phantom gage dimensioning, Dimensional measurements, Inspection and verification, functional gaging, functional gage tolerancing, functional inspection techniques, functional workholding and fixturing, Implementation and process improvement.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

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

CO1 Explain why geometric tolerancing is superior to coordinate tolerancing

CO2 Interpret the symbols and material modifiers used in GD&T

CO3 Define the key terms used in GD&T

CO4 Interpret applications of datum targets, size datum features, and size datum features

CO5 Interpret the various types of tolerance (flatness, circularity, cylindricity, straightness, perpendicularity, parallelism, angularity, position, runout, and profile)

TEXT BOOKS:

1. Alex Krulikowski, "Fundamentals of Geometric Dimensioning and Tolerancing" 3rd Edition, 2013, Cengage Learning, ISBN: 9781111129828.
2. Bob Campbell, "Integrated Product Design and Manufacturing Using Geometric Dimensioning and Tolerancing", 2003, Marcel Dekker.

REFERENCES:

1. Georg Henzold, "Geometrical Dimensioning and Tolerancing for Design, Manufacturing and Inspection A Handbook for Geometrical Product Specification Using ISO and ASME Standards", Butterworth-Heinemann, 3rd edition, 2021, ISBN: 978-0-12-824061-8.
2. ASME Y14.5-2018, "Dimensioning and Tolerancing - Engineering

Product Definition and Related Documentation Practices, ASME, 2018.

3. James D. Meadows, "Geometrical Dimensioning and Tolerancing - Application, Analysis and Measurement", ASME Press, 2009.
4. David A. Madsen and David P. Madsen, "Geometrical Dimensioning and Tolerancing", 9th Edition, The Goodheart-Willcox Company, Inc., 2013.
5. Gene R. Cogorno, "Geometrical Dimensioning and Tolerancing for Mechanical Design", McGraw-Hill, 2006.

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

ME23005 **MATERIAL SELECTION** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

To understand the material properties and criterion of selection of materials and processes for industrial design.

UNIT I **Introduction to Materials and design.** **9**

Engineering Design process and the role of materials; materials classification and their properties; material property charts; the design process, types of design, Design tools and materials data, economics of materials.

UNIT II **Material selection for mechanical properties** **9**

Material Selection criteria for static strength, Material selection for toughness, Material selection for stiffness, Material selection for fatigue resistance, Material selection for creep resistance

UNIT III **Material selection and material processing** **9**

Purpose of materials processing, Process selection background, Casting of metal and alloys, processing of polymers, processing of composites, fabrication from powder, joining

UNIT IV **Material selection in different industries** **9**

The selection strategy, Deriving property limits and indices, the selection procedure, the structural index, case studies- materials for ship structure, materials for automobile structures, Materials for Engines.

UNIT V **Materials for industrial design and recent trends.** **9**

Material selection for multiple constraints, case studies for multiple constraints, Data needs for design, aesthetics and industrial designs, economic vs performance, green design, Recycle and reuse.

TOTAL: 45

COURSE OUTCOMES:

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

1 Outline the material properties and need for material selection .
2 Discuss the material selection for different mechanical properties .
3 Outline the material selection for manufacturing processes
4 Summarize the material selection in different industries.
5 Discuss the recent trend in industrial design

TEXTBOOKS:

1. Dieter George E, Engineering Design, Tata McGraw-Hill education, 1991.
2. Michael F Ashby, Materials selection in Machine Design, Butterworth and Heinemann,2010

REFERENCES:

1. Bhandari V B, Design of Machine Elements, 3rd edition, Tata McGraw-Hill Education, 2010
2. Charles J A & Crane F AA, Selection and Use of Engineering Materials, Elsevier, 2013

3. Mangonan P L, The Principles of Materials Selection for Engineering Design, Prentice Hall, 1999
4. ASM Handbook : Materials Selection and Design, Volume 20, Taylor & Francis,1997
5. Mahmoud M Farag, Materials and Process Selection for Engineering Design, CRC Press, 2013
6. Bralla, J. C., “Design for Manufacturability Handbook”, McGraw-Hill Professional; 2/e, 1998.

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

ME23009	ROBOTICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

To impart knowledge on the anatomy of robots and use of machine vision system for robot applications, path planning and programming.

UNIT – I FUNDAMENTALS OF ROBOTICS AND THEIR ACTUATORS 9

Introduction to Robotics, Robot Joints, Robot Configurations - Joint Notations - Work Envelope – Applications and Limitations, Speed of Motion and Load Carrying Capacity, Robot Control Systems, Precision of Movement. Overview of Electric, hydraulic and Pneumatic Drives, Stepper & Servo Drives – Linear & Rotary types, Smart Actuators of Micro Robots.

UNIT – II ROBOT LOCOMOTION AND END EFFECTORS 9

Walkers - Leg Actuators – Leg Geometry – Walking Techniques, Pipe Crawlers, Tracked Vehicles and Suspension Systems, Robot End Effector – Grippers and Gripper force analysis – Robot Tools – Considerations in Gripper Selection and Design.

UNIT – III ROBOT SENSORS AND VISION 9

Tactile Sensors, Proximity and Range Sensors, Sensing and digitizing function in Robot Vision, Image processing and Analysis, Training the Vision System, Applications of Robot Sensors and Vision.

UNIT – IV ROBOT MOTION ANALYSIS AND CONTROL 9

Introduction to manipulator Kinematics, Homogeneous Transformations and Robot Kinematics, Manipulator Path Control, Robot Arm Statics and Dynamics, Trajectory Planning, Robot Control System.

UNIT – V ROBOT PROGRAMMING AND APPLICATIONS 9

Classification of Robot Languages and Programming, Graphical Simulation of Robotic Work cells, Robot Cell Design and Control, Humanoid Robots, Micro Robots, Tele-operated Robots, Application of Robots in Surgery, Manufacturing, Space and Underwater.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

1. Explain the different types of joints and drives to design robotic configurations.
2. Design the appropriate locomotive mechanisms for robots and grippers.
3. Identify the different sensors and apply the image processing techniques to enhance robots' maneuverability.
4. Apply kinematic and dynamic principles in robot motion control.
5. Develop programs for robotic applications.

TEXTBOOKS:

1. C Robert J Schilling, "Fundamentals of Robotics Analysis and Control", Pearson Education, 2009.
2. Groover M.P., Weiss M., Nagel R.N. and Odrey N.G., "Industrial Robotics - Technology, Programming and Applications", McGraw Hill Education, 2011.

REFERENCES:

1. Craig J.J., “Introduction to Robotics Mechanics and Control”, Pearson Education, 2008.
2. Fu K.S., Gonzalz R.C. and Lee C.S.G., “Robotics Control, Sensing, Vision and Intelligence”, McGraw Hill Education, 2008.
3. Deb S.R. and Deb S., “Robotics Technology and Flexible Automation”, McGraw Hill Education, 2010.
4. Maja J Mataric, “The Robotics Primer”, Universities Press, 2009.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	3	3	-	-	-	-	-	-	1	3	1	3
2	3	3	3	3	-	-	-	-	-	-	-	1	3	1	3
3	3	3	3	3	-	-	-	-	-	-	-	1	3	1	3
4	3	3	3	3	-	-	-	-	-	-	-	1	3	1	3
5	3	3	3	3	-	-	-	-	-	-	-	1	3	1	3
Avg	3	3	3	3	3	-	-	-	-	-	-	1	3	1	3

ME23010	SENSORS AND INSTRUMENTATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

To Impart knowledge on the measurement of various physical parameters using Data Acquisition system

UNIT I 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 II 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 III 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 IV OPTICAL, PRESSURE AND TEMPERATURE SENSORS **9**

Photo conductive cell, photo voltaic, Photo resistive, LDR – Fiber optic sensors – Pressure – Diaphragm, Bellows, Piezoelectric – Tactile sensors, Temperature – IC, Thermistor, RTD, Thermocouple. Acoustic Sensors – flow and level measurement, Radiation Sensors - Smart Sensors

- Film sensor, MEMS & Nano Sensors, LASER sensors.

UNIT V SIGNAL CONDITIONING AND DAQ SYSTEMS **9**

Amplification – Filtering – Sample and Hold circuits – Data Acquisition: Single channel and multichannel data acquisition – Data logging - applications - Automobile, Aerospace, Home appliances, Manufacturing, Environmental monitoring.

TOTAL : 45

COURSE OUTCOMES:

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

1. Recognize with various calibration techniques and signal types for sensors.
2. Explain the working principle and characteristics of force, magnetic, heading, pressure and temperature, smart and other sensors and transducers.
3. Apply the various sensors and transducers in various applications
4. Select the appropriate sensor for different applications.
5. Acquire the signals from different sensors using Data acquisition systems.

TEXTBOOKS:

1. Ernest O Doebelin, “Measurement Systems – Applications and Design”, Tata McGraw-Hill, 2009.
2. Sawney A K and PuneetSawney, “A Course in Mechanical Measurements and Instrumentation and Control”, Dhanpat Rai & Co, 12th edition New Delhi, 2013.

REFERENCES:

1. C. Sujatha ... Dyer, S.A., Survey of Instrumentation and Measurement, John Wiley & Sons,
   Canada, 2001.
2. Hans Kurt Tönshoff (Editor), Ichiro, “Sensors in Manufacturing” Volume 1, Wiley-VCH April
   2001.
3. John Turner and Martyn Hill, “Instrumentation for Engineers and Scientists”, Oxford Science
   Publications, 1999.
4. Patranabis D, “Sensors and Transducers”, 2nd Edition, PHI, New Delhi, 2011.
5. Richard Zurawski, “Industrial Communication Technology Handbook” 2nd edition, CRC Press, 2015.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	3	3	-	-	-	-	-	-	1	3		3
2	3	3	3	3	3	-	-	-	-	-	-	1	3	2	3
3	3	3	3	3	3	-	-	-	-	-	-	1	3	2	3
4	3	3	3	3	3	-	-	-	-	-	-	1	3	2	3
5	3	3	3	3	3	-	-	-	-	-	-	1	3	2	3
Avg	3	3	3	3	3	-	-	-	-	-	-	1	3	2	3

ME23007 ELECTRICAL DRIVES AND ACTUATORS

	L	T	P	C
	3	0	0	3

COURSE OBJECTIVE:

- To impart knowledge on AC, DC drives, actuators and their characteristics and applications

UNIT – I 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 – II DRIVE CHARACTERISTICS 9

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

UNIT – III DC MOTORS AND DRIVES 9

DC 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 – IV AC MOTORS AND DRIVES 9

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

UNIT – V STEPPER AND SERVO MOTORS 9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

1. Recognize the principles and working of relays, drives and motors.
2. Explain the working and characteristics of various drives and motors.
3. Apply the solid state switching circuits to operate various types of Motors and Drivers.
4. Interpret the performance of Motors and Drives.
5. Suggest the Motors and Drivers for given applications

TEXTBOOKS:

1. Bimbhra B.S., "Power Electronics", 5th Edition, Kanna Publishers, New Delhi, 2012.
2. Mehta V.K. &Rohit Mehta, "Principles of Electrical Machines", S.Chand& Co. Ltd., New Delhi, 2016.

REFERENCES:

1. Gobal K. Dubey, "Fundamentals of Electrical Drives", 2nd Edition, Narosal Publishing House, New Delhi, 2001.
2. Theraja B.L. &Theraja A.K., "A Text Book of Electrical Technology", 2nd Edition, S.Chand & Co. Ltd., New Delhi, 2012.
3. Singh M.D. &Kanchandhani K.B., "Power Electronics", McGraw Hill, New Delhi, 2007

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	1	1	-	-	-	-	-	-	-	1	2	1	2
2	3	3	1	1	-	-	-	-	-	-	-	1	2	1	2
3	3	3	1	1	-	-	-	-	-	-	-	1	2	1	2
4	3	3	1	1	-	-	-	-	-	-	-	1	2	1	2
5	3	3	1	1	-	-	-	-	-	-	-	1	2	1	2
Avg	3	3	1	1	-	-	-	-	-	-	-	1	2	1	2

ME23008	EMBEDDED SYSTEMS AND PROGRAMMING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To Impart knowledge on micro-controller, ARM Processors, interface devices and embedded operating systems.

UNIT – I INTRODUCTION TO MICROCONTROLLER 9

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

UNIT – II PROGRAMMING AND COMMUNICATION 9

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

UNIT – III PERIPHERAL INTERFACING 9

I/O Programming – Interfacing of Memory, Keyboard and Displays – Alphanumeric and Graphic, RTC, interfacing of ADC and DAC, Sensors - Relays - Solenoid Valve and

Heater - Stepper Motors, DC Motors - PWM Programming – Closed Loop Control Programming of Servomotor – Traffic Light

UNIT – IV ARM PROCESSOR 9

Introduction ARM 7 Processor - Internal Architecture – Modes of Operations – Register Set – Instruction Sets – ARM Thumb - Thumb State Registers – Pipelining – basic programming of ARM 7 - Applications.

UNIT – V SINGLE BOARD COMPUTERS AND PROGRAMMING 9

System on Chip – Broadcom BCM2711 SoC – SBC architecture – Models and Languages –Embedded Design – Real Time Embedded Operating Systems – Real Time Programming Languages – Python for Embedded Systems- GPIO Programming – Interfacing.

TOTAL : 45

COURSE OUTCOMES:

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

1. Discuss the various functional units of microcontroller, processors and system- on-chip based on the features and specifications.
2. Recognize the role of each functional units in microcontroller, processors and system-on-chip based on the features and specifications
3. Design the interface circuits using sensors, actuators and other I/O's with microcontroller, processors and system-on-chip based interfacing

4 Design the circuit and write the programming microcontroller, processors and system-on-chip

5. Develop the applications using Embedded system.

TEXTBOOKS:

1. Frank Vahid and Tony Givargis, “Embedded System Design”, 2011, Wiley.
2. Kenneth J. Ayala, “The 8051 Microcontroller, the Architecture and Programming Applications”, 2003.

REFERENCES:

1. Muhammad Ali Mazidi and Janice GillispieMazdi, “The 8051 Microcontroller and Embedded Systems”, Pearson Education, 2006.
2. Simon Monk, Programming the Raspberry Pi, Second Edition: Getting Started with Python McGraw Hill TAB; 2nd edition,2015.
3. James W. Stewart, “The 8051 Microcontroller Hardware, Software and Interfacing”, Prentice Hall, 2003.
4. John B. Peatman, “Design with Microcontrollers”, McGraw Hill International, USA, 2005.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	1	1	2	-	-	-	-	-	-	1	3	1	3
2	3	2	1	1	2	-	-	-	-	-	-	1	3	1	3
3	3	2	1	1	2	-	-	-	-	-	-	1	3	1	3
4	3	2	1	1	2	-	-	-	-	-	-	1	3	1	3
5	3	2	1	1	2	-	-	-	-	-	-	1	3	1	3
Avg	3	2	1	1	2	-	-	-	-	-	-	1	3	1	3

ME23011	SMART MOBILITY AND INTELLIGENT VEHICLES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

To introduce students to the various technologies and systems used to implement smart mobility and intelligent vehicles.

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

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

UNIT – II SENSOR TECHNOLOGY FOR SMART MOBILITY 9

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

UNIT – III CONNECTED AUTONOMOUS VEHICLE 9

Basic Control System Theory applied to Automobiles, Overview of the Operation of ECUs, Basic Cyber-Physical System Theory and Autonomous Vehicles, Role of Surroundings Sensing Systems and Autonomy, Role of Wireless Data Networks and Autonomy

UNIT – IV 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 – V CONNECTED CAR & AUTONOMOUS VEHICLE TECHNOLOGY 9

Connectivity Fundamentals, Navigation and Other Applications, Vehicle-to-Vehicle Technology and Applications, Vehicle-to-Roadside and Vehicle-to-Infrastructure Applications, Autonomous Vehicles - Driverless Car Technology, Moral, Legal, Roadblock Issues, Technical Issues, Security Issues

TOTAL: 45

COURSE OUTCOMES:

Upon successful completion of the course, students should be able to:

CO1: Recognize the concept of cyber-physical control systems and their application to collision avoidance and autonomous vehicles

CO2: Select the concept of remote sensing and the types of sensor technology needed to implement remote sensing

CO3: Familiar with the concept of fully autonomous vehicles

CO4: Apply the basic concepts of wireless communications and wireless data networks

CO 5: Analyze the concept of the connected vehicle and its role in automated vehicles

TEXT BOOKS

1. "Intelligent Transportation Systems and Connected and Automated Vehicles", 2016, Transportation Research Board
2. Radovan Miucic, "Connected Vehicles: Intelligent Transportation Systems", 2019, Springer

REFERENCES:

1. Tom Denton, "Automobile Electrical and Electronic systems, Roultedge", Taylor & Francis Group,5th Edition,2018.

COs/POs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	1	1	-	1	-	-	-	-	-	1	2	1	1
CO2	3	2	1	1	-	1	-	-	-	-	-	1	2	1	1
CO3	3	2	1	1	-	1	-	-	-	-	-	1	2	1	1
CO4	3	2	1	1	-	1	-	-	-	-	-	1	2	1	1
CO5	3	2	1	1	-	1	-	-	-	-	-	1	2	1	1
Ave	3	2	1	1	-	1	-	-	-	-	-	1	2	1	1

ME23C10	HAPTICS AND IMMERSIVE TECHNOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

To familiarize students with the concepts and applications of virtual reality, augmented reality, mixed reality, and extended reality.

UNIT – I INTRODUCTION TO IMMERSIVE TECHNOLOGIES 9

Introduction on Virtual reality – Augmented reality – Mixed reality – Extended reality – VR Devices – AR Devices – Applications

Suggested activities:

- Flipped Classroom: Analysis of Immersive Technology Adoption
- External learning: Explore the advancements in Augmented reality

Suggested evaluation methods:

- Tutorial: discussion on immersive technology and its application
- Group discussion on advancements in immersive technology

UNIT – II BUILDING AR AND VR APPLICATION WITH UNITY 9

AR SDKs for unity and unreal engine – Working with SDKs for unity – Developing AR/VR application in unity – Building AR and VR application

Suggested activities:

- Flipped Classroom: Working with AR SDKs for Unity
- External learning: Hands-on Exploration of Haptic Devices

Suggested evaluation methods:

- Tutorial: AR application developed using Unity and the AR SDK
- Assignment on AR/VR application in different domains

UNIT – III HAPTIC PERCEPTION AND VIRTUAL REALITY 9

Virtual Reality – Display Technologies - Input devices to Virtual Reality Systems - Interaction with Virtual Environment - Introduction to Haptics - Human haptic system - Haptic Displays

Suggested activities:

- Flipped Classroom: Explore Haptic Displays and their Role in Virtual Reality Systems
- External Learning: Study and Analyze Case Studies on the Integration of Haptic System in Virtual Reality Applications

Suggested evaluation methods:

- Tutorial: Discuss on Impact of Haptic Displays on Virtual Reality Experiences
- Assignment Summarizing the Importance and Functionality of Haptic Systems in Virtual Reality Applications.

UNIT – IV COLLISION DETECTION IN HAPTICS 9

Collision Detection for Teleoperation: Force and Torque Sensors-Tactile Sensors-Collision Detection in Virtual Environment-Representational Models for Virtual Objects- Collision Detection for Polygonal Models-Collisions Detection between Simple Geometric Shapes-Teleoperation - Virtual Fixtures

Suggested activities:

- Flipped Classroom: Explore Haptic Interaction frameworks
- External learning: Haptic interface and display devices

Suggested evaluation methods:

- Tutorial: Haptic Interaction Techniques in AR/VR
- Quiz on haptic interaction design, working principles and functionalities of haptic interfaces

UNIT – V INTERACTION DESIGN IN IMMERSION TECHNOLOGIES 9

Mixed Reality Applications – Interactive AR models – User Interface Design in AR/VR environment – Virtual Agent Interaction Framework - Gestures and Haptic Interaction

Suggested activities:

- Flipped Classroom: User Interface Design in AR/VR Environment
- External learning: Explore gestures and haptic based interaction

Suggested evaluation methods:

- Tutorial: Designing immersive and user-friendly interfaces for practical applications
- Assignment on design concepts and prototype that incorporates gestures and haptic-based interaction

TOTAL: 45

COURSE OUTCOMES:

Upon successful completion of the course, students should be able to:

1. Understand immersive technologies such as VR, AR, MR, and XR.
2. Build AR and VR applications using Unity and AR SDKs.
3. Gain knowledge of haptic perception and explore haptic devices and custom development.
4. Familiarize with haptic interfaces, immersion techniques, and haptic interaction in AR/VR.
5. Demonstrate proficiency in integrating haptic feedback into AR/VR experiences.

TEXT BOOKS:

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, RafalPijewski, March 13, 2022
3. Arnaldi, Bruno, Pascal Guitton, and Guillaume Moreau, eds. Virtual reality and augmented reality: Myths and realities. John Wiley & Sons, 2018.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	2	2	-	2	-	-	-	1	-	-	1	1	2	2
2	2	2	2	-	2	-	-	-	1	-	-	1	1	2	2
3	2	2	2	-	2	-	-	-	1	-	-	1	1	2	2
4	2	2	2	-	2	-	-	-	1	-	-	1	1	2	2
5	2	2	2	-	2	-	-	-	1	-	-	1	1	2	2
Avg	2	2	2	-	2	-	-	-	1	-	-	1	1	2	2

ME23C16	DRONE TECHNOLOGIES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

To understand the basics of drone concepts, fundamentals of design, fabrication and programming of drone

UNIT – I INTRODUCTION TO DRONE TECHNOLOGY 9

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

UNIT – II DRONE DESIGN, FABRICATION AND PROGRAMMING 9

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

UNIT – III DRONE FLYING AND OPERATION 9

Concept of operation for drone -Flight modes- Operate a small drone in a controlled environment- Drone Controls Flight operations –management tool –Sensors- Onboard storage capacity -Removable storage devices- Linked mobile devices and applications

UNIT – IV DRONE COMMERCIAL APPLICATIONS 9

Choosing a drone based on the application -Drones in the insurance sector- Drones in delivering mail, parcels and other cargo- Drones in agriculture- Drones in inspection of transmission lines and power distribution -Drones in filming and panoramic picturing

UNIT – V FUTURE DRONES AND SAFETY 9

The safety risks- Guidelines to fly safely -Specific aviation regulation and standardization- Drone license- Miniaturization of drones- Increasing autonomy of drones -The use of drones in swarms

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon successful completion of the course, students should be able to:

CO1: Know about a various type of drone technology, drone fabrication and programming.

CO2: Execute the suitable operating procedures for functioning a drone

CO3: Select appropriate sensors and actuators for Drones

CO4: Develop a drone mechanism for specific applications

CO5: Create the programs for various drones

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

REFERENCES

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.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	1	2	3	1	3	2	-	-	-	-	-	1	2	1	3
CO2	1	2	3	1	3	2	-	-	-	-	-	1	2	1	3
CO3	1	2	3	1	3	2	-	-	-	-	-	1	2	1	3
CO4	1	2	3	1	3	2	-	-	-	-	-	1	2	1	3
CO5	1	2	3	1	3	2	-	-	-	-	-	1	2	1	3
Ave	1	2	3	1	3	2	-	-	-	-	-	1	2	1	3

ME23012 **MARINE ROBOTICS**

L	T	P	C
3	0	0	3

OBJECTIVES:

- To provide the students an advanced knowledge in various types of marine robots and its applications a relatively nascent field
- To impart knowledge in students in the areas of marine robotics design, development and deployment in the real world applications

UNIT I MARINE ROBOTS 9

Types and classification of marine robots – robotic sailing – submersibles, applications of sailing robots and submersibles, Limitations in marine autonomy

UNIT II ROBOTIC SAILING 9

History and recent developments in robotic sailing – miniature sailing robot platform (MOOP) – autonomous sailing vessel – design, development and deployment

UNIT III SUBMERSIBLES 9

Unmanned submersibles- towed vehicles – Remotely Operable Vehicles (ROV) – The ROV business – Design theory and standards – control and simulation – design and stability – components of ROV - applications

UNIT IV AUTONOMOUS UNDERWATER VEHICLE (AUV) 9

Gliders – construction – buoyancy driven – Control strategies, AUV – construction – components – control strategies

UNIT V UNDERWATER VEHICLE GUIDANCE AND CONTROL 9

Modelling of marine vehicles – kinematics – rigid body dynamics – hydrodynamic forces and moments – equation of motion – stability and control of underwater vehicles

TOTAL: 45 PERIODS

OUTCOMES:

After successful completion of the course the students can able to

- Explain various types of marine robots.
- Design, develop and deploy marine robots in the field
- Design remotely operable vehicles
- Construct autonomous underwater vehicles
- Model the marine vehicle

TEXT BOOKS:

1. Alexander schlaelfer and ole blaurock, Robotic sailing, Proceedings of the 4th International sailing conference, Springer, 2011
2. Sabiha A. wadoo,pushkin kachroo, Autonomous underwater vehicles, modelling, control design and Simulation, CRC press, 2011
3. Robert D. Christ,Robert L. Wernli, Sr. “The ROV Manual A User Guide for Remotely
Operated Vehicles”, Elsevier, second edition, 2014
4. Thor I Fossen, Guidance and control of ocean vehicles, John wiley and Sons, 1999

REFERENCES

1. Mae L. Seto, Marine Robot Autonomy, Springer, 2013
2. Richard A Geyer, "Submersibles and their use in oceanography and ocean engineering", Elsevier, 1997
3. Gianluca Antonelli, Underwater robotics, Springer, 2014

COs	POs												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	3	3										3	3	3
CO2	3	3	3										3	3	3
CO3	3	3	3										3	3	3
CO4	3	3	3										3	3	3
CO5	3	3	3										3	3	3
Avg	3	3	3										3	3	3

ME23C13	MODERN ROBOTICS	L	T	P	C
		2	0	2	3

COURSE OBJECTIVE:

- To impart knowledge on anatomy of robots, kinematics, different end effector, mobile robots and its societal applications

UNIT – I 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 – II 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 – III 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 – IV 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 – V APPLICATIONS OF ROBOTS 9

Application of robotic: industrial robots, Service robots, domestic and household robots, medical robots, defence robots, agricultural robots, space robots, Aerial robotics Role of robots in inspection, assembly, material handling, underwater, space and healthcare

TOTAL : 45 PERIODS

OUTCOMES:

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

1. Explain the definition, history of robotics and robot anatomy.
2. Develop the solutions for robot kinematics
3. Describe the grasping and manipulation of robots.
4. Explain mobile robot and manipulation.
5. Summarise the applications of robots in industry, Defence, domestic & household and medical field.

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

REFERENCES:

1. Modern Robotics: Designs, Systems and Control, by Jared Kroff, Willford Press (18 June 2019)ISBN-10 : 1682856763
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), ISBN-10 : 981109263X
3. Modern Robotics: Building Versatile Machines, by Harry Henderson, Facts On File Inc; Illustrated edition (1 August 2006), ISBN-10 : 0816057451
4. Artificial Intelligence for Robotics, by Francis X. Govers, Packt Publishing Limited; Standard Edition (30 August 2018), ISBN-10 : 1788835441
5. Modern Robotics Hardcover by Lauren Barrett (Editor), Murphy & Moore Publishing (1 March 2022), ISBN-10 : 1639873732

CO	**PO**												**PSO**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	3	3	3	3	-	-	-	-	-	-	2	1	2	3
2	3	3	3	3	3	-	-	-	-	-	-	2	1	2	3
3	3	3	3	3	3	-	-	-	-	-	-	2	1	2	3
4	3	3	1	-	3	-	-	-	-	-	-	2	1	2	3
5	3	1	1	-	-	3	3	-	-	-	-	2	1	2	3
Avg	3	2.6	2.2	3	3	3	3	-	-	-	-	2	1	1	3

ME23016 LEAN MANUFACTURING

L	T	P	C
3	0	0	3

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.

UNIT – I 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 – II 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 – III 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 – IV LEAN ELEMENTS 9

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 – V 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 :45 PERIODS

OUTCOMES:

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

1. Discuss the basics of 6 SIGMA
2. Elaborate the lean manufacturing tools.

3. Illustrate about the deeper understanding methodologies of Lean manufacturing.
4. Discuss lean concepts and its elements.
5. Describe the implementation and challenges of lean manufacturing.

TEXT BOOKS:

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
3. The Toyota Way: 14 Management Principles
4. Gemba Kaizen: A Commonsense Approach to a Continuous Improvement Strategy,Masaki Imai

REFERENCES:

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).
4. Older / Previous editions of AIAG manuals on APQP, FMEA and PPAP. These are great sources of information on Quality Planning and has basics of Project Management and required skills.
5. Quality Management for Organizations Using Lean Six Sigma Techniques- Erick C Jones

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	1	1	2	1	1				1		3	1	1	2	1
2	1	1	2	1	1				1		3	1	1	2	1
3	1	1	2	1	1				1		3	1	1	2	1
4	1	1	2	1	1				1		3	1	1	2	1
5	1	1	2	1	1				1		3	1	1	2	1
Low (1) ; Medium (2) ; High (3)															

ME23015 GREEN MANUFACTURING DESIGN AND PRACTICES **L T P C**
3 0 0 3

COURSE OBJECTIVES

1. To introduce the concept of environmental design and industrial ecology.
2. To impart knowledge about air pollution and its effects on the environment.
3. To enlighten the students with knowledge about noise and its effects on the environment.
4. To enlighten the students with knowledge about water pollution and its effects on the environment.
5. To introduce the concept of green co-rating and its need

UNIT – I DESIGN FOR ENVIRONMENT AND LIFE CYCLE ASSESSMENT 9

Environmental effects of design -selection of natural friendly material - Eco design - Environmental damage Material flow and cycles – Material recycling – Emission less manufacturing- Industrial Ecology – Pollution prevention – Reduction of toxic emission – design for recycle.

UNIT – II AIR POLLUTION SAMPLING AND MEASUREMENT 9

Primary and Secondary Pollutants, Automobile Pollutants, Industrial Pollution, Ambient air quality Standards, Metrological aspects of air Pollution, Temperature lapse Rates and Stability-wind velocity and turbulence-Pump behavior dispersion of air Pollutants-solution to the atmosphere dispersion equation- the Gaussian Plume Model, Air pollution sampling-collection of gaseous air pollutants-collection of particulate pollutants-stock sampling, analysis of air pollutants-sulfur dioxide-nitrogen dixide, carbon monoxide, oxidants and ozone.

UNIT – III NOISE POLLUTION AND CONTROL 9

Frequency and Sound Levels, Units of Noise based power radio, contours of Loudness. Effect of human, Environment and properties, Natural and Anthrogenic Noise Sources, Measuring Instruments for frequency and Noise levels, Masking of sound, Types, Kinetics, Selection of different reactors used for waste treatment, Treatment of noise at source, Path and Reception, Sources of noise, Effects of noise- Occupational Health hazards, thermal Comforts, Heat Island Effects, Radiation Effects.

UNIT – IV WATER DEMAND AND WATER QUALITY 9

Factors affecting consumption, Variation, Contaminants in water, Nitrates, Fluorides, Detergents, taste and odour, Radio activity in water, Criteria, for different impurities in water for portable and non-portable use, Point and non-point Source of pollution, Major pollutants of Water, Water Quality Requirement for different uses, Global water crisis issues.

UNIT – V GREEN CO-RATING 9

Ecological Footprint - Need For Green Co-Rating – Green Co-Rating System – Intent – System Approach – Weightage- Assessment Process – Types Of Rating – Green Co-Benefits – Case Studies Of Green Co- Rating

TOTAL:45 PERIODS

OUTCOMES:

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

1. Explain the environmental design and selection of eco-friendly materials.
2. Analyse manufacturing processes towards minimization or prevention of air pollution.
3. Analyse manufacturing processes towards minimization or prevention of noise pollution.
4. Analyse manufacturing processes towards minimization or prevention of water pollution.
5. Evaluate green co-rating and its benefits.

TEXT BOOKS:

1. Gradel.T.E. and B.R. Allenby – Industrial Ecology – Prentice Hall – 2010
2. Rao M.N. and Dutta A.K. “Wastewater treatment”, Oxford & IBH publishing Co. Pvt. Ltd., New Delhi, Second Edition, 2006

REFERENCES:

1. Gradel.T.E. and B.R. Allenby – Industrial Ecology – Prentice Hall – 2010
2. Frances Cairncross– Costing the Earth: The Challenge for Governments, the Opportunities for Business – Harvard Business School Press – 1993.
3. World Commission on Environment and Development (WCED), Our Common Future, Oxford University Press 2005.
4. Rao M.N. and Dutta A.K. “Wastewater treatment”, Oxford & IBH publishing Co. Pvt. Ltd., New Delhi, Second Edition, 2006
5. Rao CS Environmental Pollution Control Engineering-, Wiley Eastern Ltd., New Delhi, 2006.
6. Lewis H Bell and Douglas H Bell, Industrial noise control, Fundamentals and applications, Marcel Decker, 1994.

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	1	1	3	1			3		1			1	1	2	2
2	1	1	3	1			3		1			1	1	2	2
3	1	1	3	1			3		1			1	1	2	2
4	1	1	3	1			3		1			1	1	2	2
5	1	1	3	1			3		1			1	1	2	2
Low (1) ; Medium (2) ; High (3)															

ME23014 **ENVIRONMENT SUSTAINABILITY AND IMPACT ASSESSMENT**

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

1. To make the students to understand the concepts of Environmental Sustainability & Impact Assessment
2. To familiarize the students in environmental decision making procedure.
3. Make the students to identify, predict and evaluate the economic, environmental, and social impact of development activities
4. To provide information on the environmental consequences for decision making
5. To promote environmentally sound and sustainable development through the identification of appropriate alternatives and mitigation measures.

UNIT – I ENVIRONMENTAL IMPACT ASSESMENT 9

Environmental impact assessment objectives – rationale and historical development of EIA - Conceptual frameworks for EIA Legislative development – European community directive – Hungarian directive.

UNIT – II ENVIRONMENTAL DECISION MAKING 9

Strategic environmental assessment and sustainability appraisal – Mitigation, monitoring and management of environmental impacts- Socio economic impact assessment.

UNIT III ENVIRONMENTAL POLICY, PLANNING AND LEGISLATION 9

Regional spatial planning and policy – Cumulative effects assessment – Planning for climate change, uncertainty and risk.

UNIT – IV LIFE CYCLE ASSESSMENT 9

Life cycle assessment; Triple bottom line approach; Industrial Ecology. Ecological foot printing, Design for Environment, Future role of LCA, Product stewardship, design, durability and justifiability, measurement techniques and reporting

UNIT – V SUSTAINABLE URBAN ECONOMIC DEVELOPMENT 9

Spatial economics – Knowledge economy and urban regions.

TOTAL: 45 PERIODS

OUTCOMES:

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

1. Explain the concepts of Environment Sustainability and trained to make decision related to Environment.
2. Make decision that has an effect on our environment
3. Evaluate the basics of environmental policy, planning and various legislation
   Get valuable information for exploring decisions in each life stage of materials, buildings, services and infrastructure.
4. Explain the Life cycle assessment of Environmental sustainability.
5. Explain sustainable urban economic development.

TEXT BOOKS:

1. The Application of Science in Environmental Impact Assessment, by Aaron J. MacKinnon, Pete N. Duinker , Tony R. Walker , Routledge; 1st edition (14 May 2019), ISBN-10 : 0367340194
2. Routledge Handbook of Environmental Impact Assessment, by Kevin Hanna, Routledge; 1

edition (11 April 2022), ISBN-10 : 0367244470

REFERENCES:

1. Clive George, C. Collin, H. Kirkpolarice – Impact Assessment and sustainable development – Edward Elgar Publishing, 2007
2. Robort B Gibsan, Sustainability Assessment, Earth Scan publishers, 2005
3. Simon Dresner, The principle of sustainability – Earth Scan publishers, 2008
4. Canter, R.L., "Environmental Impact Assessment", McGraw Hill Inc., New Delhi, 1996.
5. Shukla, S.K. And Srivastava, P.R., "Concepts In Environmental Impact Analysis", Common Wealth Publishers, New Delhi, 1992.
6. John G. Rau And David C Hooten "Environmental Impact Analysis Handbook", McGraw Hill Book Company, 1990.

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	1		2				3		1			1	1	2	1
2	1		2				3		1			1	1	2	1
3	1		2				3		1			1	1	2	1
4	1		2				3		1			1	1	2	1
5	1		2				3		1			1	1	2	1
Low (1) ; Medium (2) ; High (3)															

ME23017	GREEN SUPPLY CHAIN MANAGEMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

To familiar with the modern lead free electronic manufacturing processes, recycling of electronics, and reliability assessment.

UNIT – I 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 – II 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 – III 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 – IV 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 – V 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: 45 PERIODS

OUTCOMES:

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

1. Get concise awareness of standards and legislation of modern electronic manufacturing for green environment.
2. Explain the conventional electronic processing and lead free electronic manufacturing techniques.
3. Realize the assembly process and the need of recycle of electronics
4. Use reliability and product life cycle estimation tools for electronic manufacturing.
5. Validate the green electronic manufacturing procedures in applications.

TEXT BOOKS:

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

REFERENCES:

1. David Austen, Green Electronic Morning, Ingleby Gallery, 2006.
2. John Hu. Mohammed Ismail, CMOS High Efficiency on – Chip Power Management, Springer Publications 4th edition, 2011.
3. Yuhang yang and Maode Ma, Green Communications and Networks, Springer Publication., 2014.
4. SankaGanesan, Michael Pecht, Lead free Electronics, John Wiley & Sons, 2006.
5. Charles A. Harper, Electronic Materials and Processes Hand book, McGraw-Hill, 2010.
6. Sammy G. Shina, Green Electronics Design and Manufacturing, McGraw Hill., 2008.

CO	**PO**												**PSO**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	1	1	2	-	-	-	2	-	1	-	3	1	1	2	2
2	1	1	2	-	-	-	2	-	1	-	3	1	1	2	2
3	1	1	2	-	-	-	2	-	1	-	3	1	1	2	2
4	1	1	2	-	-	-	2	-	1	-	3	1	1	2	2
5	1	1	2	-	-	-	2	-	1	-	3	1	1	2	2
Avg	1	1	2	-	-	-	2	-	1	-	3	1	1	2	2

ME23013	MACHINE LEARNING FOR INTELLIGENT SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

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

UNIT – I 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 – II 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 – III 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 – IV 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 – V RNN AND REINFORCEMENT LEARNING 9

Unfolding Computational Graphs, Recurrent neural networks, Application Case Study of recurrent networks in Robotics, Reinforcement learning, Examples for reinforcement learning, Marko decision process, Major components of RL, Q-learning. Application Case Study of reinforcement learning in Robotics

TOTAL :45 PERIODS

OUTCOMES:

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

1. Understand basic machine learning techniques such as regression, classification
2. Understand about clustering and segmentation
3. Model a fuzzy logic system with fuzzification and defuzzification
4. Understand the concepts of neural networks and neuro fuzzy networks.
5. Gain knowledge on Reinforcement learning.

TEXT BOOKS:

1. Micheal Negnevitsky, Artificial Intelligence: A Guide to Intelligent Systems, 3rd Edition, Addision Wesley, England, 2011

REFERENCES:

1. Bruno Siciliano, Oussama Khatib, “Handbook of Robotics”, 2016 2nd Edition, Springer
2. Simon Haykin, “Neural Networks and Learning Machines: A Comprehensive Foundation”, Third Edition, Pearson, delhi 2016.
3. Timothy J Ross, “Fuzzy Logic with Engineering Applications”, 4th Edition, Chichester, 2011, Sussex Wiley.

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	3	2	1						1	3	3	2	3
2	3	2	3	2	1						1	3	3	2	3
3	3	2	3	2	1						1	3	3	2	3
4	3	2	3	2	1						1	3	3	2	3
5	3	2	3	2	1						1	3	3	2	3

ME23018 **DESIGN OF PRESSURE VESSELS**

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

1. To introduce the Mathematical knowledge to design pressure vessels and piping
2. To learn the ability to carry of stress analysis in pressure vessels and piping
3. To study the design of vessels and theory of reinforcement.
4. To study buckling and fracture analysis in vessels.
5. To learn piping layout and flow diagram.

UNIT – I INTRODUCTION 9

Methods for determining stresses – Terminology and Ligament Efficiency – Applications

UNIT – II STRESSES IN PRESSURE VESSELS 9

Introduction – Stresses in a circular ring, cylinder –Dilation of pressure vessels, Membrane stress Analysis of Vessel – Cylindrical, spherical and, conical heads – Thermal Stresses – Discontinuity stresses in pressure vessels.

UNIT – III DESIGN OF VESSELS 9

Design of Tall cylindrical self-supporting process columns – Supports for short vertical vessels – Stress concentration at a variable Thickness transition section in a cylindrical vessel, about a circular hole, elliptical openings. Theory of Reinforcement – Pressure Vessel Design.

UNIT – IV BUCKLING AND FRACTURE ANALYSIS IN VESSELS 9

Buckling phenomenon – Elastic Buckling of circular ring and cylinders under external pressure – collapse of thick walled cylinders or tubes under external pressure – Effect of supports on Elastic Buckling of Cylinders – Buckling under combined External pressure and axial loading.

UNIT – V PIPING 9

Introduction – Flow diagram – piping layout and piping stress Analysis.

TOTAL:45 PERIODS

OUTCOMES:

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

1. Explain Methods for determining stresses Terminology and Ligament Efficiency, Applications
2. Analyse stress in pressure vessels
3. Design and analysis of pressure vessels.
4. Analysis of buckling and fracture analysis in vessels
5. Design and analysis piping layout and piping.

TEXT BOOKS:

1. John F. Harvey, "Theory and Design of Pressure Vessels", CBS Publishers and Distributors,1987.
2. Theory And Design Of Pressure Vessels (Pb 2001) by HARVEY J.F. | 1 January 2001

REFERENCES:

1. Henry H. Bedner, “Pressure Vessels, Design Hand Book", CBS publishers and Distributors,1987.
2. Stanley, M. Wales, “Chemical process equipment, selection and Design". Buterworths series in Chemical Engineering, 1988.
3. William. J., Bees, “Approximate Methods in the Design and Analysis of Pressure Vessels and Piping”, Pre ASME Pressure Vessels and Piping Conference, 1997.

4. Sam Kannapan, “Introduction to Pipe Stress Analysis”. John Wiley and Sons, 1985.
5. Theory and design of Pressure Vessels (Pb 2001)by HARVEY J.F. | 1 January 2001

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	3	1	1				1			1	2	3	2
2	3	2	3	1	1				1			1	2	3	2
3	3	2	3	1	1				1			1	2	3	2
4	3	2	3	1	1				1			1	2	3	2
5	3	2	3	1	1				1			1	2	3	2

ME23019	FAILURE ANALYSIS AND NDT TECHNIQUES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

The main learning objective of this course is to

1. Understating the importance of failure analysis and causes of failures, principles of NDT methods, its applications and limitations.

UNIT I INTRODUCTION TO FAILURE ANALYSIS 9

Need and scope of failure analysis. Engineering Disasters in history and their failure analysis. Sources of failures. Description & origin of Processing defects. Types of failures- Ductile & Brittle, Fracture Analysis, FMEA.Application of fracture mechanics concepts to design for safety. NDT for failure analysis- an overview.

UNIT II DYE PENETRANT & MAGNETIC PARTICLE INSPECTION 9

Importance of NDT, Visual Inspection: Tools, applications and limitations,

Liquid Penetrant Inspection (LPI): Principles, Requisites of a good penetrant anddeveloper, Types of penetrants and developers, Techniques, procedures, interpretation and evaluation of penetranttest indications, advantages, and limitations, case study.

Magnetic Particle Inspection (MPI): Principles, Magnetization- Methods, techniques. Continuous & Residual testing of MPI, System sensitivity, Interpretation of MPI indications, Advantages and limitations, case study.

UNIT III ULTRASONIC TESTING 9

Principle, type of Ultrasonic waves, mode conversion in ultrasonics, Principle, UT testing methods: Contact testing and immersion testing, normal beam and straight beam testing, angle beam testing, dual crystal probe, Ultrasonic Testing Techniques: Resonance testing, Through transmission technique, Pulse echo testing technique,

Instruments used in UT, Transducer types, Reference blocks with artificially created defects, Calibration of equipment, A-Scan, B-scan & C-scan, case study.

UNIT IV EDDY CURRENT TESTING & THERMOGRAPHY 9

Eddy current Testing: Principles, Physics aspects of ECT- conductivity, permeability, resistivity, inductance, inductive reactance, impedance, Filed factor and lift-off effect, edge effect, endeffect, Depth of penetration of ECT, Instrumentation, application of ECT, advantages, limitations, case study.

Thermography: Principles, Contact and non-contact inspection methods, Heat sensitive paints and papers, thermally quenched phosphors, Liquid crystals, techniques for applying liquid crystals, advantage and limitations, Infrared radiation and infrared detectors, applications, case study.

UNIT V RADIOGRAPHY TESTING 9

Principle, electromagnetic radiation sources, X-ray sources, Production of X-rays, High energy X-ray source, Gama ray source, Properties of X-rays and gamma rays, Inspection techniques, Exposure, Real-time radiography, Films and screens used in radiography, Quality of radiographic film processing, interpretation, evaluation of test results, Computed Tomography, Safety aspects required in radiography, Applications, advantages and limitations, case study.

TOTAL :45 PERIODS

COURSE OUTCOMES:

Upon completion of the Course, the students will be able to:

CO1 Discuss on the various failures, their analysis and their importance

CO2 Adapt the Penetrant testing procedures for evaluating the surface defects.

CO3 Interpret the images and the results obtained from the Thermographic technique and the Eddy current testing

CO4 Describe the testing procedure and analyze the results obtained in the Ultrasonic inspection

CO5 Explain the techniques involved in the Radiographic testing and the various advancements inRadiography.

TEXTBOOKS:

1. Paul E Mix, "Introduction to Non-destructive testing: a training guide", Wiley, 2nd edition New Jersey, 2005.

2. ASM Metals Handbook, "Non-Destructive Evaluation and Quality Control", American Society of Metals, Metals Park, Ohio, USA, 200, Volume-17.

REFERENCES:

1. Vito J. Colangelo, Francis A. Heiser,Analysis of Metallurgical Failures, Wiley Publications,1987.

2. ASNT, American Society for Non Destructive Testing, Columbus, Ohio, NDT Handbook, Vol. 1, Leak Testing, Vol. 2, Liquid Penetrant Testing, Vol. 3, Infrared and Thermal Testing Vol. 4, Radiographic Testing, Vol. 5, Electromagnetic Testing, Vol. 6, Acoustic Emission Testing, Vol. 7, Ultrasonic Testing.

3. Baldev Raj, T.Jayakumar, M.Thavasimuthu "Practical Non-Destructive Testing", Narosa Publishing House, 2009.

4. Charles, J. Hellier," Handbook of Non-destructive evaluation", McGraw Hill, New York 2001.

5. Ravi Prakash, "Non-Destructive Testing Techniques", New Age International Publishers, 1st revised edition, 2010.

COs	POs											PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	3	1	3	3	3	2	-	-	-	2	3	2	1
2	3	2	1	3	2	2	2	1	-	-	-	2	3	1	1
3	3	2	1	2	2	2	2	1	-	-	-	2	3	1	1
4	3	2	1	3	2	2	2	1	-	-	-	2	3	1	1
5	3	2	1	3	2	2	2	1	-	-	-	2	3	1	1
Avg	3	2	1.4	2.4	2.2	2.2	2.2	1.2	-	-	-	2	2	1.2	1

ME23020	MATERIALS HANDLING & SOLID PROCESSING EQUIPMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

The main objective of the course is to prepare the students for understanding and applying the principles of material handling and solid processing equipment in industries

UNIT I INTRODUCTION & PRINCIPLES OF MATERIAL HANDLING 9

Materials Handling: Definition – Scope – Importance – Characteristics - Classification of Materials – Twenty Principles of Materials Handling – Unit Load Concept – Definition of Unit Load – Advantages and Disadvantages – Load Unitization Process and Handling Methods – Pallets, Skids and Containers – Classification of Materials Handling Equipment – Basic Equipment Types – Classification of Handling Equipment.

UNIT II INDUSTRIAL VEHICLES/TRUCKS 9

Hand Trucks – Power Trucks – Fork Lift Trucks – Tractors.

UNIT III CONVEYORS 9

Belt Conveyors – Chain Conveyors – Haulage Conveyors – Cable Conveyors – Bucket Conveyors – Roller Conveyors – Screw Conveyors – Pneumatic Conveyors – Hydraulic Conveyors

UNIT IV HOISTING EQUIPMENT 9

Parts of Hoisting Equipment – Hoists – Winches – Elevators – Cranes – Derricks

UNIT V SOLID (BULK) HANDLING EQUIPMENT 9

Storage of Bulk Solids – Bulk Handling Equipment – Robotic Handling – Materials Handling at the Workplace – Robots and their Classification – Robotic Handling Applications - Auxiliary Equipment – Gates – Feeders – Chutes – Positioners – Ball Table – Pallet Loader and Un-loader.

TOTAL:45 PERIODS

COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

CO1 Apply the principles of material handling equipment in industries.

CO2 Apply the principles of industrial vehicles / trucks in industries.

CO3 Apply the principles of conveyer in industries.

CO4 Apply the principles of hoisting equipment in industries.

CO5 Apply the principles of solid (bulk) handling equipment in industries.

TEXT BOOKS:

1. Siddhartha Ray, Introduction to Materials Handling, New Age International Pub., 2008.

REFERNCES:

1. Alexandrov, M., Materials Handling Equipments, MIR Publishers, 1981.
2. Boltzharol, A., Materials Handling Handbook, The Ronald Press Company, 1958.
3. Norton. L Robert. “Machine Design – An Integrated Approach” Pearson Education, 2nd Ed. 2005.
4. Rudenko, N., Materials Handling Equipment, ELnvee Publishers, 1970.
5. Spivakovsy, A.O. and Dyachkov, V.K., Conveying Machines, Volumes I and II, MIR Publishers, 1985.

APPROVED DATA BOOKS:

1. P.S.G. Tech., “Design Data Book”, KalaikathirAchchagam, Coimbatore, 2003.
2. Lingaiah. K. and Narayana Iyengar, “Machine Design Data Hand Book”, Vol. 1 & 2, Suma Publishers, Bangalore, 1983

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

ME23021 ROTATING MACHINERY DESIGN

	L	T	P	C
	3	0	0	3

COURSE OBJECTIVES:

To familiarize with various operations of gas turbines and other driven rotating machines, its design and failure criteria.

UNIT I INTRODUCTION 9

Overview of the different operational regimes for gas turbine applications: base load, peak load, standby and backup operations, alongside their individual operational requirements. Fundamentals of Creep and Fatigue damage mechanisms. Material, design and operational parameters that affect creep and fatigue. Experimental and test procedures to characterise creep and fatigue damage.

UNIT II DESIGNING FORCES 9

Loads/forces/stresses in gas turbine engines: loads - rotational inertia, flight, precession of shafts,pressure gradient, torsion, seizure, blade release, engine mountings and bearings-Discussion of majorloadings-rotating components and pressure casing components.

UNIT III FAILURE CRITERIA 9

Monotonic failure criteria: proof, ultimate strength. Theories of failure - bi-axial loads. Other failuremechanisms - gas turbine engines including creep and fatigue. Fatigue properties - SN and RMdiagrams. Stress concentration, mean stress, Cumulative fatigue, Goodman diagram and safety factorfor gas turbine components. Larson-Miller time-temperature parameter.

UNIT IV BLADE DESIGN 9

Design of discs, blades. Illustration of magnitude stresses in conventional axial flow blades-simple desk-top method -effects of leaning the blade. Design of flanges and bolted structures. Leakages through a flanged joint and failure from fatigue.

UNIT V BLADE VIBRATIONS AND DAMAGE MECHANISMS 9

Natural frequencies turbomachine blades. Blade twist, centrifugal stiffening, Sources of blade excitation, Stationary flow disturbance, rotating stall and flutter. Campbell diagram and troublesome resonances. Allowances for temperature, pre-twist and centrifugal stiffening. Methods for dealing with resonances.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

1. Differentiate the operational regimes and requirements related to different gas turbine applications.
2. Describe and distinguish the design requirements and loads encountered by gas turbine components during normal operation.
3. Analyse, evaluate and assess the loads, stresses, failure criteria and factors of safety used in gas turbine engine
4. Evaluate impact of vibrations on design and operation of gas turbine
5. Assess the creep and fatigue damage of gas turbine components based on design and operational parameters

TEXTBOOKS:

1. A S Rangawala, Turbomachinery Dynamics-Design and operations, McGraw-Hill, 2005, ISBN-13: 978-0071453691.
2. Design, Modeling and Reliability in Rotating Machinery, Robert X. Perez (Editor) ISBN: 978-1- 119-63169-9

REFERENCES:

1. P.P Walsh and P. Peletcher, Gas Turbine Performance’ Blackwell Science, 1998, ISBN0632047843.
2. Turbines, Compressors & Fans S. M. Yahya Tata McGraw Hill Co. Ltd 2nd edition, 2002
3. Principals of Turbo machines D. G. Shepherd The Macmillan Company 1964
4. Fluid Mechanics & Thermodynamics of Turbo machines S. L. Dixon Elsevier 2005
5. Shaft Alignment Handbook (Mechanical Engineering) by John Piotrowski | 2 November 2006

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

ME23022 THERMAL AND FIRED EQUIPMENT DESIGN

	L	T	P	C
	3	0	0	3

COURSE OBJECTIVES:

To introduce the design concepts and construction of thermal and fired equipment.

UNIT – I INTRODUCTION 9

Principal equipment in Thermal Power Plant, Historical developments of Boiler, Utility, Industrial boilers, Morden trends in boiler design , Basic knowledge of different types of Thermal Fired Equipment ,sub critical and super critical boilers - Coal , Oil ,Gas , Pulverised fuel cyclone, FBC, CFBC , MSW , and Stoker firing, Boiler efficiency , auxiliary power consumption , Performance data , Performance Correction Curves

UNIT – II BASIS OF BOILERS AND DESIGN 9

Codes- Design and Construction, IBR, ISO, ASME, BS, Heat balance diagram, Boiler parameters, Fuel analysis and variations, Site conditions, Furnace heat loadings, FOT, Plan area loading, Volumetric loading Balanced Draft and Pressurised Furnace, Natural / Controlled Circulation, Constant and Sliding Pressure, Boiler heat transfer surfaces, Flue gas velocities, boiler auxiliaries, Boiler schemes, Boiler Layouts

UNIT – III FIRING SYSTEM- FUEL AND MILLING 9

Coal / Oil / Natural Gas in any combination, Lignite, Blast Furnace Gas / Coke Oven Gas / Corex Gas Carbon Monoxide / Tail gas, Asphalt, Black Liquor, Bagasse, Rice Husk, Washery Rejects, Wheat / Rice straw MSW, wind box, Burner, Type of Stokers, Pulverisers - Bowl mill, Tube mill, Direct firing, Indirect firing, Wall firing (Turbulent / Vortex Burners), Tangential firing (Jet Burners), Fire Ball.

UNIT – IV PRESSURE PARTS AND DESIGN AND MATERIALS 9

Economiser, Drums , Water Walls , Headers , Links , Super Hater , Super Heaters , Reheaters, Tubes , Spiral Tubes , Surface area , Free Gas Area , Metal temperature , LMTD , Acid Due Point Temperature , Carbon steel , Low alloy steel , Titanium alloy steel

UNIT – V BOILER AUXILIARIES 9

Air preheaters (APH) – bi sector APH , Tri sector APH, Cold PA System, Hot PA System, Tubular APH, Steam coil Air preheater , FANS – Axial, Radial, Performance curves, MILLS- Tube , Vertical mills , Air quality Control systems ,Dust Collection System - Mechanical Precipitator, Electrostatic Precipitator, FGD , SCR , SNCR

TOTAL :45 PERIODS

OUTCOMES:

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

1. Explain the concepts of thermal and fired equipment.
2. Discuss the basis, design, and construction of boilers.
3. Describe of typical fuel firing systems in the boiler.
4. Discuss the materials requirements for pressure parts.
5. Discuss of various boiler auxiliaries' system.

TEXTBOOKS:

A Course in Power Plant Engineering; Dhanapat Rai and Sons - Domkundwar Power Plant Engineering by B. VijayaRamnath C. Elanchezhian, L. Saravanakumar

REFERENCES:

1 Elwakil M, Power Plant Technology, McGraw Hill, New York, 1964

2 Steam Generators and Waste Heat Boilers: For Process and Plant Engineers (Mechanical Engineering) by V. Ganapathy

3 Steam Generators: Description and Design by Donatello Annaratone

4 An Introduction to Coal and Wood Firing Steam Generators (Power Plants Engineering) by J Paul Guyer

5 Advances in Power Boilers (JSME Series in Thermal and Nuclear Power Generation)by Mamoru Ozawa and Hitoshi Asano | 28 January 2021

CO	**PO**												**PSO**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	3	1	-	-	-	-	1	-	-	1	2	3	2
2	2	1	3	1	-	-	-	-	1	-	-	1	2	3	2
3	2	1	3	1	-	-	-	-	1	-	-	1	2	3	2
4	2	1	3	1	-	-	-	-	1	-	-	1	2	3	2
5	2	1	3	1	-	-	-	-	1	-	-	1	2	3	2
Avg	2	1	3	1	-	-	-	-	1	-	-	1	2	3	2

ME23023	INDUSTRIAL LAYOUT DESIGN AND SAFETY	L	T	P	C
		2	0	2	3

COURSE OBJECTIVE:

To introduce the industrial layout design principles, process and material flow analysis and product and equipment analysis.

UNIT – I INTRODUCTION 6

Industrial Facility Layout: Definition, Types of Layout Problems, Engineering Design Problem Approach – Product Analysis, Equipment Selection, Personnel Requirement Analysis, Space Requirement and Availability – Process and Material Flow Analysis, Data Requirement for Layout Decisions, Tools for Presenting Layout Designs.

UNIT – II FACILITIES LAYOUT DESIGN & ALGORITHMS 6

Traditional Approaches to Facility Layout, Systematic Layout Planning, Special Considerations in Office Layout, Engineering Design Problem Approach, Code Compliance, OSHA, ADA Regulations, and Other Considerations in Facility Design – Algorithms for the Layout Problem, Construction Algorithms, Improvement Algorithms, Hybrid Algorithms, Layout Software (CRAFT, BLOCPLAN, PFAST, Layout-iQ, VIP- PLANOPT, Factory CAD, Factory FLOW, Plant Simulation)

UNIT – III FACILITIES LAYOUT PROBLEM MODELS & ALGORITHMS 6

Models for the Layout Problem, Generic Modeling Tools, Models for the Single-Row Layout Problem, Models for the Multi row Layout Problem with Departments of Equal and Unequal Area – Material Handling, Principles, Types, Models for Material- Handling System Design – Storage and Warehousing, Warehouse Functions, Warehouse Design and Operation.

UNIT – IV SAFETY PLANNING & MANAGEMENT 6

Introduction: Elements of Safety Programming, Safety Management. Upgrading Safety Developmental Programs: Safety Procedures, Arrangements and Performance Measures, Education, Training and Development in Safety. Safety Performance: An Overview of an Accident, Occupational Health and Industrial Hygiene. Understanding
the Risks: Prevention of Accidents Involving Hazardous Substances. Indian Factories Act 1948 for Health and Safety.

UNIT – V APPROACHES IN SAFETY MANAGEMENT 6

Safeguarding against Common Potential Hazards: Trips, Slips and Falls, Preventing Electrocution, Static Electricity, Hazardous Energy Control. Specific Hazard Control Measures: Forklift Hazard Control, Tractor Hazard Control. Safe Handling and
Storage: Material Handling, Compressed Gas Cylinders, Corrosive Substances, Hydrocarbons, Waste Drums and Containers.

TOTAL: 30 PERIODS

INDUSTRIAL LAYOUT DESIGN LABORATORY
Experiments

1. Simulation of Manufacturing Shop
2. Simulation of Batch Production System
3. Simulation of Multi Machine Assignment System
4. Simulation of Manufacturing and Material Handling Systems
5. Simulation of a Shop Floor
6. Simulation of Material Handling Systems

TOTAL: 30

COURSE OUTCOMES:

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

1. Explain the industrial facility layout design principles, process and material flow analysis and product and equipment analysis.
2. Discuss the facilities layout design algorithms and selecting appropriate software.
3. Describe the facilities layout problem modeling tools and algorithms for production, warehouse, and material handling.
4. Explain the safety planning and management principles in industries.
5. Illustrate the various safety management approaches in industries.

TEXT BOOKS:

1. Sunderesh S. Heragu, "Facilities Design", 3rd Edition, CRC Press Taylor & Francis Group, 2008.
2. L. M. Deshmukh, "Industrial Safety Management: Hazard Identification and Risk Control", Tata McGraw-Hill Publishing Co. Ltd., 2005.

REFERENCES:

1. Eric Teicholz, "Facility Design and Management Handbook", Tata McGraw-Hill Publishing Co. Ltd., 2001.
2. James A. Tompkins, John A. White, Yavuz A. Bozer, and J. M. A. Tanchoco, "Facilities Planning", 4th Edition, John Wiley & Sons, 2010.
3. Matthew P. Stevens and Fred E. Meyers, "Manufacturing Facilities Design and Material Handling", 5th Edition, Purdue University Press, 2013.
4. Charles D.Reese, Occupational Health and Safety Management: A Practical Approach, CRC Press, 2003.
5. J Maiti, Pradip Kumar Ray, Industrial Safety Management: 21st Century Perspectives of Asia, Springer, 2017.
6. Industrial Hazard and Safety Handbook: (Revised impressionby Ralph W King and John Magid | 24 September 2013

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	1	2	2	2	1	3	3	3	2	1	1	3	2	2	2
2	1	2	2	2	1	3	3	3	2	1	1	3	2	2	2
3	1	2	2	2	1	3	3	3	2	1	1	3	2	2	2
4	1	2	2	2	1	3	3	3	2	1	1	3	2	2	2
5	1	2	2	2	1	3	3	3	2	1	1	3	2	2	2
Avg	1	2	2	2	1	3	3	3	2	1	1	3	2	2	2

ME23024	DESIGN CODES AND STANDARDS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

To study the Codes and Standards used in different industries and government norms and regulations

UNIT – I INTRODUCTION 9

Introduction to Codes and Standards. What is code? What is Standard Need for codes and standards. Objective of Codes and Standards. Codes, Standards and Good Engineering Practices.

UNIT – II CODES 9

Codes and Standards used in Different Industry. Material, Design, Inspection and Construction Codes. Process Industry Codes. Machinery Design codes. Codes used in Oil and Gas Industry. Welding Codes. Machine Design. Automotive. HVAC. Performance Test Codes. Other Discipline codes

UNIT – III STANDARDS 9

Sources of Codes and Standards. Who publishes Codes and Standards? International Societies and Professional Bodies. Process of Standardisation and Code publishing in Professional Bodies and Companies. Interdisciplinary Codes.

UNIT – IV REGULATIONS 9

Government and Federal Regulations. Need for them. Indian and International Regulations. Standards organisations. Weather and Climatic codes. IS, ISO, IBR, OISD. Certification Bodies. Authorities and Engineers to certify. PE, Chartered Engineers

UNIT – V DESIGN CODES 9

Codes and Standards applicable in Process Industry Equipment Design. Pressure Vessel Design Codes. Heat Exchanger Design Codes. Wind and Seismic Codes. Machinery Codes. Package Equipment Design Codes. Performance Test Codes. ASTM, ASME, API, AWS, ANSI, ISO, ASHRAE.

TOTAL :45 PERIODS

OUTCOMES:

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

1. Explain the need for codes and Standards in Industry.
2. Discuss the different codes and standards used in different industry.
3. Discuss the sources of different codes and standards and the societies that publish them and how these are evolved
4. Explain need for Government regulations and Certification authorities and familiar with common regulations in India and International
5. Discuss knowledge of codes and standards used in Process equipment design for Oil and Gas Industry.

TEXTBOOKS:

1. Mechanical Engg. Handbook. ASME. ASTM.API
2. Perrys Chemical Engg Handbook

REFERENCES:

1. ASME
2. API
3. ISO, IBR, OISD
4. AWS
5. ISHRAE

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

ME23025	BIOENERGY CONVERSION TECHNOLOGIES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

To elucidate on biomass, types, availability, and characteristics

UNIT – I INTRODUCTION **9**

Biomass: types – advantages and drawbacks – typical characteristics – proximate & ultimate analysis – comparison with coal - Indian scenario - carbon neutrality – biomass assessment studies – typical conversion mechanisms - densification technologies

UNIT – II BIOMETHANATION **9**

Biomethenation process – influencing parameters – typical feed stocks – Biogas plants: types and design, Biogas appliances – burner, luminaries and power generation systems – Industrial effluent based biogas plants.

UNIT – III COMBUSTION **9**

Perfect, complete and incomplete combustion – stoichiometric air requirement for biofuels - equivalence ratio – fixed Bed and fluid Bed combustion

UNIT – IV GASIFICATION, PYROLYSIS AND CARBONISATION **9**

Chemistry of gasification - types – comparison – typical application – performance evaluation –economics. Pyrolysis - Classification - process governing parameters – Typical yield rates. Carbonization – merits of carbonized fuels – techniques adopted for carbonization

UNIT – V LIQUIFIED BIOFUELS **9**

Straight Vegetable Oil (SVO) as fuel - Biodiesel production from oil seeds, waste oils and algae - Process and chemistry - Biodiesel Vs. Diesel – comparison on emission and performance fronts. Production of alcoholic fuels (methanol and ethanol) from biomass – engine modifications

TOTAL :45

OUTCOMES:

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

1. Estimate the surplus biomass availability of any given area.
2. Design a biogas plant for a variety of biofuels.
3. Determine and compare the cost of steam generation from biofuels with that of coal and petroleum fuels.
4. Analyse the influence of process governing parameters in thermochemical conversion of biomass.
5. Synthesize liquid biofuels for power generation from biomass.

TEXTBOOKS:

1. Biomass for Bioenergy and Biomaterials, by Nidhi Adlakha, Rakesh Bhatnagar , Syed Shams Yazdani, CRC Press; 1st edition (22 October 2021), ISBN-10 : 0367745550
2. Bioenergy and Biochemical Processing Technologies, by Augustine O. Ayeni, Samuel EshorameSanni , Solomon U. Oranusi, Springer (30 June 2022).

REFERENCES:

1. David Boyles, Bio Energy Technology Thermodynamics and costs, Ellis Hoknood Chichester,1984.
2. Iyer PVR et al, Thermochemical Characterization of Biomass, M N E S
3. Khandelwal KC, Mahdi SS, Biogas Technology – A Practical Handbook, Tata McGraw Hill, 1986
4. Mahaeswari, R.C. Bio Energy for Rural Energisation, Concepts Publication,1997
5. Tom B Reed, Biomass Gasification – Principles and Technology, Noyce Data Corporation, 1981

CO	**PO**												**PSO**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	2	3	2	2	-	3	-	1	-	2	2	3	-	-
2	2	2	3	2	-	2	2	-	-	-	2	2	3	-	-
3	2	2	3	2	-	-	1	-	-	-	2	2	3	2	-
4	2	2	3	2	-	-	1	-	-	-	2	2	3	1	-
5	2	2	3	2	-	-	1	-	-	-	2	2	3	1	-
Avg	2	2	3	2	2	2	1.6	-	-	-		-		1.3	-

ME23026	**CARBON FOOTPRINT ESTIMATION AND REDUCTION TECHNIQUES**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

1. To introduce climate change and carbon footprint
2. To study the principle of product life cycle and Green House Gas emissions accounting
3. To study the Methodology for Carbon Footprint Calculation
4. To learn emission mitigation and carbon sink
5. To study the case study of carbon footprint.

UNIT – I CLIMATE CHANGE AND CARBON FOOTPRINT 9

Green House Effect and Climate Change - Causes and Impacts of Climate Change – Economic implications of Climate Change -IPCC Reports and Projected Climate Change Scenarios – Green House Gas (GHG) Emission – Carbon footprint of Activities, Processes, Products and Services of Organisations – GHG Emission factors and Calculations

UNIT – II PRODUCT LIFE CYCLE AND GHG EMISSIONS 9

Life - cycle GHG Accounting - Principles of Product Life Cycle GHG Accounting and Reporting - Fundamentals of Product Life Cycle GHG Accounting - Establishing the Scope of a Product Inventory- GHG Emission Inventories and Accounting - Collecting Data and Assessing Data Quality- Allocation and Assessing Uncertainty

UNIT – III METHODOLOGICAL ASPECTS OF CARBON FOOTPRINT 9

Methodology for Carbon Footprint Calculation in Crop and Livestock Production, End of Life Scenarios and Carbon Footprint of Wood Cladding, Carbon Footprints and Greenhouse Gas Emission Savings of Alternative Synthetic Biofuels, Making Food Production GHG Efficient, Carbon Footprint of Wood-Based Products and Buildings, Challenges and Merits of Choosing Alternative Functional Units, modeling aspects of carbon footprint, Quantifying Spatial–Temporal Variability of Carbon Stocks and Fluxes

UNIT – IV EMISSION MITIGATION AND CARBON SINK 9

Setting GHG Reduction Targets and Tracking Inventory Changes – Non-Fossil Fuel based Energy Systems - Carbon Dioxide capture and Storage Technologies –Mitigation potentials of different Sectors and systems – Innovation, Technology Development and Transfer, - Social aspects of mitigation –Polcies, Institutions and international corporations – Carbon Pricing and Finance –GHG Offsetting and Green marketing.

UNIT – V CASE STUDIES 9

Carbon Footprint Estimation from Building Sector - Urban Carbon Footprint Evaluation - Applications of carbon footprint in urban planning – Mechanical Equipment and Electronic Product Carbon Footprint - Carbon Footprint of Aqua and Agriculture products- GHG Emissions from Municipal Wastewater Treatment and Solid waste management

TOTAL:45 PERIODS

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

1. Explain the climate change and carbon footprint
2. Discuss the principle of product life cycle and Green House Gas emissions accounting
3. Explain the Methodology for Carbon Footprint Calculation
4. Discuss emission mitigation and carbon sink
5. Explain the case study of carbon footprint.

TEXT BOOKS:

1. Assessment of Carbon Footprint in Different Industrial Sectors, Volume 1, by Subramanian Senthilkannan Muthu, Springer; Softcover reprint of the original 1st ed. 2014 edition (23 August 2016), ISBN-10 : 9811011737
2. Assessment of Carbon Footprint in Different Industrial Sectors, Volume 2, by Subramanian Senthilkannan Muthu, Springer Nature; 2014th edition (30 April 2014), ISBN-10 : 9814585742

REFERENCES:

1. Subramanian, Senthil Kannan, Muthu (2016), Carbon Foot Print Handbook, CRC Press
2. Subramanian, Senthil Kannan, Muthu (2016), Environmental Carbon Foot Print Industrial case Studies, Butterworth Heinemann Publishers
3. World Resources Institute, Green House Gas Protocol - Product Life Cycle Accounting and Reporting Standard
4. ISO 14067 -2018, Green House gases and carbon footprint, Requirements and Guidelines for Quantification, International Organisation for Standardisation.
5. IPCC (2022) –Sixth Assessment Reports – Intergovernmental Panel on Climate Change, United Framework convention on Climate Change.

CO	**PO**												**PSO**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	1	1	2				3		1			1	1	1	2
2	1	1	2				3		1			1	1	1	2
3	1	1	2				3		1			1	1	1	2
4	1	1	2				3		1			1	1	1	2
5	1	1	2				3		1			1	1	1	2
Low (1) ; Medium (2) ; High (3)															

ME23027 ENERGY CONSERVATION IN INDUSTRIES **L T P C**

3 0 0 3

COURSE OBJECTIVE:

To learn quantifying the energy demand and energy supply scenario of nation and explaining the need for energy auditing for becoming environmentally benign

UNIT – I INTRODUCTION 9

Energy scenario of World, India and TN - Environmental aspects of Energy Generation – Material and Energy balancing - Energy Auditing: Need, Types, Methodology and Barriers. Role of Energy Managers. Basic instruments for Energy Auditing.

UNIT – II ELECTRICAL SUPPLY SYSTEMS 9

Electricity Tariff structures – Typical Billing - Demand Side Management - HT and LT supply - Power Factor – Energy conservation in Transformers – Harmonics

UNIT – III ENERGY CONSERVATION IN MAJOR THERMAL UTILITIES 9

Stoichiometry - Combustion principles. Energy conservation in: Boilers - Steam

Distribution Systems - Furnaces - Thermic Fluid Heaters – Cooling Towers – D.G. sets. Insulation and Refractories - Waste Heat Recovery Devices.

UNIT – IV ENERGY CONSERVATION IN MAJOR ELECTRICAL UTILITIES 9

Energy conservation in: Motors - Pumps – Fans – Blowers - Compressed Air Systems - Refrigeration and Air Conditioning Systems - Illumination systems

UNIT – V ENERGY MONITORING, TARGETING, LABELLING AND ECONOMICS 9

Elements of Monitoring & Targeting System – CUSUM - Energy / Cost index diagram – Energy Labelling - Energy Economics – Cost of production and Life Cycle Costing - Economic evaluation techniques – Discounting and Non-Discounting - ESCO concept – PAT scheme

TOTAL :45 PERIODS

OUTCOMES:

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

1. Discuss Quantify the energy demand and energy supply scenario of nation and appreciate the need for energy auditing for becoming environmentally benign
2. Analyse factors behind energy billing and apply the concept of demand side management for lowering energy costs
3. Compute the stoichiometric air requirement for any given fuel and quantify the energy losses associated with thermal utilities of industries
4. Diagnose the causes for under performance of various electrical utilities and suggest remedies for improving their efficiency
5. Apply CUSUM and other financial evaluation techniques to estimate the accruable energy savings/monetary benefits for any energy efficiency project

TEXTBOOKS:

1. Guide book for National Certification Examination for "Energy Managers and Energy Auditors" (4 Volumes). Available at http://www.em-ea.org/gbook1.asp. This website is administered by Bureau of Energy Efficiency (BEE), a statutory body under Ministry of Power, Government of India.
2. K. Nagabhushan Raju, Industrial Energy Conservation Techniques: (concepts, Applications and Case Studies), Atlantic Publishers &Dist, 2007.

REFERENCES:

1. Abbi Y P, Shashank Jain., Handbook on Energy Audit and Environment Management, TERI Press, 2006.
2. Albert Thumann and Paul Mehta D, "Handbook of Energy Engineering", 7thEdition, The Fairmont Press, 2013.
3. Murphy.W.R. and McKay.G, "Energy Management", Butterworth, London 1982.
4. Paul W.O'Callaghan, Design and management for energy conservation: A handbook for energy managers, plant engineers, and designers, Pergamon Press, 1981.
5. Steve Doty, Wayne Turner C, Energy Management Handbook 7th Edition, The Fairmont Press, 2009.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	2	1	-	-	-	3	-	1	-	-	1	2	2	2
2	2	2	1	-	-	-	3	-	1	-	-	1	2	2	2
3	2	2	1	-	-	-	3	-	1	-	-	1	2	2	2
4	2	2	1	-	-	-	3	-	1	-	-	1	2	2	2
5	2	2	1	-	-	-	3	-	1	-	-	1	2	2	2
Low (1) ; Medium (2) ; High (3)															

ME23028	WIND ENERGY TECHNOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

The main learning objective of this course

1. To understand the fundamentals of wind energy and its conversion system
2. To impart knowledge on Airfoil based Wind Turbine blades and blade manufacturing
3. To brief on the working of different wind energy conversion systems
4. To impart knowledge on modern wind turbine control & monitoring system
5. To understand the wind farm siting and grid integration

UNIT – I WIND ENERGY FUNDAMENTALS & RESOURCE ASSESSMENT 9

Wind Energy Basics, Wind Speeds and scales, Terrain, Roughness, Wind Mechanics, Power Content, Class of wind turbines, Instrumentation for wind measurements, Wind resource estimation, Betz's Limit, Wind Histogram, Wind Rose

.

UNIT – II WIND TURBINE AERODYNAMICS & MANUFACTURING 9

Airfoil terminology, Blade design, Rotor performance and dynamics, Balancing technique (Rotor & Blade), Materials of Construction, Types of loads.

Evolution of wind turbine blade production, Manufacturing high-tech wind blades, Wind turbine standards.

.

UNIT – III TECHNOLOGY OF WIND ENERGY CONVERSION SYSTEM 9

Wind Turbines, Wind Mills.Generators,Classification of WECS -Vertical Axis Type, Horizontal Axis, Constant Speed Constant Frequency, Variable speed Variable Frequency, Up Wind, Down Wind, Gear Coupled Generator type, Direct Generator Drive /PMG/Rotor Excited Sync Generator, Airborne wind energy technology.

UNIT – IV WIND TURBINE SYSTEMS AND CONTROL 9

Integration of wind energy systems to electrical networks, converters, inverters, Power Electronics Interfaces, Stall Control , Pitch Control & Control Algorithms, Protections used & Safety Consideration in Wind turbines, Wind Turbine Monitoring, Engineering challenges associated with wind turbine systems.

UNIT – V OFFSHORE AND ONSHORE WIND FARM 9

Introduction to off-shore wind, the off-shore environment, support structures, dynamics, Introduction to electrical systems and grid integration, Wind Farm-Layouts, Array Effects, Weibull Statistics, Measure-Correlate-Predict & Energy Yield

TOTAL : 45 PERIODS

COURSE OUTCOMES

On Completion of the course the student will be able to

CO1 Perform wind resource estimation and Wind data analysis

CO2 Design airfoil based wind turbine blades and analyze the rotor performance

CO3 Understand working of wind turbine, types, anatomy, mechanics, and components

CO4 Comprehend on the wind turbine systems and control

CO5 Understand the details of offshore and onshore wind farm

TEXT BOOKS

1. Joshua Earnest and Tore Wizelius, “Wind Power Plants and Project Development”, PHI Learning Pvt. Ltd., New Delhi, Second edition, 2015.
2, J. F. Manwell, J. G. McGowan and A. L. Rogers, “Wind Energy Explained – Theory, Design and Application”, John Wiley & Sons, Ltd, 2009.

REFERENCES

1. Freris. L. L., “Wind Energy Conversion Systems”, Prentice Hall 1990.
2. David A. Spera, “Wind Turbine Technology: Fundamental Concepts in Wind Turbine Engineering”, ASMS Press, Second Edition, 2009
3. Martin Hansen, Aerodynamics of Wind Turbines, Routledge, Third edition, 2015.
4. T. Burton, D. Sharpe, N. Jenkins and E. Bossanyi, “Wind energy Handbook”, John Wiley & Sons, 2001

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	1	1	2	1	2					1	2	1	1
2	2	3	1	1	2	1	2					1	2	1	1
3	3	3	3	2	3	1	3					1	2	1	1
4	1	2	1	1	2	1	2						2	1	1
5	1	1	1	1		1	1						1	2	1

ME23029	ENERGY STORAGE DEVICES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1. To study the various types of energy storage devices and technologies and them comparison.
2. To learn the techniques of various energy storage devices and their performances.
3. To learn the basics of batteries and hybrid systems for EVs and other mobile applications.
4. To learn about the renewable energy storage systems and management systems.
5. To have an insight into other energy storage devices, hydrogen, and fuel cells.

UNIT – I INTRODUCTION TO ENERGY STORAGE 9

Need for Energy Storage – Types of Energy Storage – Various forms of Energy Storage – Mechanical– Thermal - Chemical– Electrochemical – Electrical - Other alternative energy storage technologies – Efficiency and Comparison.

UNIT – II ENERGY STORAGE SYSTEMS 9

Pumped Air Energy Storage – Compressed Air Energy Storage – Flywheel – Sensible and Latent Heat Storage – Storage Materials – Performance Evaluation - Thermochemical systems – Batteries – Types- Charging and Discharging – Battery testing and performance.

UNIT – III MOBILE AND HYBRID ENERGY STORAGE SYSTEMS 9

Batteries for electric vehicles - Battery specifications for cars, heart pacemakers, computer standby supplies – V2G and G2V technologies – HESS.

UNIT – IV RENEWABLE ENERGY STORAGE AND ENERGY MANAGEMENT 9

Storage of Renewable Energy Systems –Solar Energy – Wind Energy – Energy Storage in Micro grid– Smart Grid – Energy Conversion Efficiency - Battery Management Systems – EVBMS – Energy Audit and Management

UNIT – V OTHER ENERGY DEVICES 9

Superconducting Magnetic Energy Storage (SMES), Supercapacitors – MHD Power generation – Hydrogen Storage - Fuel Cells – Basic principle and classifications – PEMFC, AMFC, DMFC, SOFC,MCFC and Biofuel Cells – Biogas Storage.

TOTAL:45 PERIODS

OUTCOMES:

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

1. Discuss the need and identify the suitable energy storage devices for applications.
2. Explain the working of various energy storage devices and their importance.
3. Explain the basic characteristics of batteries for mobile and hybrid systems.
4. Discuss the storage of renewable energies and management systems.
5. Explain the need for other energy devices and their scope for applications.

TEXT BOOKS:

1. Rober Huggins, “Energy Storage: Fundamentals, Materials and Applications”, 2 nd Edition, Springer, 2015.
2. Dell, Ronald M Rand, David A J, “Understanding Batteries”, Royal Society of Chemistry, 2001

REFERENCES:

1. Francisco Díaz-González, Andreas Sumper, Oriol Gomis-Bellmunt," Energy Storage in Power Systems" Wiley Publication, 2016.
2. Ibrahim Dincer and Mark A Rosen, "Thermal Energy Storage Systems and Applications", John Wiley & amp; Sons, 2002.
3. Lindon David, "Handbook of Batteries", McGraw Hill, 2002.
4. Aulice Scibioh M. and Viswanathan B, "Fuel Cells – principles and applications', University Press(India), 2006
5. Ru-Shiliu, Leizhang, Sueliang Sun, "Electrochemical Technologies for Energy Storage and Conversion", Wiley Publications, 2012.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	1	1	1	-	2	-	-	-	-	-	1	2	3
2	3	2	1	1	1	-	2	-	-	-	-	-	1	2	3
3	3	2	1	1	1	-	2	-	-	-	-	-	1	2	3
4	3	2	1	1	1	-	2	-	-	-	-	-	1	2	3
5	3	2	1	1	1	-	2	-	-	-	-	-	1	2	3
Low (1) ; Medium (2) ; High (3)															

ME23030	RENEWABLE ENERGY TECHNOLOGIES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

To learn the various renewable energy technologies and its applications.

UNIT – I 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 – II 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 – III 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 – IV 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 – V 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:45 PERIODS

OUTCOMES:

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

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

TEXT BOOKS:

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

REFERENCES:

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.

CO	**PO**												**PSO**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	1	1	1	1	1	2	3	2	2	1	1	3	2	1	2
2	3	2	2	1	1	1	3	1	1	1	2	3	2	1	2
3	3	2	3	1	2	1	3	1	1	1	1	3	1	1	2
4	2	2	2	1	2	1	3	1	1	1	2	3	2	2	2
5	2	1	2	1	2	1	3	1	1	1	1	3	2	1	2
Avg	2.2	1.6	2	1	1.6	1.2	3	1.2	1.2	1	1.4	3	1.8	1.2	2
Low (1) ; Medium (2) ; High (3)															

ME23031 **POLYGENERATION SYSTEMS**

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

The main learning objective of this course

- To gain knowledge and expertise in polygeneration systems, including energy systems integration, basic processes and components, performance estimation, methods, and applications in buildings and industries, for promoting sustainable development

UNIT – I ENERGY SYSTEMS AND INTERGRATION

Energy and Sustainability indicators – Steady flow devices – Thermodynamic approach – System integration – Polygeneration layout – Polygeneration Fuels – Fossil Fuels, Renewable energy fuels and Hybrid fuels – Products of Polygeneration

.

UNIT – II PROCESSES AND COMPONENTS OF POLYGENERATION SYSTEMS

Process and components in IC Engines, Steam Cycles, Organic Rankine Cycles, Gas power Cycles, Combined Cycles, Fuel Cells, Electric and Heat driven heat pump and refrigeration cycles; Renewable energy based systems – Energy Storage Systems – Electric and Hydrogen based systems

.

UNIT – III PERFORMANCE EVALUATION OF POLYGENERATION SYSTEMS

Natural gas, biomass and solar based polygeneration systems – Effective first law and Exergy efficiency – optimum design for plant and operation – Environmental benefits – Thermoeconomic analysis of polygeneration systems

UNIT – IV POLYGENERATION SYSTEMS IN BUILDINGS

Energy in buildings – Space heating and cooling, Energy Demand, Storage Options – Net Zero Buildings – Fuel based polygeneration systems – IC Engines, Fuel Cell – Solar based polygeneration systems - Case Studies

UNIT – V POLYGENENRATION SYSTEMS IN INDUSTRIES

Polygeneration concepts in Industries – Evaluation – Coal based Polygeneration Systems – Renewable energy polygeneration systems – Low grade industrial waste heat based polygeneration systems- Case Studies

TOTAL: 45 PERIODS

COURSE OUTCOMES

On Completion of the course the student will be able to

CO1 Analyze the energy systems and their integration for sustainable development
CO2 Apply the basic processes and components of polygeneration systems
CO3 Estimate the performance of various polygeneration systems
CO4 Apply various methods of polygeneration systems and its application in buildings
CO5 Incorporate and analysis polygeneration systems in Industries

TEXT BOOKS

1. Ibrahim Dincer and Yusulf bicer, “Integrated Energy Systems for multigeneration”, Elesvier Ltd, 2020

REFERENCES

1. Franceso Calise, Maasimo Daccadia, Laura Vanoli and Maria Vicidomini, "Polygeneration systems – Deign, Process and echnlogies", Academic Press, 2022
2. Yang Chen, "Optimal Design and Operation of Energy Polygeneration Systems", MIT Press, 2013
3. Cristina Gil de Moya, Carl-Johan Fogelholm, "Technoeconomic Assessment of Polygeneration Systems", Universitat Politècnica de Catalunya. Escola Tècnica Superior d' Enginyeria Industrial de Barcelona, 2008.
4. Majid Amidpour, Mohammad Hasan Khoshgoftar Manesh, "Cogeneration and Polygeneration Systems", Elesevier Science, 2020

CO	**PO**												**PSO**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	2	2	2	2		3				2	1	1	2	3
2	2	2	2	2	2		3				2	1	2	2	2
3	2	2	2	2	2		3				2	1	3	2	3
4	2	2	2	2	2		3				2	1	3	2	3
5	2	2	2	2	2		3				2	2	3	2	2

ME23032 SOLAR POWER GENERATION

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

The main learning objective of this course

1. To understand the fundamentals of solar energy and energy scenario
2. To learn the function and design aspects of various types of solar collectors
3. To brief on the working of solar PV systems and evaluation of solar PV systems design
4. To impart knowledge on solar energy storage systems
5. To know the economics of solar power plants

UNIT – I SOLAR ENERGY FUNDAMENTALS & ENERGY SCENARIO 9

The structure and basic parameters of the Sun - Solar angles – Solar constant – Sun path diagrams – Solar Radiation - Extraterrestrial characteristics, measurement and estimation on horizontal and tilted surfaces - Various approaches of utilizing solar energy.
Present conventional and non-conventional energy status - Indian energy scenario in various sectors — Solar energy deployment in India - Per capita energy consumption - Future energy plans.

.

UNIT – II SOLAR THERMAL POWER GENERATION 9

Working principle of various types of Solar collectors - Solar concentrating collectors - Design considerations, tracking and control systems, performance study - Sterling engine, Brayton cycle - Solar tower concepts - Heliostat design – Solar thermal power plant – System components, site selection and land requirement - Techno-economic analysis of solar thermal power plants

.

UNIT – III SOLAR PHOTOVOLTAIC POWER GENERATION 9

Fundamentals of solar photo voltaic conversion – Solar cells – Solar PV Systems and its applications. Solar cell array system analysis and performance prediction- solar cell array design concepts - PV system detailed array design - storage autonomy - voltage regulation - maximum tracking - centralized and decentralized SPV systems - standalone - hybrid and grid connected system - System installation - operation and maintenances - PV market analysis and economics of SPV systems

UNIT – IV SOLAR ENERGY STORAGE SYSTEMS 9

Necessity of storage for solar energy - Thermal Storage Concepts - Materials for Sensible and Latent Heat Energy Storage. Organic, Inorganic Eutectic Materials, Materials for Low and High Temperature Storage Applications. Chemical storage Concepts - Rechargeable Batteries – Types, Operating range, Comparison and suitability for various applications - measuring of battery performance, charging and discharging of a battery, storage density, energy density, and safety issues Super Capacitors.

UNIT – V ECONOMICS OF SOLAR POWER PLANTS 9

Methods of fixing power tariff - Simple Methods to Calculate the Plant Economy - Life Cycle Cost analysis – Factors affecting solar energy costs - Return on Investment – Solar CSP and PV LCOE – Business model - Risk assessment & Strategy - Net metering – Government Incentives and Financing Options - Recycling solar panels.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On Completion of the course the student will be able to

CO1 Know the basics of solar energy and status of Indian energy scenario
CO2 Design different types of solar collectors applicable for solar thermal power plants
CO3 Understand the working and design of solar PV system components
CO4 Learn the various types of energy storage systems suitable for solar energy
CO5 Understand the evaluation of economics of solar power plants

TEXT BOOKS

1. John A. Duffie, William A. Beckman, Solar Engineering of Thermal Processes, John Wiley & Sons, 4th edition, 2013
2, Chetan Singh Solanki, Solar Photovoltatics – Fundamentals, Technologies and Applications, PHI Learning Private limited, 3rd edition, 2015

REFERENCES

Sukhatme S P, Nayak J K, Solar Energy, Tata McGraw Hill, 4th edition, 2017
Soteris A Kalogirou, Solar Energy Engineering - Processes and Systems, Elsevier, 3rd Edition, 2023
Jayarama Reddy, Solar Power Generation: Technology, New Concepts & Policy, CRC Press, 2019.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1						1						1			
2	2	2	2			1	2				1	1	2		1
3	1	2	2			1	2				1	1	2		1
4	2	1	2			1	2				1	1	2		1
5	2	2				1	2				1	1	2		1

ME23C18	GREEN HYDROGEN PRODUCTION STORAGE AND TRANSPORTATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

The main learning objective of this course is

1. To impart knowledge about hydrogen properties and its safety
2. To impart knowledge about green hydrogen production techniques
3. To impart knowledge about storing hydrogen under different conditions in different medium
4. To impart knowledge on methods of hydrogen transportation
5. To impart knowledge on hydrogen utilisation for transportation

UNIT – I INTRODUCTION

Properties of hydrogen, safety and storage aspects of hydrogen, hydrogen leakage detection, regulation - codes – standards.

UNIT II GREEN HYDROGEN PRODUCTION

Electrolysis fundamentals and various types of Electrolyzers, Hydrogen production from renewables Fundamentals of electrolysis of water, sizing of electrolyzers, electrolysis parameters – current density, pressure, operating temperature, hydrogen purity

UNIT – III HYDROGEN STORAGE

Hydrogen storage fundamentals, underground hydrogen storage, fundamentals of hydrogen compression and expansion, Mechanical and non-mechanical hydrogen compressors Compressed and liquid state storage of hydrogen- thermodynamics, equipment and processes; compressed hydrogen tank types and design considerations, relevant standards.

UNIT – IV TRANSPORT OF HYDROGEN

Hydrogen Transport - different ways of transporting and distributing hydrogen to the point of utilization, current status

of existing methods globally, hydrogen refueling stations-concepts and components

UNIT – V UTILIZATION OF HYDROGEN FOR TRANSPORTATION

Merits and demerits of hydrogen as a fuel for IC engines, Strategies for using hydrogen as fuel in IC engines, hydrogen fuel supply system, Performance – combustion - emission characteristics. Fuels cells for automotive applications – Sizing - Performance evaluation - Parameters affecting the efficiency

TOTAL : 45 PERIODS

COURSE OUTCOMES

On Completion of the course the student will be able to

CO1 Utilise the advantages of hydrogen and adopt appropriate standards
CO2 Generate green hydrogen under various conditions
CO3 Store hydrogen under various conditions in different phases
CO4 Propose transport of hydrogen using different techniques.
CO5 Utilizing hydrogen as fuel in IC engine and fuel cells

TEXT BOOKS

1. Gupta, R. B., Hydrogen Fuel: Production, Transport and Storage, CRC Press, Taylor &

Francis Group, 2009.
2. NPTEL :: Chemical Engineering - NOC: Hydrogen Energy: Production, Storage, Transportation and Safety

REFERENCES

1. Global Hydrogen Review 2021, IEA (2021), Paris, https://www.iea.org/reports/global-hydrogen-review-2021
2. AgataGodula-Jopek, Hydrogen Production by Electrolysis, Wiley-VCH, Germany, 2015
3. Tzimas, E., Filiou, C., Peteves, S.D., &Veyret, J.B. "Hydrogen storage: state-of-the-art and future perspective. Netherlands": European Communities, 2003.
4. Michael Hirscher, "Handbook of Hydrogen Storage", Wiley-VCH, 2010.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	2	2	1							1	2	1	1
2	3	2	2	2	1							1	2	1	1
3	3	2	2	2	1							1	2	1	1
4	3	2	2	2	1							1	2	1	1
5	3	2	2	2	1							1	2	1	1

ME23033 NON-TRADITIONAL MACHINING PROCESSES

L	T	P	C
3	0	0	3

COURSE OBJECTIVE:

To impart knowledge on working principles, process characteristics and applications of various nontraditional machining processes

UNIT I INTRODUCTION AND MECHANICAL ENERGY BASED PROCESSES 9

Need for non-traditional machining processes - Classification of non-traditional machining processes - Applications, advantages and limitations of non-traditional machining processes - Mechanical energy based non-traditional machining processes - Abrasive jet machining, Abrasive water jet machining, Ultrasonic machining - working principle, equipment, effect of process parameters, applications, advantages and limitations.

UNIT II CHEMICAL AND ELECTRO CHEMICAL ENERGY BASED PROCESSES 9

Principles, equipment, effect of process parameters, applications, advantages and limitations of Chemical machining, Electro-chemical machining, Electro-chemical honing, Electro-chemical grinding, Electro chemical deburring

UNIT III THERMO-ELECTRIC ENERGY BASED PROCESSES 9

Electric discharge machining - Principle, equipment, effect of process parameters, workpiece and electrode materials, applications, advantages and limitations, Improvements - Powder mixed EDM, cryogenic assisted EDM, magnetic field assisted EDM, Wire electric discharge machining, Electro-discharge grinding, Laser beam machining, Plasma arc machining, Electron beam machining, Ion beam machining.

UNIT IV NANO FINISHING PROCESSES 9

Abrasive flow machining - Principle, equipment, effect of process parameters, applications, advantages and limitations – Chemo-mechanical polishing, Drag finishing of cutting tools and biomedical implants, Magnetic field assisted nanofinishing processes - Magnetic abrasive finishing, Magnetorheological finishing, Magnetorheological abrasive flow finishing

UNIT V HYBRID NON-TRADITIONAL MACHINING PROCESSES 9

Assisted hybrid machining processes their working principles, equipment, effect of process parameters, applications, advantages and limitations - Vibration assisted conventional processes - turning, drilling, milling and grinding, Vibration assisted non-traditional processes - ECM, EDM; Thermal assisted machining - Laser assisted conventional machining, Plasma assisted conventional machining, Laser assisted ECM, EDM

TOTAL : 45 PERIODS

COURSE OUTCOMES:

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

CO1 Classify different types of non-traditional machining processes and evaluate mechanical energy based non-traditional machining processes.

CO2 Explain the principle and applications of chemical and electro chemical energy based processes.

CO3 Explain the principle of thermo-electric energy based processes and analyse the effect of process parameters on EDM.
CO4 Select a suitable nano-finishing process for the given application.
CO5 Explain the need and principle of assisted / hybrid conventional and non-traditional machining processes.

TEXTBOOKS:

1. Helmi Youssef and Hassan El-Hofy, “Non-Traditional and Advanced Machining Technologies”, CRC Press, Boca Raton, Florida, 2nd Edition, 2021. ISBN 13: 978-0-367-43134-1
2. Anand Pandey, “Modern Machining Processes”, Ane Books Pvt. Ltd., New Delhi, India, 2019..

REFERENCES:

1. Benedict, G.F., “Non-traditional Manufacturing Processes”, Marcel Dekker Inc., New York 1987. ISBN-13: 978-0824773526.
2. Carl Sommer, “Non-Traditional Machining Handbook”, Advance Publishing., United States, 2000, ISBN-13: 978-1575373256.
3. Golam Kibria, Bhattacharyya B. and Paulo Davim J., “Non-traditional Micromachining Processes: Fundamentals and Applications”, Springer International Publishing., Switzerland, 2017, ISBN:978-3-319-52008-7.
4. Jain V.K., “Nanofinishing science and Technology- Basic and Advanced Finishing and Polishing Processes”, CRC Press, Boca Raton, Florida, 2017, ISBN-13: 9781498745949.
5. Kapil Gupta, Neelesh K. Jain and Laubscher R.F., “Hybrid Machining Processes: Perspectives on Machining and Finishing”, 1st edition, Springer International Publishing., Switzerland, 2016, ISBN-13: 978-3319259208.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	3	3	3	-	-	2	-	-	-	-	-	3	3	-
2	3	3	3	3	-	-	2	-	-	-	-	-	3	3	-
3	3	3	3	3	3	-	3	-	-	-	-	-	3	3	-
4	3	-	3	-	3	-	2	-	-	-	-	-	3	2	-
5	3	-	3	-	3	-	2	-	-	-	-	-	3	3	-
Avg	3	3	3	3	3	-	1.4	-	-	-	-	-	3	2.6	-

ME23034	CASTING AND WELDING PROCESSES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

To study the casting of ferrous and non-ferrous alloys casting and their metallurgy and its applications.

UNIT – I 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 – II 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 – III 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 – IV 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 – V 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:45 PERIODS

OUTCOMES:

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

1. Explain the ferrous casting metallurgy and its applications.
2. Explain the non-ferrous casting metallurgy and its applications.
3. Explain the ferrous welding metallurgy and its applications.
4. Explain the welding metallurgy of alloy steels and non ferrous metals and its applications.
5. Identify the causes and remedies of various welding defects; apply welding standards and codes.

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.

REFERENCES:

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
5. John Campbell, "Casting", Butterworth-Heinemann, 2003.

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

ME23064 PROCESS PLANNING AND COST ESTIMATION

L	T	P	C
3	0	0	3

COURSE OBJECTIVE:

To impart knowledge on the creation of process plan and estimation of cost for various manufacturing operations.

UNIT – I INTRODUCTION TO PROCESS PLANNING 9

Introduction – Process layouts – Drawing Interpretation – Material evaluation – Steps in process selection – Production equipment and tooling selection – Work study and Ergonomics – Value analysis – Value Engineering – Business process Re-Engineering (BPR).

UNIT – II PROCESS PLANNING STEPS 9

Design of a process plan – Selection of production processes, tools and process parameters- Positioning and work holding devices, Selection of inspection devices and tools, Documenting the process plan, Computer-Aided Process Planning (CAPP) – Benefits, Architecture and approaches.

UNIT – III INTRODUCTION TO COST ESTIMATION 9

Importance of costing and estimation – methods of costing-elements of cost estimation – Types of estimates – Estimating procedure – Estimation labor cost, material cost-

Classification of costs – Cost elements, Overhead expenses, Break-even analysis, Calculation of depreciation cost.

UNIT IV PRODUCTION COST ESTIMATION 9

Estimation of production cost for - Casting processes, Welding processes, and Forging processes.

UNIT – V ESTIMATION OF MACHINING TIME AND COST 9

Estimation of Machining time – Lathe operations, Drilling, Milling, Shaping and Planning, and Grinding, Cost estimation for machining processes.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

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

1. Explain the process flow for a given Product.
2. Create a process plan for manufacturing a component.
3. Estimate the overhead cost and breakeven associated with manufacturing.
4. Evaluate the total cost for the Cast, welded and Forged products.
5. Analyze the machining time and estimate the cost of machined product.

TEXTBOOKS:

1. Gideon Halevi, “Process and operation planning”, Kluwer academic publishers (Printed ebook), 2003.
2. M. Adithan,” Process Planning and Cost Estimation”, New Age International Publishers, 2007.

References:

1. Peter Scallan, “Process planning, The Design/Manufacture interface”, Butterworth-Heinemann, 2003.
2. Robert Creese, M. Adithan, B.S Pabla, “Estimating and Costing for the Metal Manufacturing Industries”, Marcel Dekker, 1992.
3. Phillip F. Ostwald, Jairo Munoz, “Manufacturing Processes And Systems”, 9th Edition, Wiley student edition, 2002.
4. Chitale, A, K., and Gupta, R. C,, “Product Design and manufacturing”, Prentice Hall of India, New Delhi , 1997.

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	3	2	1	-	-	-	-	-	-	-	1	2	1	1
2	3	3	3	1	-	-	-	-	-	-	-	1	2	1	3
3	3	3	3	1	-	-	-	-	-	-	-	1	2	1	3
4	3	3	3	1	-	-	-	-	-	-	-	1	2	1	3
5	3	3	3	1	-	-	-	-	-	-	-	1	2	1	3
Avg	3	3	3	1	-	-	-	-	-	-	-	1	2	1	3

ME23035	SURFACE ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

The main learning objective of this course is to prepare the students to understand metallurgical changes that occur during surface modification.

UNIT I SURFACES & FRICTION 9

Basics of surfaces features – Roughness parameters – surface measurement - Cause of frictionLaws of friction – Static friction – Rolling Friction – Stick-slip Phenomenon - Friction properties ofmetal and nonmetals – Friction in extreme conditions – Thermal considerations in sliding contact.Contact mechanics.

UNIT II WEAR & CORROSION 9

Types of Wear, Adhesive, Abrasive, Oxidative, Corrosive, Erosive and Fretting Wear, Roles of Friction and Lubrication, Wear-debris analysis, Theoretical wear models, Standards,

Expressions for Corrosion Rate. Pourbaix Diagram, Forms of Corrosion – Uniform, Pitting, Intergranular, Stress Corrosion. Corrosion Fatigue. Dezincification. Erosion Corrosion,

Crevice Corrosion – Cause and Remedial Measures – Pilling Bed-worth Ratio – High Temperature Oxidation-Hydrogen Embrittlement – Remedial Measures. Standards.

UNIT III CORROSION OF INDUSTRIAL COMPONENTS& TESTING 9

Corrosion in Fossil Fuel Power Plants, Automotive Industry, Chemical Processing Industries,
Corrosion in Petroleum Production Operations and Refining, Corrosion of Pipelines, Wear of
Industrial Components.
Purpose of Corrosion Testing – Classification – Susceptibility Tests for Intergranular CorrosionStress Corrosion Test. Salt Spray Test Humidity and Porosity Tests, Accelerated Weathering Tests. ASTM Standards for Corrosion Testing and Tests For Assessment of Wear

UNIT IV PLATING & THIN FILM COATINGS 9

Surface properties – Hydrophobic – Super hydrophobic – Hydrophilic - surface metallurgy, Fundamentals of electroplating, Electrodeposition from plating baths,Electroless plating, Metalliding, Selective plating, CLC, Hard anodizing. Thermal evaporation, PVD and CVD, Sputter coating, Ion plating, Thinfilm for wear application, Coating specifications.

UNIT V HARD FACING PROCESSES AND APPLICATIONS 9

Thermal spray processes and their applications, Hardfacing transformation, Fusion alloys, Non -fusion materials. Hardfacing for repairs, Hardfacing with fusion processes, Non-fusion deposits, WeldabilityConsiderations, Finishing considerations.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

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

CO1 Explain the different failures that occur on the surface of the engineering components.

CO2 Discuss on the kinetic aspects and the effect of various parameters on the rate of corrosion.

CO3 Interpret the corrosion failures that occur in different industrial components and articulate the results obtained from the corrosion testing.

CO4 Discuss on the various plating techniques and thin film coatings

CO5 Implement suitable corrosion protection methods in critical engineering components.

TEXTBOOKS:

1. Mars Guy Fontana ,Corrosion Engineering, Tata McGraw-Hill, 2005.
2. Dheerendra Kumar Dwivedi , Surface Engineering -Enhancing Life of Tribological Component, Springer India, 2018.

REFERENCES:

1. Gabe. D.R., “Principles Of Metal Surface Treatment And Protection”, Pergamon, 1990
2. P. K. Dutta & I. S. Gray, Surface Engineering, Vol. I - III, Royal Society of Chemistry, 1993
3. Kenneth G. Budinsk, Surface Engineering for wear resistance, Prentice Hall, NJ 1988
4. Stand Grainger Engineering Coatings – Design and Application Jaico Publishing House,
5. 1994.Parthasarathy. N.V., Electroplating Handbooks, Prentice Hall, 1992

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	1	3	3	3	2	-	-	-	2	3	1	1
2	3	1	1	3	2	2	2	1	-	-	-	2	3	1	1
3	3	1	1	2	2	2	2	1	-	-	-	2	3	1	1
4	3	2	1	3	2	2	2	1	-	-	-	2	3	1	1
5	3	2	1	3	2	2	2	1	-	-	-	2	3	1	1
Avg	3	1.8	1.4	2.4	2.2	2.2	2.2	1.2	-	-	-	2	2	1	1

ME23036 **PRECISION MANUFACTURING** **L T P C**
3 0 0 3

COURSE OBJECTIVE:

To acquire knowledge on various precision machining techniques and the design aspects of precision machine tools.

UNIT I PRECISION ENGINEERING 9

Introduction to Precision Engineering, Need for precision manufacturing, Taniguchi diagram, Four Classes of Achievable Machining Accuracy – Normal, Precision, High-precision, Ultra-precision Processes and Nanotechnology

UNIT II PRECISION MACHINING 9

Overview of Micro- and Nano-machining, Conventional micro machining techniques - micro-turning, micro-milling, micro-drilling, micro-grinding, Ultra-precision diamond turning, Non-conventional micromachining techniques – abrasive jet and water jet micromachining, Ultrasonic micromachining, micro electrical discharge machining, photochemical machining, electrochemical micromachining, laser beam micromachining, Electron beam micromachining, Focused Ion Beam micromachining, Fabrication of optical components by ultraprecision finishing, Secondary finishing of AM parts – Need, Challenges and Processes.

UNIT III MACHINE DESIGN FOR PRECISION MANUFACTURING 9

Philosophy of precision machine design, Ultra-Precision Machine Elements: Guide- ways, Drive Systems, Friction Drive, Linear Motor Drive, Spindle Drive. Bearings: Principle, construction and application of Rolling, Hydrodynamic and Hydrostatic Bearings, Aerostatic Bearings, Magnetic bearings

UNIT IV MECHANICAL AND THERMAL ERRORS 9

Sources of error, Principles of measurement, Errors due to machine elements, bearings, spindles, Kinematic design, Structural compliance. Vibration, Thermal errors – background, thermal effects, Environmental control of precision machinery, Error mapping and error budgets

UNIT V MEASUREMENT AND CHARACTERISATION 9

Optical dimensional metrology of precision features – Machine vision, Multi-sensor coordinate metrology, Laser Tracking Systems, Laser scanners, White-Light Interference 3D Microscopes, Focus variation based Optical Metrology- Fringe projection method, Measurement of Typical Nanofeatures.

Surface metrology - 3D surface topography - Need, Measurement – Chromatic confocal Microscopy, Interferometry, Confocal laser scanning microscopy, Non-optical Scanning Microscopy – Scanning electron Microscopes, Scanning probe microscopes, Parameters for characterizing 3D surface topography, ISO standards for 3D surface Metrology

TOTAL:45 PERIODS

COURSE OUTCOMES:

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

CO1 Explain the need, significance and progress of precision manufacturing and the different levels of manufacturing.

CO2 Explain the principle and working of different methods of precision machining.

CO3 Explain the special construction requirements of precision machine tools.

CO4 Explain the errors involved in precision machine tools and calculate the error budgets for a given situation.

CO5 Select a suitable measurement solution to measure and characterize precision machined features.

TEXTBOOKS:

1. Jain, V.K., Introduction to micromachining, Narosa publishers, 2018
2. Venktesh V.C., Sudin Izman, Precision Engineering, Tata Mc.Graw Hill Publishing Company, New Delhi 2007.

REFERENCES:

1. David Dornfeld, Dae-Eun Lee, Precision Manufacturing, Springer, 2008.
2. Jain, V.K., Micromanufacturing Processes, CRC Press, 2012.
3. Joseph McGeough, Micromachining of Engineered Materials, Marcel Dekker Inc., 2002.
4. Kevin Harding, "Handbook of Optical Dimensional Metrology, Series: Series in Optics and optoelectronics", Taylor & Francis, 2013.
5. Murty, R.L., Precision Engineering in Manufacturing, New Age publishers, 2005.

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	-	-	-	-	-	-	-	-	-	-	3	-	-
2	3	2	2	3	3	-	-	-	-	-	-	-	3	3	-
3	3	3	3	3	3	-	-	-	-	-	-	-	3	3	-
4	3	3	3	3	3	-	-	-	-	-	-	-	3	3	-
5	3	3	2	3	3	-	-	-	-	-	-	-	3	3	-
Avg	3	2.6	2	3	3	-	-	-	-	-	-	-	3	3	-

ME23037	INDUSTRY 4.0 IN MANUFACTURING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

The main learning objective of this course

1 Understand the basic concepts of Industry 4.0 and smart manufacturing.
2 Understand the importance of data in the context of I4.0 enabled manufacturing to optimize manufacturing processes
3 Explain the use of Machine Learning to improve manufacturing processes.
4 Develop an understanding of the various elements of cyber physical systems
5 Analyse the performance of manufacturing processes using digital twins.

UNIT – I INTRODUCTION TO INDUSTRY 4.0 AND SMART MANUFACTURING

1st, 2nd, 3rd, and 4th Industrial Revolutions; I4.0 in Manufacturing; Major components of Smart Manufacturing – Industrial IoT sensors, Big data, Artificial Intelligence, Networking and cybersecurity, Robotics, Additive Manufacturing; I4.0 Design principles, Benefits of Smart Manufacturing.

UNIT – II BIG DATA IN MANUFACTURING

Concept and characteristics of big data, Data sharing and collaboration, Structured data, and relational databases, Unstructured data, Four levels of data analytics, Lifecycle of Big data in Manufacturing.

UNIT – III MACHINE LEARNING IN MANUFACTURING

Introduction to Machine Learning, The Machine Learning Process, Advantages and disadvantages of ML, ML for sustainable manufacturing, ML to improve manufacturing, Challenges in implementing ML in manufacturing, Case studies of ML in manufacturing.

UNIT – IV CYBER-PHYSICAL SYSTEMS

Introduction to Cyber-Physical Systems (CPS), Concept and Characteristics of CPS, Architecture of CPS- Components, Data science and technology for CPS, Classification of CPS in the context of I4.0, Application of CPS in Manufacturing

UNIT – V DIGITAL TWINS IN MANUFACTURING

Background and concept of Digital Twin, Digital Twin, and related concepts, Value of digital twin, Applications of Digital Twin, Digital Twin modeling and key technologies, Digital Twin driven smart manufacturing, Case studies – Equipment energy consumption management, Machining process improvement, Prognostics, and health management

TOTAL: 45 PERIODS

COURSE OUTCOMES

On Completion of the course the student will be able to

CO1 Explain the components of I4.0 in manufacturing.
CO2 Explain the importance of data in manufacturing.
CO3 Apply Machine Learning techniques for optimization of manufacturing processes.
CO4 Understand the concept and architecture of cyber physical systems.

CO5 Develop digital twins for manufacturing processes.

TEXT BOOKS

1. Diego Galar Pascual, Pasquale Daponte, Uday Kumar, Handbook of Industry 4.0 and SMART Systems‖ Taylor and Francis,2020
2. Fei Tao, Meng Zhang, A.Y.C. Nee, Digital Twin Driven Smart Manufacturing, Academic Press, 2019

REFERENCES

1. Anthony Tarantino, Smart Manufacturing: The Lean Six Sigma Way, Wiley, 2022
2. Raman Kumar, Sita Rani, Sehijpal Singh Khangura, Machine Learning for Sustainable Manufacturing in Industry, CRC Press, 2023.
3. Ravi Kant, Hema Gurung, Industry 4.0 Concepts, Processes and Systems, CRC Press, 2024.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	1	2	2	-	1	2	-	-	2	-	3	1	-	1
2	3	2	1	2	2	1	1	-	-	2	-	3	2	2	3
3	3	2	1	2	2	1	1	-	-	2	-	3	2	2	3
4	3	1	1	1	2	1	1	-	-	2	-	3	2	2	3
5	3	2	3	3	2	1	2	-	-	2	-	3	3	2	3

ME23038	COMPUTER INTEGRATED MANUFACTURING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

To impart knowledge on production planning & control, cellular manufacturing, flexible manufacturing system and role of robots in industrial automation.

UNIT – I FUNDAMENTALS OF CIM 9

Various phases in Product Design and CAD, CAM, Concepts of CAD/CAM – Concurrent Engineering – CIM concepts and elements – Types of production – Manufacturing Metrics and Economics – Production Performance Metrics – Manufacturing Cost - Problems – Lean Production and Just-In-Time Production.

UNIT – II PRODUCTION PLANNING & CONTROL AND COMPUTER AIDED PROCESS PLANNING 9

Production planning and Control System - Aggregate Production Planning and Master Production Schedule – Material Requirement Planning (MRP I) – Simple Problems – Capacity Planning – Shop Floor Control – Inventory Control – EOQ, WIP costs & Inventory Holding Costs - Simple Problems –Introduction to Manufacturing Resource Planning (MRP II) & Enterprise Resource Planning (ERP) –Process planning – Manual Process Planning and case studies Computer Aided Process Planning (CAPP).

UNIT – III AUTOMATION IN MANUFACTURING SYSTEMS 9

Automation principles and strategies – Automation migration strategies – Basic Elements of an Automated system – Advanced Automation Functions – Levels of Automation. CNC – DNC – Automated assembly lines – Line balancing – Automated production lines – Automatic identification and data capture.

UNIT – IV CELLULAR MANUFACTURING AND FMS 9

Group Technology(GT) - Part Families – Parts Classification and coding – Simple Problems in OPITZ Part Coding system – Production flow Analysis – Cellular Manufacturing – Composite part concept – Machine cell design and layout – Quantitative analysis in Cellular Manufacturing –Rank Order Clustering Method - Arranging Machines in a GT cell – Hollier Method – Performance Metrics in Cell Operation. FMS: Types of FMS & Flexibility – FMS Components – FMS Application & Benefits – FMS Planning and Implementation Issues – Quantitative analysis of

Bottleneck Model in FMS.

UNIT – V INDUSTRIAL ROBOTICS AND AGVs 9

Robot Anatomy and Related Attributes – Classification - Control systems – End Effectors –Sensors – Applications – Basics of Robot Part Programming – Robot Accuracy and Repeatability – Simple Problems. sensor - Sensor and Actuator interactions. Automated Guided Vehicle System (AGVS) –Types of AGVS - Applications – Vehicle Guidance technologies –Vehicle Management & Safety.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

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

1. Explain the fundamentals of CIM.
2. Identify and solve the problems in Production Planning and Control.
3. Apply the automation techniques in manufacturing systems.
4. Implement Cellular Manufacturing Processes and FMS.
5. Select and apply the suitable Robots and AGVs for industrial applications.

TEXTBOOKS:

1. Mikell .P. Groover, “Automation, Production Systems and Computer Integrated Manufacturing”, Pearson Education, 2018
2. Kant Vajpayee S, “Principles of Computer Integrated Manufacturing”, Prentice Hall India, 2003.

References:

1. Gideon Halevi and Roland Weill, “Principles of Process Planning – A Logical Approach” Chapman & Hall, London, 1995.
2. Peter Scallan, “Process Planning: The design/manufacture interface,” Elsevier Science & Technology Books, 2003.
3. Radhakrishnan P., Subramanyan S. and Raju V., “CAD/CAM/CIM”, New Age International (P) Ltd, New Delhi, 2018.
4. Rao. P. N., Tewari. N. and Kundra. T.K., “Computer Aided Manufacturing”, Tata McGraw Hill Publishing Company, 2000.

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	2	1	-	-	-	-	-	-	-	1	2	1	3
2	3	3	3	2	-	-	-	-	-	-	-	1	2	1	3
3	3	3	3	3	-	-	-	-	-	-	-	1	2	1	3
4	3	3	3	3	-	-	-	-	-	-	-	1	2	1	3
5	3	3	2	1	-	-	-	-	-	-	-	1	2	1	3
Avg	3	3	2.4	2	-	-	-	-	-	-	-	1	2	1	3

ME23039	APPLIED OPERATIONS RESEARCH	L	T	P	C
		3	0	0	3

.

COURSE OBJECTIVES:

The main learning objective of this course is
1. To provide an insight to the fundamentals of linear programming problems.
2. To inculcate the methodology of formulation and solution to Transportation and assignment problems.
3. To enlighten the principles of the inventory management.
4. To outline the basics of the queuing theory, Simulation and its application.
5. To expose the essentials of project management and Replacement problems

UNIT – I LINEAR PROGRAMMING PROBLEMS 9

OR-Definition - Phases - models, LP problem formulation – Graphical solution, GLPP, Standard and Canonical forms of LPP- simplex methods- Big M, Two phase methods, Alternate optimal solutions, Duality in LP.

UNIT – II TRANSPORTATION 9

Transportation problems- Basic feasible solution, Optimal solution By MODI method, Balanced and Unbalanced TP, Degeneracy, Production problems. Assignment problems – Hungarian method Traveling salesman problems - Sequencing models- Johnson algorithm, n job 2 machines,n job 3 machines and n job m machines

UNIT – III INVENTORY CONTROL 9

Types of inventory- Inventory cost - EOQ - Deterministic inventory problems – Purchase and Production models with and without shortages-EOQ with price breaks - Stochastic inventory problems - Multi product problems - Systems of inventory control (P and Q Systems)- Determination of buffer stock and re-order levels -Selective inventory control techniques (ABC,VED, SDE, etc.)

UNIT – IV QUEUING THEORY 9

Queuing system - Characteristics - symbols - Poisson process and exponential distribution – Single server queuing models - Multiserver queuing models, Simulation Monte Carlo technique- Inventory& Queuing problems.

UNIT – V PROJECT MANAGEMENT AND REPLACEMENT MODELS 9

Project management: Network logic – Ford-Fulkerson's rule - AON diagram - CPM and PERT techniques, Critical path and float calculations Replacement models -types of failures – Gradual failures-replacement of items: Efficiency deteriorates with time, sudden failures- individual and group replacement policies.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On Completion of the course the student will be able to

1.) Select the constraints on the availability of resources, develop a model and render an optimal solution during the given circumstances.
2.) Appraise the challenges in the transportation and production problems and furnish a rational solution to maximize the benefits.
3.) Plan the purchase/ manufacturing policies, manage the spares/ stocks and meet the customer demands.
4.) Analyze the queue discipline and explore the avenues for better customer service.
5.) Investigate the nature of the project/ failure and offer methodical assistance towards decision making.

TEXT BOOKS

1.) Wayne.L.Winston, "Operations research applications and algorithms",4th edition, C engage learning, 2004.

2.) HamdyATaha, "Operations research an introduction", 10th edition, PHI/Pearson education, 2017.

REFERENCES

1.) Srinivasan G, "Operations research principles and applications", 3rd edition EEE PHI, 2017.

2.) Pannerselvam R, "Operations research", 2nd edition, PHI, 2009.

3.) Ravindran, Phillips and Solberg, "Operations research principles and practice", 2nd edition, Wiley India, 2007.

4.) Sharma J K, "Operations research theory and applications",5th edition, Macmillan India, 2013.

5.) Premkumar Gupta and D.S.Hira, "Problems in Operations research", S.Chand, 2009

CO	**PO**												**PSO**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	1	2	2	2	3	1	1	1		1		1	1	2	1
2	1	2	2	2	3	1	1	1		1		1	1	2	1
3	1	2	2	2	3	1	1	1		1		1	1	2	1
4	1	2	2	2	3	1	1	1		1		1	1	2	1
5	1	2	2	2	3	1	1	1		1		1	1	2	1
Low (1) ; Medium (2) ; High (3)															

ME23040 **MEASUREMENTS AND CONTROLS** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To impart knowledge about measurement system and statistical analysis of measured data and design and development of measurement and control systems.

UNIT – I MEASUREMENT SYSTEM: CHARACTERISTICS AND STATISTICAL ANALYSIS 9

Introduction to measurement system, Errors in Measurement, Static and Dynamic characteristics of transducers, Statistical analysis of experimental data – Uncertainty analysis, Regression analysis, Design of experiments – Full and Half factorial design.

UNIT – II ELECTRICAL MEASUREMENTS AND SIGNAL CONDITIONING 9

Voltage, Current, Power, Energy, Time and Frequency measurement, Frequency Counter, Signal conditioning Circuits: Wheatstone bridge – Differential Amplifier – V to I Converter, I to V Converter, Integrator, Differentiator, Instrumentation Amplifier, Attenuators and Filters, DAC and ADC.

UNIT – III MEASUREMENT OF PHYSICAL QUANTITIES 9

Displacement, velocity, acceleration, Impact – Force, torque, power- Pressure, Temperature, Heat Flux, Heat Transfer Coefficients, Humidity – Flow – Velocity - Time, frequency and phase angle – noise and sound level.

UNIT – IV CONTROL SYSTEMS 9

Basic elements – feedback principle, implication of measurements – Error detectors – final actuating elements – Two position, multi-position, floating, proportional controls – relays – servo amplifiers – servo motors – Electrical, magnetic, electronic control systems, PID Controller.

UNIT – V APPLICATION OF CONTROL SYSTEMS 9

Measurement by Data Acquisition System, Governing of speed, kinetic and process control – pressure, temperature, fluid level, flow-thrust and flight control – photo electric controls – Application of PID controller – Application of Smart Sensors and Intelligent instrumentation and Control.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

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

1. Analyze and evaluate the uncertainties in measurement data.
2. Identify appropriate sensors for measuring electrical quantities and signal conditioning circuits.
3. Apply suitable technique to measure the given physical quantity.
4. Explain the fundamentals of control systems.
5. Design and develop the appropriate measurement and control system for an application

TEXTBOOKS:

1. Venkateshan S P, Mechanical Measurements, John Wiley & Sons, Ltd, 2015.
2. William Bolton, Instrumentation and Control Systems,Newnes, 2015

REFERENCES:

1. Beckwith, Marangoni and Lienhard, Mechanical Measurements, Pearson, 2013.
2. Ernest Doebelin and DhaneshManik, Measurement Systems, McGraw Hill International Edition, 2017.
3. Holman J P, “Experimental Methods for Engineers”, McGraw Hill Int. Edition, 7th Ed., 2017.
4. Nagrath I J, “Control Systems Engineering”, New Age International Publishers, 2018.
5. Nakra B.C , and Chaudhry K.K, Instrumentation, Measurement, and Analysis, Tata McGraw Hill, 2016.

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

ME23041 DESIGN CONCEPTS IN ENGINEERING

L	T	P	C
3	0	0	3

COURSE OBJECTIVE:

The main learning objective of this course is to prepare the students for analyzing the various design requirements and get acquainted with the processes involved in product development.

UNIT I DESIGN TERMINOLOGY 9

Definition-various methods and forms of design-importance of product design-static and dynamic products-various design projects-morphology of design-requirements of a good design-concurrent engineering-computer aided engineering-codes and standards-product and process cycles-bench marking.

UNIT II DESIGN PROCESSES AND DESIGN FOR QUALITY 9

Basic modules in design process-scientific method and design method-Need identification, importance of problem definition-structured problem, real life problem-information gathering - customer requirements- Quality Function Deployment (QFD)-product design specifications-generation of alternative solutions- Analysis and selection-Detail design and drawings-Prototype, modeling, simulation, testing and evaluation - Design of Experiments

UNIT III CREATIVITY IN DESIGN AND RELIABILITY 9

Creativity and problem solving-vertical and lateral thinking-invention-psychological view, mental blocks-Creativity methods-brainstorming, synectics, force fitting methods, mind map, concept map- Theory of innovative problem solving (TRIZ) - conceptual decomposition creating design concepts.

Reliability-Survival and Failure-Series and parallel systems-Mean time between failure-Weibull distribution

UNIT IV HUMAN AND SOCIETAL ASPECTS IN PRODUCT DEVELOPMENT 9

Human factors in design, ergonomics, user friendly design-Aesthetics and visual aspects environmental aspects-marketing aspects-team aspects-legal aspects-presentation aspects

UNIT V MATERIAL AND PROCESSES IN DESIGN 9

Material selection for performance characteristics of materials-selection for new design substitution for existing design-economics of materials-selection methods- recycling and material selection-types of manufacturing process, process systems- Design for Manufacturability (DFM) - Design for Assembly (DFA).

TOTAL : 45 PERIODS

COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

CO1 Articulate the various design requirements and get acquainted with the processes involved in product development.

CO2 Design the processes to develop a successful and a quality product.

CO3 Implement the scientific approaches to provide reliable design solutions.
CO4 Integrate human and societal aspects in design.
CO5: Select materials and manufacturing processes in design.

TEXTBOOKS:

1. Dieter. G. N., Linda C. Schmidt, “Engineering Design”, McGraw Hill, 2013.
2. Horenstein, M. N., Design Concepts for Engineers, Prentice Hall, 2015.

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	2	2	2	2	1	1	1	2	2	2	2	2
2	3	3	3	2	2	2	2	1	1	1	2	2	2	2	2
3	3	3	3	2	2	2	1	1	1	1	2	2	2	2	2
4	3	3	3	2	1	2	2	1	1	1	2	2	2	2	2
5	3	3	3	2	1	2	2	1	1	1	2	2	2	2	2
Avg	3	3	3	2	1.6	2	1.8	1	1	1	2	2	2	2	2

ME23042 COMPOSITE MATERIALS AND MECHANICS

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

To study the processing of different types of composite material and mechanics approach to design a laminate

UNIT – I 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 – II 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 – III 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 – IV 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 – V ANALYSIS OF LAMINATED FLAT PLATES 9

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

TOTAL : 45 PERIODS

OUTCOMES:

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

1. Summarize the various types of Fibers, Equations and manufacturing methods
2. Derive Flat plate Laminate equations
3. Analyze Lamina strength

4. Analyze the thermal behavior of Composite laminates
5. Analyze Laminate flat plates

TEXT BOOKS:

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

REFERENCES:

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
4. Mallick, P.K., Fiber,” Reinforced Composites: Materials, Manufacturing and Design”, Maneel Dekker Inc, 1993.
5. Mallick, P.K. and Newman, S., (edition), “Composite Materials Technology: Processes and Properties”, Hansen Publisher, Munish, 1990.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	2	3	3	-	2	2	-	-	-	-	2	3	-	-
2	2	2	2	2	-	2	2	-	-	-	-	2	3	-	-
3	2	2	2	2	-	2	2	-	-	-	-	2	3	-	-
4	2	2	2	2	-	2	2	-	-	-	-	2	3	-	-
5	2	2	2	2	-	2	2	-	-	-	-	2	3	-	-
Avg	2	2	2.2	2.2	-	2	2	-	-	-	-	2	3	-	-

ME23043 REFRIGERATION AND AIR CONDITIONING

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

1. To introduce the underlying principles of operations in different Refrigeration & Air conditioning systems and components.
2. To provide knowledge on design aspects of Refrigeration & Air conditioning systems.
3. To study the Vapour absorption and air refrigeration systems.
4. To learn the psychrometric properties and processes.
5. To study the air conditioning systems and load estimation.

UNIT – I INTRODUCTION 9

Introduction to Refrigeration - Unit of Refrigeration and C.O.P.– Ideal cycles- Refrigerants Desirable properties – Classification - Nomenclature - ODP & GWP.

UNIT – II VAPOUR COMPRESSION REFRIGERATION SYSTEM 9

Vapor compression cycle: p-h and T-s diagrams - deviations from theoretical cycle – subcooling and super heating- effects of condenser and evaporator pressure on COP- multipressure system -low temperature refrigeration - Cascade systems – problems. Equipments: Type of Compressors, Condensers, Expansion devices, Evaporators.

UNIT – III OTHER REFRIGERATION SYSTEMS 9

Working principles of Vapour absorption systems and adsorption cooling systems – Steam jet refrigeration- Ejector refrigeration systems- Thermoelectric refrigeration- Air refrigeration - Magnetic-Vortex and Pulse tube refrigeration systems.

UNIT – IV PSYCHROMETRIC PROPERTIES AND PROCESSES 9

Properties of moist Air-Gibbs Dalton law, Specific humidity, Dew point temperature, Degree of saturation, Relative humidity, Enthalpy, Humid specific heat, Wet bulb temperature Thermodynamic wet bulb temperature, Psychrometric chart; Psychrometric of air-conditioning processes, mixing of air streams.

UNIT – V AIR CONDITIONING SYSTEMS AND LOAD ESTIMATION 9

Air conditioning loads: Outside and inside design conditions; Heat transfer through structure, Solar radiation, Electrical appliances, Infiltration and ventilation, internal heat load; Apparatus selection; fresh air load, human comfort & IAQ principles, effective temperature & chart, calculation of summer & winter air conditioning load; Classifications, Layout of plants; Air distribution system;Filters; Air Conditioning Systems with Controls: Temperature, Pressure and Humidity sensors,Actuators & Safety controls.

TOTAL:45 PERIODS

OUTCOMES:

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

1. Explain the basic concepts of Refrigeration
2. Explain the Vapor compression Refrigeration systems and to solve problems
3. Discuss the various types of Refrigeration systems
4. Calculate the Psychrometric properties and its use in psychrometric processes
5. Explain the concepts of Air conditioning and to solve problems

TEXT BOOKS:

1. Arora, C.P., "Refrigeration and Air Conditioning", 3rd edition, McGraw Hill, New Delhi, 2010

2. Textbook of Refrigeration And Air-Conditioning (M.E.)by R.S. Khurmi | 10 February 2019

REFERENCES:

1. ASHRAE Hand book, Fundamentals, 2010
2. JonesW.P., "Air conditioning engineering", 5th edition, Elsevier Butterworth-Heinemann, 2007
3. Roy J. Dossat, "Principles of Refrigeration", 4th edition, Pearson Education Asia, 2009.
4. Stoecker,W.F. and Jones J.W., "Refrigeration and Air Conditioning", McGraw Hill, New Delhi,1986.
5. A Textbook of Refrigeration and Air-Conditioning by R.K. Rajput | 1 January 2013

CO	**PO**												**PSO**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	1	1			2		1			1	2	2	1
2	2	1	1	1			2		1			1	2	2	1
3	2	1	1	1			2		1			1	2	2	1
4	2	1	1	1			2		1			1	2	2	1
5	2	1	1	1			2		1			1	2	2	1
Low (1) ; Medium (2) ; High (3)															

ME23C07 ENERGY EFFICIENT BUILDINGS **L T P C**
3 0 0 3

COURSE OBJECTIVE:

To learn energy saving concepts in buildings through incorporation of renewable energy systems

UNIT – I INTRODUCTION 9

Climate and Building, Historical perspective, Aspects of Net Zero building design – Sustainable Site, Water, Energy, Materials and IGBC, LEED, GRIHA, IEQ and ECBC Standards

UNIT – II LANDSCAPE AND BUILDING ENVELOPES 9

Energy efficient landscape design – Micro climates – various methods – Shading, water bodies – Building envelope: Building materials, Envelope heat loss and heat gain and its evaluation, paints, insulation, Design methods and tools

UNIT – III THERMAL COMFORT, PASSIVE HEATING AND COOLING 9

Thermal comfort, Psychrometry, Comfort indices – ASHRAE / ISHRAE Standards on thermal Comfort – Passive heating and cooling systems - HVAC Systems for build environment – Heat Pumps, Evaporative Cooling and Radiant Cooling.

UNIT – IV ENERGY CONSERVATION IN BUILDING UTILITIES 9

Energy conservation in Hot water generator – Boiler, Heat Pumps, DG Sets, Motors , Pumps, Illumination Systems, Electrical distribution systems, Cooling Towers,Refrigeration and Air Conditioning Systems, Water and Waste Management systems

UNIT – V RENEWABLE ENERGY IN BUILDINGS 9

Introduction of Renewable sources in buildings, , Stand-alone PV systems, BIPV, Solar water heating, Solar Air Conditioning in Buildings, Small wind turbines, Poly- generation systems in Buildings

TOTAL:45

OUTCOMES:

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

1. Familiar with climate responsive building design and basic concepts
2. Explain the basic terminologies related to buildings
3. Discuss the energy efficient air conditioning techniques
4. Evaluate the performance of buildings
5. Gets acquainted with Renewable energy systems in buildings

TEXTBOOKS:

1. Advanced Decision Making for HVAC Engineers, by JavadKhazaii, Springer; Softcover reprint of the original 1st ed. 2016 edition (23 June 2018),ISBN-10 : 3319814869

2. Thermal Comfort and Energy-Efficient Cooling of Non-residential Buildings, by Doreen E. Kalz, Jens Pfafferott, Springer; 2014th edition (8 April 2014), ISBN-10 : 9783319045818.

REFERENCES:

1. ASHRAE Handbook – Fundamentals / Equipment's/ Applications – ASHRAE 2021,2020, 2019 Editions
2. Baruch Givoni: Climate considerations in building and Urban Design, John Wiley & Sons, 1998
3. Baruch Givoni: Passive Low Energy Cooling of Buildings by, John Wiley & Sons, 15-Jul-1994
4. JA Duffie and WA Beckman: Solar Engineering of Thermal Processes, Third Edition, John Wiley & Sons, 2006.
   Jan F. Kreider, Peter S. Curtiss, Ari Rabl, Heating and Cooling of buildings: Design for Efficiency, Revised Second Edition, CRC Press, 28-Dec-2009.

CO	**PO**												**PSO**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	2	1	-	-	-	3	-	1	-	-	1	2	1	1
2	2	2	1	-	-	-	3	-	1	-	-	1	2	1	1
3	2	2	1	-	-	-	3	-	1	-	-	1	2	1	1
4	2	2	1	-	-	-	3	-	1	-	-	1	2	1	1
5	2	2	1	-	-	-	3	-	1	-	-	1	2	1	1
Avg	2	2	1	-	-	-	3	-	1	-	-	1	2	1	1

ME23044 **TURBO MACHINES** **L T P C**
3 0 0 3

COURSE OBJECTIVES

1 To study the energy transfer in rotor and stator parts of the turbo machines.
2 To study the function of various elements of centrifugal fans and blowers.
3 To evaluating the working and performance of centrifugal compressor
4 To analyzing flow behavior and flow losses in axial flow compressor.
5 To study the types and working of axial and radial flow turbines.

UNIT – I WORKING PRINCIPLES 9

Classification of Turbomachines. Energy transfer between fluid and rotor - Euler equation and its interpretation. Velocity triangles. Efficiencies in Compressor and Turbine stages. Degree of reaction. Dimensionless parameters for Turbomachines.

UNIT – II CENTRIFUGAL FANS AND BLOWERS 9

Types – components – working. Flow analysis in impeller blades-volute and diffusers. Velocity triangles - h-s diagram. Stage parameters in fans and blowers. Performance characteristic curves – various losses. Fan – bearings, drives and noise.

UNIT – III CENTRIFUGAL COMPRESSOR 9

Components - blade types. Velocity triangles - h-s diagram, stage work. Slip factor and Degree of Reaction. Performance characteristics and various losses. Geometry and performance calculation.

UNIT – IV AXIAL FLOW COMPRESSOR 9

Construction details. Work done factor. Velocity triangles - h-s diagram, stage work. Work done factor. Performance characteristics, efficiency and stage losses – Stalling and Surging. Free and Forced vortex flow.

UNIT – V AXIAL AND RADIAL FLOW TURBINES 9

Axial flow turbines - Types – Elements - Stage velocity diagrams - h-s diagram, stage work - impulse and reaction stages. Compounding of turbines. Performance coefficients and losses. Radial flow turbines: Types – Elements - Stage velocity diagrams - h-s diagram, stage work Performance coefficients and losses.

TOTAL : 45 PERIODS

OUTCOMES:

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

1. Explain the energy transfer in rotor and stator parts of the turbo machines.
2. Explain the function of various elements of centrifugal fans and blowers
3. Evaluate the working and performance of centrifugal compressor.
4. Analyze flow behavior and flow losses in axial flow compressor.
5. Explain the types and working of axial and radial flow turbines

TEXT BOOKS:

1. Ganesan, V., “Gas Turbines”, 3rd Edition, Tata McGraw Hill, 2011. .
2. Yahya, S.M., “Turbines, Compressor and Fans”, 4th Edition, Tata McGraw Hill, 2011.

REFERENCES:

1. Dixon, S.L., “Fluid Mechanics and Thermodynamics of Turbomachinery”, 7th Edition, Butterworth-Heinemann, 2014.
2. Gopalakrishnan. G and Prithvi Raj. D,” A Treatise on Turbomachines”, Scitech Publications (India) Pvt. Ltd., 2nd Edition, 2008.
3. Lewis, R.I., “Turbomachinery Performance Analysis” 1st Edition, Arnold Publisher, 1996.

4. Saravanamutto, Rogers, Cohen, Straznicky., “Gas Turbine Theory” 6th Edition, Pearson Education Ltd, 2009.
5. Venkanna, B.K., “Fundamentals of Turbomachinery”, PHI Learning Pvt. Ltd., 2009.

CO	**PO**												**PSO**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	1	1					1			1	3	2	1
2	2	1	1	1					1			1	3	2	1
3	2	1	1	1					1			1	3	2	1
4	2	1	1	1					1			1	3	2	1
5	2	1	1	1					1			1	3	2	1
Low (1) ; Medium (2) ; High (3)															

ME23045 **COMPUTATIONAL FLUID DYNAMICS** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

The main learning objective of this course

1. To acquire knowledge on significance of CFD and governing equations
2. To perform finite difference and finite volume based analysis for steady and transient diffusion problems
3. To analyze various discretization schemes used in the Finite volume method applicable to convention-diffusion problems
4. To get insight into finite volume method for incompressible flow analysis
5. To impart knowledge on various aspects of turbulence modelling and grid generation

UNIT – I INTRODUCTION TO COMPUTATIONAL FLUID DYNAMICS 9

CFD – Basics and Applications - Governing equations of Fluid Dynamics - Classification of partial differential equations and their physical behaviour - Initial and Boundary conditions – Equilibrium and Marching problems – Numerical strategies in solving the CFD equations - Overview of CFD simulation.

.

UNIT – II FINITE DIFFERENCE AND FINITE VOLUME METHODS FOR DIFFUSION 9

Introduction to direct and iterative solution methods - Finite difference and Finite volume methods for steady and unsteady diffusion problems – Numerical stability and convergence.

.

UNIT – III FINITE VOLUME METHOD FOR CONVECTION-DIFFUSION 9

Steady one-dimensional convection and diffusion – Central, upwind differencing, Hybrid and QUICK Schemes – Properties, assessments and comparison of discretization schemes

UNIT – IV FINITE VOLUME METHOD FOR INCOMPRESSIBLE FLOW 9

Incompressible Navier-Stokes equation – Vorticity-Stream function formulation and Primitive variable formulation - Staggered and Collocated grids – SIMPLE algorithm and its variants – PISO Algorithms.

UNIT – V TURBULENCE MODELING AND MESH GENERATION 9

Reynolds-averaged Navier−Stokes (RANS) equations, Turbulence models, mixing length model, Two equation (k-Є) models – Mesh Generation and refinement Techniques - Adaptive meshing and Moving grids.

TOTAL : 45 PERIODS

COURSE OUTCOMES

On Completion of the course the student will be able to

CO1 Apply the basics of CFD, and develop case specific governing equations.
CO2 Perform finite difference and finite volume based analysis for steady and transient diffusion problems.
CO3 Select and apply suitable discretization schemes to solve convention-diffusion problems using the Finite volume method
CO4 Apply finite volume method for analysis of incompressible flow
CO5 Interpret the use of turbulence modeling and significance of mesh generation

TEXT BOOKS

1. Versteeg, H.K., and Malalasekera, W.,”An Introduction to Computational Fluid Dynamics”: The finite volume Method, Pearson Education, Second Edition 2007
2. Ghoshdastidar, P.S., “Computer Simulation of flow and heat transfer”, Tata McGraw Hill, 1998.

REFERENCES

1. Chung T. J., “Computational Fluid Dynamics”, Cambridge University Press, 2nd edition, 2010.
2. Joel H. Ferziger & Milovan Peric, “Computational Methods for Fluid Dynamics” Springer; 3rd edition 2002.
3. Suhas V, Patankar, “Numerical Heat transfer and Fluid flow”, Taylor & Francis, 2009.
4. K.Muralidhar & T.Sundararajan, Computational Fluid Flow and Heat Transfer, Narosa Publishing House, Second edition, 2014

CO	**PO**												**PSO**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	1		1		2	2	2					1	1	1	
2	1					2	2					1	1		
3	1					2	2					1	1		
4	1	1	1		2	2	2					1	1		
5	1		1		2	2	2					1	1		

ME23046	ADVANCED STATISTICS AND DATA ANALYTICS	L T P C
		3 0 0 3

COURSE OBJECTIVES:

To introduce the basic concepts of linear, multiple regression models and forecasting techniques for prediction of future behaviour

UNIT – I REGRESSION 9

Introduction – Linear regression - Correlation analysis -Limitations, errors, and caveats of using regression and correlation analyses - Multiple regression and correlation analysis - Inferences about population parameters – Modeling techniques. - Coefficient of determination, Interpretation of regression coefficients, Categorical variables, heteroscedasticity, Multi-co linearity outliers, Ridge regression.

UNIT – II EXPLORATORY DATA ANALYSIS 9

Rise of statistics, Data Wrangling, Data Quality. Visual encoding – Mapping Data to Visual Variables, Encoding Effectiveness, Scales & Axes, Aspect Ratio, Regression Lines, Multidimensional Data, Parallel Coordinates, Dimensionality Reduction.

UNIT – III LOGISTIC AND MULTINOMIAL REGRESSION 9

Logistic function, Estimation of probability using Logistic regression, Variance, Wald Test, Hosmer Lemshow Test, Classification Table, Gini Co-efficient.

UNIT – IV FORECASTING AND CAUSAL MODELS 9

Moving average, Exponential Smoothing, Casual Models.

UNIT – V TIME SERIES ANALYSIS 9

Auto regression (AR), Moving Average(MA) Models, ARMA, ARIMA models , Multivariate Models

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course the students would be able to: CO1: Develop how to do regression fit for the given data.
CO2: Visualize the data through explanatory data analysis
CO3: Classify the given data through logistic regression
CO4: Analyzing forecasting techniques and causal inferences.
CO5: Utilize the effective time series analysis to predict/forecast the future behavior of data.

TEXT BOOKS:

1. Douglas C Montgomery and George C Runges, “Applied Statistics and Probability for Engineers”, John Wiley &Sons, 2014.
2. Douglas C. Montgomery, Cheryl L. Jennings, Murat Kulachi, “Introduction to Time Series Analysis and Forecasting” ,Wiley,2015

REFERENCES:

1. David Forsyth, ‘Probability and Statistics for Computer Science’, Springer; 2018
2. Michael J. Evans, Jeffrey S. Rosenthal, ‘Probability and Statistics - The Science of Uncertainty’. W H Freeman & Co, 2010
3. Max Kuhn, Kjell Johnson, “Applied Predictive Modeling”, Springer, 2014.

4. Ronald E. Walpole, Raymond H. Meyers, Sharon L. Meyers, “Probability and Statistics for Engineers and Scientists”, Pearson Education, 2014.
5. Daniel T. Larose, Chantal D. Larose “Data Mining and Predictive Analytics”, Wiley,2015
6. Thomas W.Miller, “Modeling Techniques in Predictive Analytics with Python and R: A guide to Data Science”, Pearson Education, 2014.

CO	**PO**												**PSO**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	3	1	2	1	-	-	-	1	-	-	1	3	1	1
2	3	3	1	2	1	-	-	-	1	-	-	1	3	1	1
3	3	3	1	2	1	-	-	-	1	-	-	1	3	1	1
4	3	3	1	2	1	-	-	-	1	-	-	1	3	1	1
5	3	3	1	2	1	-	-	-	1	-	-	1	3	1	1
Avg	3	3	1	2	1	-	-	-	1	-	-	1	3	1	1

UC23E01 ENGINEERING ENTREPRENEURSHIP DEVELOPMENT

L	T	P	C
2	0	2	3

COURSE OBJECTIVES:

1. Learn basic concepts in entrepreneurship, develop mind-set and skills necessary to explore entrepreneurship
2. Apply process of problem - opportunity identification and validation through human centred approach to design thinking in building solutions as part of engineering projects
3. Analyse market types, conduct market estimation, identify customers, create customer persona, develop the skills to create a compelling value proposition and build a Minimum Viable Product
4. Explore business models, create business plan, conduct financial analysis and feasibility analysis to assess the financial viability of a venture ideas & solutions built with domain expertise
5. Prepare and present an investible pitch deck of their practice venture to attract stakeholders

MODULE – I: ENTREPRENEURIAL MINDSET 4L,8P

Introduction to Entrepreneurship: Definition – Types of Entrepreneurs – Emerging Economies – Developing and Understanding an Entrepreneurial Mindset – Importance of Technology Entrepreneurship – Benefits to the Society.

Case Analysis: Study cases of successful & failed engineering entrepreneurs - Foster Creative Thinking: Engage in a series of Problem-Identification and Problem-Solving tasks

MODULE – II: OPPORTUNITIES 4L,8P

Problems and Opportunities – Ideas and Opportunities – Identifying problems in society – Creation of opportunities – Exploring Market Types – Estimating the Market Size, - Knowing the Customer and Consumer - Customer Segmentation - Identifying niche markets – Customer discovery and validation; Market research techniques, tools for validation of ideas and opportunities

Activity Session: Identify emerging sectors / potential opportunities in existing markets - Customer Interviews: Conduct preliminary interviews with potential customers for Opportunity Validation - Analyse feedback to refine the opportunity.

MODULE – III: PROTOTYPING & ITERATION 4L,8P

Prototyping – Importance in entrepreneurial process – Types of Prototypes - Different methods – Tools & Techniques.

Hands-on sessions on prototyping tools (3D printing, electronics, software), Develop a prototype based on identified opportunities; Receive feedback and iterate on the prototypes.

MODULE – IV: BUSINESS MODELS & PITCHING 4L,8P

Business Model and Types - Lean Approach - 9 block Lean Canvas Model - Riskiest Assumptions in Business Model Design – Using Business Model Canvas as a Tool – Pitching Techniques: Importance of pitching - Types of pitches - crafting a compelling pitch – pitch presentation skills - using storytelling to gain investor/customer attention.

Activity Session: Develop a business model canvas for the prototype; present and receive feedback from peers and mentors - Prepare and practice pitching the business ideas- Participate in a Pitching Competition and present to a panel of judges - receive & reflect feedback

MODULE – V: ENTREPRENEURIAL ECOSYSTEM 4L,8P

Understanding the Entrepreneurial Ecosystem – Components: Angels, Venture Capitalists, Maker Spaces, Incubators, Accelerators, Investors. Financing models – equity, debt, crowdfunding, etc, Support from the government and corporates. Navigating Ecosystem Support: Searching & Identifying the Right Ecosystem Partner – Leveraging the Ecosystem - Building the right stakeholder network

Activity Session: Arrangement of Guest Speaker Sessions by successful entrepreneurs and entrepreneurial ecosystem leaders (incubation managers; angels; etc), Visit one or two entrepreneurial ecosystem players (Travel and visit a research park or incubator or makerspace or interact with startup founders).

TOTAL: 60 PERIODS

COURSE OUTCOMES:

Upon the successful completion of the course, students will be able to:

CO1: Develop an Entrepreneurial Mind-set and Understand the Entrepreneurial Ecosystem Components and Funding types

CO2: Comprehend the process of opportunity identification through design thinking, identify market potential and customers

CO3: Generate and develop creative ideas through ideation techniques

CO4: Create prototypes to materialize design concepts and conduct testing to gather feedback and refine prototypes to build a validated MVP

CO5: Analyse and refine business models to ensure sustainability and profitability Prepare and deliver an investible pitch deck of their practice venture to attract stakeholders

REFERENCES:

1. Robert D. Hisrich, Michael P. Peters, Dean A. Shepherd, Sabyasachi Sinha (2020). Entrepreneurship, McGrawHill, 11th Edition
2. Bill Aulet (2024). Disciplined Entrepreneurship: 24 Steps to a Successful Startup. John Wiley & Sons.
3. Bill Aulet (2017). Disciplined Entrepreneurship Workbook. John Wiley & Sons.
4. Ries, E. (2011). The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses. Crown Business
5. Blank, S. G., & Dorf, B. (2012). The Startup Owner's Manual: The Step-by-Step Guide for Building a Great Company. K&S Ranch
6. Osterwalder, A., & Pigneur, Y. (2010). Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers. John Wiley & Sons
7. Marc Gruber & Sharon Tal (2019). Where to Play: 3 Steps for Discovering Your Most Valuable Market Opportunities. Pearson.