DHANALAKSHMI SRINIVASAN ENGINEERING COLLEGE

(An Autonomous Institution, Affiliated to Anna University, Chennai)

PERAMBALUR - 621212

REGULATIONS–2023

CHOICE BASED CREDIT SYSTEM

B.E. MECHANICAL ENGINEERING

CURRICULUM & SYLLABI

DEPARTMENT OF MECHANICAL ENGINEERING

(Applicable to students admitted from the Academic year 2023 – 2024 and subsequently under Choice Based Credit System)

Discussed in BOS meeting Dated: 13.04.2023/ Mechanical Ratified & Approved in Academic Council on 02.09.2023

VISION AND MISSION OF THE INSTITUTUION

Vision:

An active and committed centre of advanced learning focused on research and training in the fields of Engineering, Technology and Management to serve the nation better.

Mission:

- To develop eminent scholar with a lifelong follows up of global standards by offering UG, PG and Doctoral Programmes.
- To pursue Professional and Career growth by collaborating mutually beneficial partnership with industries and higher institutes of research.
- To promote sustained research and training with emphasis on human values and leadership qualities.
- To contribute solutions for the need based issues of our society by proper ways and means as dutiful citizen.

DEPARTMENT OF MECHANICAL ENGINEERING

About the Department

The Department of Mechanical Engineering was established in 2005. It is equipped with state-of-the-art workshops, laboratories, and computing facilities. The department has highly qualified and experienced faculty members. These faculty members actively engage in research and consistently publish papers in international and national journals. Guest lectures and industrial visits are periodically arranged for the students to enhance their curriculum. The department strives for all-around excellence in students, encouraging them in all extracurricular activities.

Vision:

To develop highly skilled Mechanical Engineers dedicated to serving society

Mission:

M1: To Foster a dynamic learning environment that prepares competent student-research scholars in Mechanical Engineering.

M2: To Build state-of-the-art laboratories to meet technological advancements and transformations.

M3: To Uphold moral and ethical principles among faculty and students.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEO 1	**Academic Excellence** Excel as successful engineers or entrepreneurs.
PEO 2	**Leadership Quality** Become effective leaders, demonstrating professionalism and a commitment to lifelong learning.
PEO 3	**Research skill and Ethics** Handle real-time projects while upholding ethical values.

PROGRAM OUTCOMES (POs)

PO	Graduate Attribute
PO1	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	**Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles ofmathematics, natural sciences, and engineering sciences.
PO3	**Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	**Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation ofdata, and synthesis of the information to provide valid conclusions.
PO5	**Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	**The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequentresponsibilities relevant to the professional engineering practice.
PO7	**Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, andneed for sustainable development.
PO8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	**Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	**Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technologicalchange.

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO 1	Apply fundamental and advanced concepts in mechanical engineering across multiple domains, such as materials, design, manufacturing, and thermal engineering, to effectively design, develop, and implement complex products and systems.
PSO 2	Identify, select, and effectively utilize ICT tools commonly employed Mechanical Engineering such as Computer-Aided Design (CAD) software, simulation software, and data analysis tools to create and apply innovative solutions for the betterment of society.

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(AUTONOMOUS), PERAMBALUR – 621 212
B.E. MECHANICAL ENGINEERING

REGULATIONS – 2023

CHOICE BASED CREDIT SYSTEM

SEMESTER I

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	IP3151	Induction programme	MC	-	-	-	-	0
2	U23HST11	Communicative English	HSM	3	0	0	3	3
3	U23MAT12	Matrices and Calculus	BS	3	1	0	4	4
4	U23PHT13	Physics for Engineers and Technologists	BS	3	0	0	3	3
5	U23CYT14	Chemistry for Engineering and Technology	BS	3	0	0	3	3
6	U23GET16	Engineering Graphics	ES	2	0	4	6	4
7	GE3152	Heritage of Tamils /தமிழர் மரபு	HSM	1	0	0	1	1
PRACTICAL								
8	U23BSP11	Physics and Chemistry Laboratory	BS	0	0	4	4	2
9	U23HSP12	English Laboratory	EE	0	0	2	2	1
10	U23GEP14	Engineering Practices Laboratory	ES	0	0	4	4	2
		TOTAL		**15**	**1**	**14**	**30**	**23**

SEMESTER II

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	U23HST21	Professional English	HSM	2	0	0	2	2
2	U23MAT22	Statistics and Numerical Methods	BS	3	1	0	3	4
3	U23GET15	Problem Solving and Python Programming	ES	3	0	0	3	3
4	U23PHT23	Applied Material Science	BS	3	0	0	3	3
5	U23EET23	Basic Electrical and Electronics Engineering	ES	3	0	0	3	3
6	U23MET21	Engineering Mechanics	ES	3	0	0	3	3
7	GE3252	தமிழரும் தொழில்நுட்பமும் / Tamils and Technology	HSMC	1	0	0	1	1
8		NCC Credit Course level 1	-	2	0	0	2	2*
PRACTICAL								
9	U23GEP13	Problem Solving and Python Programming Laboratory	ES	0	0	4	4	2
10	U23EEP22	Basic Electrical and Electronics Engineering Laboratory	ES	0	0	4	4	2
11	U23HSP22	Communication Laboratory	EE	0	0	4	4	2
		TOTAL		**16**	**1**	**12**	**28**	**25**

SEMESTER III

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	U23MAT31	Transforms and Partial Differential Equations	BS	3	1	0	4	4
2	U23MET31	Engineering Thermodynamics	PC	3	0	0	3	3
3	U23MET32	Fluid Mechanics and Machinery	ES	3	0	0	3	3
4	U23MET34	Engineering Materials and Metallurgy	ES	3	0	0	3	3
5	U23MET35	Manufacturing Processes	PC	3	0	0	3	3
PRACTICAL								
6	U23MEP31	Computer Aided Machine Drawing Laboratory	ES	0	0	4	4	2
7	U23MEP32	Manufacturing Technology Laboratory	PC	0	0	4	4	2
8	GE3361	Professional Development	EE	0	0	2	2	1
			TOTAL	**18**	**1**	**10**	**26**	**21**

SEMESTER IV

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	U23MET41	Kinematics of Machinery	PC	3	0	0	3	3
2	U23MET42	Thermal Engineering	PC	3	0	0	3	3
3	U23MET43	Strength of Materials	PC	3	0	0	3	3
4	U23MET44	Computer Aided Design	PC	3	0	0	3	3
5	U23MET45	Manufacturing Technology	PC	3	0	0	3	3
6	U23GET41	Environmental Sciences and Sustainability	BS	2	0	0	2	2
PRACTICAL								
7	U23MEP41	Strength of Materials and Fluid Machinery Laboratory	PC	0	0	4	4	2
8	U23MEP42	Thermal Engineering Laboratory	PC	0	0	4	4	2
			TOTAL	**17**	**0**	**8**	**26**	**21**

SEMESTER V

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	U23MET51	Design of Machine Elements	PC	3	0	0	3	3
2	U23MET52	Dynamics of Machinery	PC	3	0	0	3	3
3	U23MET53	Metrology and Measurements	PC	3	0	0	3	3
4		Professional Elective-I	PE	3	0	0	3	3
5		Professional Elective-II	PE	3	0	0	3	3
6		Open Elective – I	OE	3	0	0	3	3
PRACTICAL								
7	U23MEP51	Metrology and Measurements Laboratory	PC	0	0	4	4	2
8	U23MEP52	Dynamics of Machinery Laboratory	PC	0	0	4	4	2
			TOTAL	**18**	**0**	**8**	**26**	**22**

SEMESTER VI

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	U23MET61	Heat and Mass Transfer	PC	3	0	0	3	3
2	U23MET62	Design of Transmission System	PC	3	0	0	3	3
3	GE3791	Human Values and Ethics	HSM	2	0	0	2	2
4		Professional Elective-III	PE	3	0	0	3	3
5		Professional Elective-IV	PE	3	0	0	3	3
6		Open Elective – II	OE	3	0	0	3	3
PRACTICAL								
7	U23MEP61	CAD/CAM Laboratory	PC	0	0	4	4	2
8	U23MEP62	Heat Transfer Laboratory	PC	0	0	4	4	2
9		Summer Internship*	EE	0	0	0	0	1
			TOTAL	**17**	**0**	**8**	**25**	**22**

SEMESTER VII

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	U23MET71	Mechatronics and IoT	PC	3	0	0	3	3
2	U23MET72	Computer Integrated Manufacturing	PC	3	0	0	3	3
3	U23MET73	Power Plant Engineering	PC	3	0	0	3	3
4		Professional Elective-V	PE	3	0	0	3	3
5		Professional Elective-VI	PE	3	0	0	3	3
6		Professional Elective-VII	PE	3	0	0	3	3
PRACTICAL								
7	U23MEP71	Mechatronics and IoT Laboratory	PC	0	0	4	4	2
8	U23MEP72	Simulation and Analysis Laboratory	PC	0	0	4	4	2
			TOTAL	**18**	**0**	**8**	**26**	**22**

SEMESTER VIII

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	U23MET81	Production Planning and Control	PC	3	0	0	3	3
2	U23MET82	Industrial Management	HSM	3	0	0	3	3
PRACTICAL								
3	U23MEP81	Project Work	EE	0	0	12	12	6
			TOTAL	**6**	**0**	**12**	**18**	**12**

VERTICALS – I (PROCESS EQUIPMENT AND PIPING DESIGN)

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	U23MEV11	Design of Pressure Vessels	PE	3	0	0	3	3
2	U23MEV12	Failure Analysis and NDT Techniques	PE	2	0	2	4	3
3	U23MEV13	Material Handling and Solid Processing Equipment	PE	3	0	0	3	3
4	U23MEV14	Rotating Machinery Design	PE	3	0	0	3	3
5	U23MEV15	Thermal and Fired Equipment Design	PE	3	0	0	3	3
6	U23MEV16	Industrial Layout Design and Safety	PE	2	0	2	4	3
7	U23MEV17	Design Codes and Standards	PE	3	0	0	3	3

VERTICALS – II (ROBOTICS AND AUTOMATION)

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	U23MEV21	Sensors and Instrumentation	PE	3	0	0	3	3
2	U23MEV22	Electrical Drives and Actuators	PE	3	0	0	3	3
3	U23MEV23	Embedded Systems and Programming	PE	2	0	2	4	3
4	U23MEV24	Modeling and Control of Robot	PE	3	0	0	3	3
5	U23MEV25	Smart Mobility and Intelligent Vehicles	PE	3	0	0	3	3
6	U23MEV26	Haptics and Immersive Technologies	PE	3	0	0	3	3
7	U23MEV27	Drone Technologies	PE	3	0	0	3	3

VERTICALS – III (CLEAN AND GREEN ENERGY TECHNOLOGIES)

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	U23MEV31	Bio energy Conversion Technologies	PE	3	0	0	3	3
2	U23MEV32	Carbon Footprint Estimation and Reduction Techniques	PE	3	0	0	3	3
3	U23MEV33	Energy Conservation in Industries	PE	3	0	0	3	3
4	U23MEV34	Energy Efficient Buildings	PE	3	0	0	3	3
5	U23MEV35	Energy Storage Devices	PE	3	0	0	3	3
6	U23MEV36	Renewable Energy Technologies	PE	3	0	0	3	3
7	U23MEV37	Equipment for Pollution Control	PE	3	0	0	3	3

VERTICALS – IV (3D PRINTING)

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	U23MEV41	Introduction to Product Design	PE	3	0	0	3	3
2	U23MEV42	Additive Manufacturing Processes	PE	3	0	0	3	3
3	U23MEV43	Design for Additive Manufacturing	PE	3	0	0	3	3
4	U23MEV44	Reverse Engineering	PE	3	0	0	3	3
5	U23MEV45	Business Value Enhancement with Additive Manufacturing	PE	3	0	0	3	3
6	U23MEV46	Lithographic process	PE	3	0	0	3	3
7	U23MEV47	Printing Technology	PE	3	0	0	3	3

VERTICALS – V (DIVERSIFIED COURSES GROUP)

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	U23MEV51	Automobile Engineering	PE	3	0	0	3	3
2	U23MEV52	Measurements and Controls	PE	3	0	0	3	3
3	U23MEV53	Non-traditional Machining Processes	PE	3	0	0	3	3
4	U23MEV54	Composite Materials and Mechanics	PE	3	0	0	3	3
5	U23MEV55	Gas Dynamics and Jet Propulsion	PE	3	0	0	3	3
6	U23MEV56	Hydraulics and Pneumatics	PE	3	0	0	3	3
7	U23MEV57	Dynamics of Ground Vehicles	PE	3	0	0	3	3

OPEN ELECTIVES-I

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	U23MEO11	Applied Design Thinking	OE	2	0	2	4	3
2	U23MEO12	Reverse Engineering	OE	3	0	0	3	3
3	U23MEO13	Quality Engineering	OE	3	0	0	3	3
4	U23MEO14	Functional Materials	OE	3	0	0	3	3
5	U23MEO15	Fire Safety Engineering	OE	3	0	0	3	3

OPEN ELECTIVES-II

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	U23MEO21	Industrial Design & Rapid Prototyping Techniques	OE	2	0	2	4	3
2	U23MEO22	Micro and Precision Engineering	OE	3	0	0	3	3
3	U23MEO23	Energy Conservation and Management	OE	3	0	0	3	3
4	U23MEO24	Nanomaterials and applications	OE	3	0	0	3	3
5	U23MEO25	Industrial Design & Rapid Prototyping Techniques	OE	2	0	2	4	3

SUMMARY

Sl. No.	Subject Area	Credits persemester								Credits Total	Percentage %
		I	II	III	IV	V	VI	VII	VIII		
1	Humanities and Social Sciences	4	3	-	-	-	2	-	3	12	7.1
2	Basic Sciences	12	7	4	2	-	-	-	-	25	14.88
3	Engineering Sciences	6	13	8	-	-	-	-	-	27	16.07
4	Professional Core	-	-	8	19	13	10	13	3	66	39.28
5	Professional Elective	-	-	-	-	6	6	9	-	21	12.5
6	Open Elective	-	-	-	-	3	3	-	-	6	3.5
7	Employability Enhancement Courses	1	2	1	-	-	1	-	6	11	6.5
Total		23	25	21	21	22	22	22	12	168	100

IP3151	INDUCTION PROGRAMME	L	T	P	C
		0	0	0	0

This is a mandatory 2 week programme to be conducted as soon as the students enter the institution. Normal classes start only after the induction program is over.

The induction programme has been introduced by AICTE with the following objective:

To train graduates well in the branch/department of admission, have a holistic outlook, and have a desire to work for national needs and beyond. The graduating student must have knowledge and skills in the area of his/her study. However, he/she must also have broad understanding of society and relationships. Character needs to be nurtured as an essential quality by which he/she would understand and fulfill his/her responsibility as an engineer, a citizen and a human being. Besides the above, several meta-skills and underlying values are needed.

"One will have to work closely with the newly joined students in making them feel comfortable, allow them to explore their academic interests and activities, reduce competition and make them work for excellence, promote bonding within them, build relations between teachers and students, give a broader view of life, and build character".

Hence, the purpose of this programme is to make the students feel comfortable in their new environment, open them up, set a healthy daily routine, create bonding in the batch as well as between faculty and students, develop awareness, sensitivity and understanding of the self, people around them, society at large, and nature.

The following are the activities under the induction program in which the student would be fully engaged throughout the day for the entire duration of the program.

(i) Physical Activity

This would involve a daily routine of physical activity with games and sports, yoga, gardening, etc.

(ii) Creative Arts

Every student would choose one skill related to the arts whether visual arts or performing arts. Examples are painting, sculpture, pottery, music, dance etc. The student would pursue it everyday for the duration of the program. These would allow for creative expression. It would develop a sense of aesthetics and also enhance creativity which would, hopefully, grow into engineering design later.

(iii) Universal Human Values

This is the anchoring activity of the Induction Programme. It gets the student to explore oneself and allows one to experience the joy of learning, stand up to peer pressure, take decisions with courage, be aware of relationships with colleagues and supporting stay in the hostel and department, be sensitive to others, etc. A module in Universal Human Values provides the base. Methodology of teaching this content is extremely important. It must not be through do's and dont's, but get students to explore and think by engaging them in a dialogue. It is best taught through group discussions and real life activities rather than lecturing. Discussions would be conducted in small groups of about 20 students with a faculty mentor each. It would be effective that the faculty mentor assigned is also the faculty advisor for the student for the full duration of the UG programme.

(iv)Literary Activity

Literary activity would encompass reading, writing and possibly, debating, enacting a play etc.

(v) Proficiency Modules

This would address some lacunas that students might have, for example, English, computer familiarity etc.

(vi) Lectures by Eminent People

Motivational lectures by eminent people from all walks of life should be arranged to give the students exposure to people who are socially active or in public life

(vii) Visits to Local Area

A couple of visits to the landmarks of the city, or a hospital or orphanage could be organized. This would familiarize them with the area as well as expose them to the under privileged.

(viii) Familiarization to Dept./Branch & Innovations

They should be told about what getting into a branch or department means what role it plays in society, through its technology. They should also be shown the laboratories, workshops & other

facilities.

(ix) Department Specific Activities

About a week can be spent in introducing activities (games, quizzes, social interactions, small experiments, design thinking etc.) that are relevant to the particular branch of Engineering /Technology/Architecture that can serve as a motivation and kindle interest in building things (become a maker) in that particular field. This can be conducted in the form of a workshop. For example, CSE and IT students may be introduced to activities that kindle computational thinking, and get them to build simple games. ECE students may be introduced to building simple circuits as an extension of their knowledge in Science, and so on. Students may be asked to build stuff using their knowledge of science.

Induction Programme is totally an activity based programme and therefore there shall be no tests / assessments during this programme.

U23HST11	COMMUNICATIVE ENGLISH (COMMON TO ALL B.E./ B.TECH. PROGRAMMES)	L 3	T 0	P 0	C 3

COURSE OBJECTIVES

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

1. To enhance students listening ability for academic and Professional purposes.
2. To learn to use basic grammatical structures in suitable contexts
3. To help students acquire the ability to speak effectively in English in real -life situations.
4. To help learners use language effectively in professional contexts.
5. To develop student's ability to read and write complex texts, summaries, articles, definitions, Paragraph user manuals.

UNIT I INTRODUCTION TO EFFECTIVE COMMUNICATION 9

Define communication. Kinds of communication. Quintessential of communication in technical progression. Key characteristics of an effective communicator- listening, attitude modification, way of response with appropriate language, tone modulation.

Listening- Listening to TV news, Guest lectures. Speaking- Answering the Questions.

Reading - Reading brochures and technical magazines (technical context), telephone messages / social media messages relevant to technical contexts and emails, **Writing**-Reading comprehension, Parts of Speech.

UNIT II READING QUEST 9

Listening- listening and responding to video lectures/talks. **Speaking**- Day today conversations. **Reading** –Edison of India-GD Naidu "The Great Inventor". **Writing-** Emails / Informal Letters - Inviting, Congratulating & Thanking, Punctuations.

UNIT III LANGUAGE RESOURCE GROWS CRITICAL JUDGEMENT 9

Listening- listening to specific task-focused audio tracks. Speaking- summary of Robert Frost "Stopping by woods on a snowy evening". Reading – Reading advertisements, gadget reviews; user manuals. Writing – Essay Writing: Analytical essay: Narrative Essay, Developing Hints, Usage of tenses in sentence formation. Voices.

UNIT IV LANGUAGE IN LIFE SKILL 9

Listening- Listening to speech of Great Scholars. Speaking- mechanics of presentation. **Reading** – Newspaper articles, power point presentation. **Writing** – Checklist, Jumbled sentences-Rearrange the sentences in correct order, WH-Questions-Form questions by using statements, Prefixes and Suffixes.

UNITV IMPROVING SPEAKING &READING 9

Listening- listening to situational based dialogues; **Speaking-** Stating intention to do something- Expressing opinion-asking people to repeat themselves**. Reading** – Summary of O.Henry's "The last Leaf". **Writing** – Dialogue Writing.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 : Remember appropriate words in a situational conversation.
CO2 : Gain understanding of basic grammatical structures and use them in right context.
CO3 : Read and infer the denotative and connotative meanings of technical texts.
CO4 : Write Dialogue, Letter and paragraphs on various topics.
CO5 : Make the students prepare effective notes for main sources available.
CO6 : Enhance them to give operational talk.

TEXT BOOKS:

1. English for Engineers & Technologists Orient Blackswan Private Ltd. Department of English, Anna University, (2020 edition).
2. English for Science & Technology Cambridge University Press, 2021. Authored by Dr. VeenaSelvam, Dr. SujathaPriyadarshini, Dr. Deepa Mary Francis, Dr. KN. Shoba, and Dr. Lourdes Joevani, Department of English, Anna University.
3. The Gift of the Magi by O.Henry, McClure,Philips and company.

REFERENCE BOOKS:

1. Technical Communication – Principles And Practices By Meenakshi Raman &Sangeeta Sharma, Oxford Univ. Press, 2016, New Delhi.
2. A Course Book On Technical English By Lakshminarayanan, Scitech Publications (India) Pvt. Ltd.
3. English For Technical Communication (With CD) By AyshaViswamohan, Mcgraw Hill Education.
4. Effective Communication Skill, Kulbhusan Kumar, RS Salaria, Khanna Publishing House.
5 Learning to Communicate – Dr. V. Chellammal, Allied Publishing House, New Delhi, 2003.

U23MAT12	MATRICES AND CALCULUS	L	T	P	C
		3	1	0	4

COURSE OBJECTIVES

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

1. To develop the use of matrix algebra techniques that is needed by engineers for practical applications.
2. To familiarize the students with differential calculus.
3. To familiarize the student with functions of several variables.
4. To acquaint the student with mathematical tools needed in evaluating multiple integrals and their applications.
5. To make the student acquire sound knowledge of techniques in solving ordinary differential equations that model engineering problems.

UNIT I MATRICES 12

Introduction – Characteristic equation – Eigen values and Eigenvectors of a real matrix – Properties of Eigen values and Eigenvectors – Cayley Hamilton theorem – Diagonalization of the matrices by Orthogonal Transformations – Reduction of a quadratic form to canonical form by orthogonal transformation – Nature of quadratic forms.

UNIT II DIFFERENTIAL CALCULUS 12

Limit of a function – Continuity – Derivatives – Differentiation rules – Implicit differentiation – Logarithmic differentiation – Maxima and Minima of functions of one variable.

UNIT III MULTIVARIABLE CALCULUS 12

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

UNIT IV MULTIPLE INTEGRAL AND THEIR APPLICATIONS 12

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.

UNITV ORDINARY DIFFERENTIAL EQUATIONS 12

Higher order linear differential equations with constant coefficients – Method of variation of parameters – Homogenous equation of Euler's and Legendre's type – System of simultaneous linear differential equations with constant coefficients – Method of undetermined coefficients.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

CO1 : Use the matrix algebra methods for solving practical problems.

CO2 : Use both the limit definition and rules of differentiation to differentiate functions.

CO3 : Apply differential calculus tools in solving various application problems.

CO4 : Able to use differential calculus ideas on several variable functions.

CO5 : Apply multiple integral ideas in solving areas, volumes and other practical problems.

CO6 : Solve the ordinary differential equations using different techniques for that model engineering problems.

TEXT BOOKS:

1. Kreyszig.E, "Advanced Engineering Mathematics", John Wiley and Sons, 10th Edition, New Delhi, 2016.
2. Grewal. B.S., “Higher Engineering Mathematics”,Khanna Publishers, New Delhi, 44th Edition, 2018.
3. James Stewart, "Calculus: Early Transcendentals", Cengage Learning, 8th Edition, New Delhi, 2015. [For Units II & IV - Sections 1.1, 2.2, 2.3, 2.5, 2.7 (Tangents problems only), 2.8, 3.1 to 3.6, 3.11, 4.1, 4.3, 5.1 (Area problems only), 5.2, 5.3, 5.4 (excluding net change theorem), 5.5, 7.1 - 7.4 and 7.8].

REFERENCE BOOKS:

1. Bali. N., Goyal. M. and Watkins. C., “Advanced Engineering Mathematics”, Firewall Media (An imprint of Lakshmi Publications Pvt.,Ltd.,), New Delhi, 7th Edition, 2009.
2. Jain. R.K. and Iyengar. S.R.K., “Advanced Engineering Mathematics”, Narosa Publications, New Delhi, 5th Edition,2016.
3. Narayanan. S. and Manicavachagom Pillai. T. K.,“Calculus" Volume I and II, S.Viswanathan Publishers Pvt. Ltd., Chennai, 2009.
4. Ramana. B.V., "Higher Engineering Mathematics", McGraw Hill Education Pvt.Ltd, New Delhi, 2016.
5. Thomas. G. B., Hass. J, and Weir. M.D,"Thomas Calculus", 14th, Pearson India, 2018.

U23PHT13	PHYSICS FOR ENGINEERS AND TECHNOLOGISTS (COMMON TO ALL B.E./ B.TECH. PROGRAMMES)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

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

1. To make the students to gain the knowledge in elastics and plastic nature of the materials in the presence and absence of load.
2. To understand the students to know the application of the sound waves in different fields.
3. To motivate the students towards the applications of photo electric phenomena.
4. To know the physical principle of LASER, the working of LASER applications.
5. To understand the propagation of light in optical fibers and its applications.

UNIT I ELASTICITY 9

Introduction- Elasticity - plasticity– Hooke's law - relationship between three Modulii of elasticity (Qualitative) – stress & strain diagram and its uses -Poisson's ratio - factors affecting elasticity - twisting ouple of wire - Torsion Pendulum: theory and experiment.

Beam: Internal bending moment – Cantilever: theory and experiment – Young's Modulus: uniform and non – uniform bending (Qualitative) – I-shaped girders- advantages and applications.

UNIT II ULTRASONICS 9

Introduction – classification of sound- properties of infrasonic, audible and ultrasonics - production: Magnetostriction and Piezoelectric methods – determination of velocity of sound in liquid (Acoustic Grating Method) – general applications – industrial application: Non - Destructive Testing: pulse echo system through transmission and reflection modes. ultrasonic scanning methods – medical application: sonogram.

UNIT III MODERN PHYSICS 9

Introduction –Black Body Radiation – Classical and Quantum Laws of Black Body Radiation - Photon and its Properties - Wave Particle Duality and Matter waves – De - Broglie Wavelength - Schrodinger's Time Independent and Time Dependent Wave Equations - Physical Significance of The Wave Function. Application: Particle in One Dimensional Box - Normalization Process – Photo Electric Effect – Laws Governing the Photoelectric Effect – Einstein's Formula - Derivation – Applications: Solar Cell – Solar Water Heater – Photo resistor (LDR).

UNIT IV LASERS 9

Lasers: Introduction - Properties of Laser-Spontaneous and Stimulated Emission Process - Einstein's Theory of Matter Radiation Interaction & A and B Coefficients; Amplification of Light By Population Inversion – Pumping Methods - Types of Lasers: Solid-State Laser (Homo And Hetero Junction Semiconductor Lasers), Gas Laser (CO_2), Applications: Laser Cutting and Welding, LIDAR and Barcode Scanner.

UNIT V FIBER OPTICS AND APPLICATIONS 9

Optical Fiber: Structure - advantages- Principle [TIR]–Propagation Phenomena in optical fiber - Expression For Acceptance Angle and Numerical Aperture – Relation between Refractive Index of Core, Numerical Aperture and Fractional Index Change – Fabrication: Double Crucible Method - Types: Material, Mode, Refractive Index - Applications: Optical Fiber Communication System – fiber optic sensors (Displacement and pressure sensors) – Medical Endoscope.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 : Differentiate the elastic and plastic nature of the materials.

CO2 : Know the experimental techniques in both production and applications of ultrasonic waves.

CO3: Gain knowledge in the basics of quantum mechanics concepts.

CO4: Develop new devices based on LASER source.

CO5: Understand the advantages of optical fiber than metal wire.

CO6: Demonstrate the some useful experiments based on optical fibre

TEXT BOOKS:

1. Dr. P.Mani, "Engineering Physics", Dhanam Publications, 2013.
2. Dr. G. Senthilkumar, "Engineering Physics", VRB Publishers, 2017.
3. K. Thyagarajan, Ajoy Ghatak, "Lasers Fundamentals and Applications" II nd Edition, Springer, 2010.
4. D.K. Bhattacharya, Poonam Tandon," Engineering Physics", Oxford HED Publishers, 2017.

REFERENCE BOOKS:

1. Marikani, "Engineering Physics", PHI, New Delhi, 2013.
2. Bhattacharya & Bhaskaran, "Engineering Physics", Oxford Publications, 2012.
3. R Murugeshan, Kiruthiga, Sivaprasath S, "Modern Physics", Chand Publishing, 2021.
4. S. Rajivgandhi & A. Ravikumar, " Engineering Physics I", RK Publications, 2023
5. Sathyaprakash, "Quantum Mechanics", Pragati Prakashan, Meerut, 2016.

U23CYT14	CHEMISTRY FOR ENGINEERING & TECHNOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

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

1. To inculcate sound understanding of water quality parameters and water treatment techniques.
2. Impart knowledge on the basic principles and preparatory methods of nanomaterial.
3. To introduce the basic concepts and applications of phase rule and composites.
4. To facilitate the understanding of different types of fuels, their preparation, properties and combustion characteristics.
5. To familiarize the students with the operating principles, working processes and applications of energy conversion and storage devices.

UNIT I Water Treatment 9

Water: Sources , impurities, Parameters. Types of water Hardness of water -types – expression of hardness – units – Estimationof hardness of water by EDTA. Desalination - Reverse Osmosis. Boiler troubles: Internal treatment (phosphate, colloidal, sodium aluminate and calgon conditioning) and External treatment – Ion exchange demineralisation and zeolite process.

UNIT II Electro and Nano chemistry 9

Electrochemical cells – reversible and irreversible cells – EMF – measurement of emf by Poggendorff's compensation principle. Single electrode potential – Nernst equation – reference electrodes -types–Calomel electrode - electrolysis of water.

Nanomaterials:Basics of Nano Chemistry: Distinction between molecules, nanomaterials and bulkmaterials. Preparation of nanomaterials- laser ablation method and Chemical VapourDeposition(CVD). Application of Nanomaterials in medicine, agriculture, energy, electronics and catalysis.

UNIT III Phase Rule and Composites 9

Phase rule terms with examples. water system; Reduced phase rule Two component system: lead-silver system – Composites , Need , Constitution: Matrix materials, Applications and Reinforcement and applications of Metal matrix composites (MMC), Ceramic matrix composites and Polymer matrix composites. Hybrid composites - definition and examples.

UNIT IV Fuels & Combustion 9

Fuels –Classification-Coal and coke: Analysis of coal (proximate and ultimate), Carbonization, Manufacture of metallurgical coke (Otto Hoffmann method). Petroleum and Diesel: Manufacture of synthetic petrol (Bergius process), Knocking - octane number, diesel oil - cetane number; Power alcohol and biodiesel.

Combustion of fuels: Introduction: Calorific value - higher and lower calorific values, Theoretical calculation of calorific value; Ignition temperature: spontaneous ignition temperature, Explosive range; Flue gas analysis - ORSAT Method. CO_2 emission and carbon foot print.

UNITV Energy Sources and Storage devices 9

Nuclear energy: light water nuclear power plant, breeder reactor. Solar energy conversion: Principle, working and applications of solar cells; Recent developments in solar cell materials. Wind energy; Geothermal energy; Batteries: Types of batteries, Primary battery - dry cell, Secondary battery - lead acid battery and lithium-ion- battery; Electric vehicles-working principles; Fuel cells: H_2-O_2 fuel cell, microbial fuel cell; Supercapacitors: Storage principle, types and examples.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 : Develop innovative methods to produce soft water for industrial use and potable water at cheaper cost.

CO2 : Apply the basic knowledge of Corrosion and various electrodes.

CO3 : Know the economically and new methods of synthesis nano materials.

CO4 : Apply the knowledge of phase rule and composites for material selection requirements.

CO5 : Understand the concepts of suitable fuels for engineering processes and applications.

CO6 : Have the knowledge of different forms of energy resources and apply them for suitable applications in energy sectors.

TEXT BOOKS:

1. P. C. Jain and Monica Jain, "Engineering Chemistry", 17th Edition, DhanpatRai Publishing Company (P) Ltd, New Delhi, 2018.
2. Sivasankar B., "Engineering Chemistry", Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2008.
3. S.S. Dara, "A text book of Engineering Chemistry", S. Chand Publishing, 12th Edition, 2018.
4. J.Manivel , "Engineering Chemistry" R.K.Publishers, 1st Edition 2022.

REFERENCE BOOKS:

1. B. S. Murty, P. Shankar, Baldev Raj, B. B. Rath and James Murday, "Text book of nanoscience and nanotechnology", Universities Press-IIM Series in Metallurgy and Materials Science, 2018.
2. O.G. Palanna, "Engineering Chemistry" McGraw Hill Education (India) Private Limited, 2nd Edition, 2017.
3. Friedrich Emich, "Engineering Chemistry", Scientific International PVT, LTD, New Delhi, 2014.
4. ShikhaAgarwal, "Engineering Chemistry-Fundamentals and Applications", Cambridge University Press, Delhi, Second Edition, 2019.

U23GET16	ENGINEERING GRAPHICS	L	T	P	C
		2	0	4	4

COURSE OBJECTIVES

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

1. To develop in students, graphic skills for communication of concepts, ideas and design of engineering products.
2. To expose them to existing national standards related to technical drawings.

UNIT I PLANE CURVES AND ORTHOGRAPHIC PROJECTION 6+12

Importance of graphics in engineering applications – Use of drafting instruments – BIS conventions and specifications – Size, layout and folding of drawing sheets – Lettering and dimension. Basic Geometrical constructions, Curves used in engineering practices: Conics – Construction of ellipse, parabola and hyperbola by eccentricity method – Construction of cycloid – construction of involutes of square and circle – Drawing of tangents and normal to the above curves. Visualization concepts and Free Hand sketching: Visualization principles –Representation of Three-Dimensional objects – Layout of views- Freehand sketching of multiple views from pictorial views of objects.

UNIT II PROJECTION OF POINTS, LINES AND PLANE SURFACE 6+12

Orthographic projection- principles-Principal planes-First angle projection-projection of points. Projection of straight lines (only First angle projections) inclined to both the principal planes - Determination of true lengths and true inclinations by rotating line method (polygonal and circular surfaces) inclined to both the planes.

UNIT III PROJECTION OF SOLIDS 6+12

Projection of simple solids like prisms, pyramids, cylinder, cone and truncated solids when the axis is inclined to one of the principal planes by rotating object method.

UNIT IV PROJECTION OF SECTIONED SOLIDS AND DEVELOPMENT OF SURFACES 6+12

Sectioning of above solids in simple vertical position when the cutting plane is inclined to the one of the principal planes and perpendicular to the other – obtaining true shape of section. Development of lateral surfaces of simple solids – Prisms, pyramids cylinders and cones.

UNIT V ISOMETRIC PROJECTION 6+12

Principles of isometric projection – isometric scale –Isometric projections of simple solids and truncated solids - Prisms, pyramids, cylinders, cones- combination of two solid objects in simple vertical positions-Perspective Projection.

TOTAL: 90 PERIODS

COURSE OUTCOMES:

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

CO1 : Familiarize with the fundamentals and standards of Engineering graphics

CO2 : Perform freehand sketching of basic geometrical constructions and multiple views of objects.

CO3 : Project orthographic projections of lines and plane surfaces.

CO4 : Draw projections and solids and development of surfaces.

CO5 : Visualize and to project isometric and perspective sections of simple solids.

TEXT BOOKS:

1. Natrajan K.V., ―A text book of Engineering Graphics‖, Dhanalakshmi Publishers, Chennai, 2009.
2. Venugopal K. and Prabhu Raja V., ―Engineering Graphics‖, New Age International (P) Limited, 2008.

REFERENCE BOOKS:

1. Bhatt N.D. and Panchal V.M., ―Engineering Drawing‖, Charotar Publishing House, 50th Edition, 2010.
2. Basant Agarwal and Agarwal C.M., ―Engineering Drawing‖, Tata McGraw Hill Publishing Company Limited, New Delhi, 2008.
3. Gopalakrishna K.R., ―Engineering Drawing‖ (Vol. I&II combined), Subhas Stores, Bangalore, 2007.
4. Luzzader, Warren.J. and Duff,John M., ―Fundamentals of Engineering Drawing with an introduction to Interactive Computer Graphics for Design and Production, Eastern Economy Edition, Prentice Hall of India Pvt. Ltd, New Delhi, 2005.
5. N S Parthasarathy and Vela Murali, ―Engineering Graphics‖, Oxford University, Press, New Delhi, 2015.
6. Shah M.B., and Rana B.C., ―Engineering Drawing‖, Pearson, 2nd Edition, 2009.

GE3152	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 a Classical Language - Classical Literature in Tamil – Secular Nature of Sangam Literature – Distributive Justice in Sangam Literature - Management Principles in Thirukural - Tamil Epics and Impact of Buddhism & Jainism in Tamil Land - Bakthi Literature Azhwars and Nayanmars - Forms of minor Poetry - Development of Modern literature in Tamil - Contribution of Bharathiyar and Bharathidhasan.

UNIT II HERITAGE - ROCK ART PAINTINGS TO MODERN ART – SCULPTURE 3

Hero stone to modern sculpture - Bronze icons - Tribes and their handicrafts - Art of temple car making - Massive Terracotta sculptures, Village deities, Thiruvalluvar Statue at Kanyakumari, Making of musical instruments - Mridhangam, Parai, Veenai, Yazh and Nadhaswaram - Role of Temples in Social and Economic Life of Tamils

UNIT III FOLK AND MARTIAL ARTS 3

Therukoothu, Karagattam, Villu Pattu, Kaniyan Koothu, Oyillattam, Leather puppetry, 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.

UNITV 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 Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)

U23BSP11	PHYSICS AND CHEMISTRY LABORATORY (COMMON TO ALL B.E. / B.TECH. PROGRAMMES)	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES

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

1. To learn the proper use of various kinds of physics laboratory equipment.
2. To learn how data can be collected, presented and interpreted in a clear and concise manner.
3. To learn problem solving skills related to physics principles and interpretation of experimental data.
4. To determine error in experimental measurements and techniques used to minimize such error.
5. To make the student as an active participant in each part of all lab exercises.
6. To inculcate experimental skills to test basic understanding of water quality parameters, as, acidity, alkalinity, chloride.
7. To Induce the students to analyze the hardness of water
8. To induce the students to familiarize with electro analytical techniques such as, pH metry, conductometry in the determination of impurities in aqueous solutions.

LIST OF EXPERIMENTS

1. Torsion pendulum - Determination of rigidity modulus of wire and moment of inertia of regular disc.
2. Non - Uniform bending–Determination of Young's modulus.
3. Laser – (i) Determination of the wavelength of the laser using grating.
   (ii) Determination of size of the particles using laser source.
4. Air wedge – Determination of thickness of a thin sheet/wire.
5. Determination of Band gap of a semiconductor using PN junction kit.
6. To study the V-I Characteristics of Light Dependent Resistor (LDR).
7. Determination of types and amount of alkalinity in water sample.
8. Determination of total, temporary & permanent hardness of water by EDTA method.
9. Determination of chloride content of water sample by Argentometric method.
10. Determination of strength of given hydrochloric acid using pH meter.
11. Determination of strength of acids in a mixture of acids using conductivity meter.
12. Conduct metric titration of barium chloride against sodium sulphate (precipitation titration)

TOTAL: 60 PERIODS

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

Sl No	Name of the Equipment	Quantity
1.	Torsion pendulum set up (Metal Disc, Symmetrical Mass(2x100g), Stop Clock, Screw Gauge)	**5**
2.	Non – Uniform bending set up (Travelling Microscope, Knife Edges, Weight Hanger with Mass(5x50g), Screw Gauge, Vernier Caliper, Meter Scale)	**5**
3.	Laser set up (Semiconductor Laser, Screen, Grating Stand, Wooden Stand With Meter Scale)	**5**
4.	Air wedge (Air Wedge Set Up, Travelling Microscope, Sodium Vapour Lamp, Transformer)	**5**
5.	Band gap of a semiconductor (PN Junction Kit, Thermometer, Heater, Beaker, Oil)	**5**
6.	Light Dependent Resistor (Power Suppy, Voltmeter, Ammeter, LDR, Bulb, Resistors)	**5**
7.	PH meter	**5**

8.	Conductivity meter	**10**
9.	Common Apparatus(Pipette, Burette, Conical Flask, Porcelain tile, Dropper)	**15**

COURSE OUTCOMES:

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

CO1 : Understand the functioning of various physics laboratory equipment.
CO2 : Observe and tabulate experimental data.
CO3: Solve problems individually and collaboratively.
CO4: Analyse the quality of water samples with respect to their acidity, alkalinity
CO5: Determine the amount of hardness in the water
CO6: Analyse quantitatively the impurities in solution by electro analytical techniques

U23HSP12	ENGLISH LABORATORY (COMMON TO ALL B.E. / B.TECH. PROGRAMMES)	L	T	P	C
		0	0	2	1

COURSE OBJECTIVES

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

1. To improve the communicative competence of learners.
2. To help learners use language effectively in academic /work contexts.
3. To develop various listening strategies to comprehend various types of audio materials like lectures, discussions, videos etc.
4. To build on students' English language skills by engaging them in listening, speaking and grammar learning activities that are relevant to authentic contexts.
5. To use language efficiently in expressing their opinions via various media.

LIST OF EXPERIMENTS

1 Listening for general information-specific details.
2 Conversation: Introduction to classmates.
3 Speaking - making telephone calls-Self Introduction.
4 Talking about current and temporary situations & permanent and regular situations.
5 Listening to podcasts, anecdotes / stories / event narration.
6 Event narration; documentaries and interviews with celebrities.
7 Events-Talking about current and temporary situations & permanent and regular situations.
8 Engaging in small talk.
9 Describing requirements and abilities- Picture description.
10 Discussing and making plans.
11 Talking about tasks- progress- positions -directions of movement.
12 Talking about travel preparations and transportation.
13 Listening to debates/ discussions.
14 Making prediction talking about a given topic.
15 Describing processes.

TOTAL: 30 PERIODS

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

Sl no	Name of the Equipment	Quantity
1.	Communication laboratory with sufficient computer systems	**30**
2.	Server	**1**
3.	Head phone	**30**
4.	Audio mixture	**1**
5.	Collar mike	**1**
6.	Television	**1**
7.	Speaker set with amplifier	**1**
8.	Power point projector and screen	**1**
9.	Cordless mike	**1**

COURSE OUTCOMES:

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

CO1 : Identify and comprehend complex academic texts.

CO2 : Interpret accurately and fluently in formal and informal communicative contexts.

CO3: Demonstrate their opinions effectively in both oral and written medium of communication.

CO4: Plan travelogue and construct paragraphs on various aspects.

CO5: Develop journal reading skills and small talk.

CO6: Utilizing technical terms and making power point presentations.

U23GEP14 ENGINEERING PRACTICES LABORATORY

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. Drawing pipe line plan; laying and connecting various pipe fittings used in common household plumbing work; Sawing; planing; making joints in wood materials used in common house hold wood work.
2. Wiring various electrical joints in common household electrical wire work.
3. Welding various joints in steel plates using arc welding work; Machining various simple processes like turning, drilling, tapping in parts;
4. Soldering and testing simple electronic circuits; Assembling and testing simple electronic components on PCB.
5. Assembling simple mechanical assembly of common household equipments; Making a tray out of metal sheet using sheet metal work.

GROUP – A (CIVIL AND MECHANICAL)

PART I CIVIL ENGINEERING PRACTICES PLUMBING WORK: 30

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

MECHANICAL PRACTICES

WELDING WORK:

a) Welding of Butt Joints, Lap Joints, and Tee Joints using arc welding.
b) Practicing gas welding.

BASIC MACHINING WORK:

a) Turning
b) Drilling
c) Tapping

ASSEMBLY WORK:

a) Assembling a centrifugal pump.
b) Assembling a household mixer.

SHEET METAL WORK:

a) Making of a square tray

WOOD WORK:

a. Sawing,
b. Planing and
c. Making joints like T-Joint, Mortise joint and Tenon joint and Dovetail joint.

PART II ELECTRICAL & ELECTRONICS 30

1. Residential house wiring using switches, fuse, indicator, lamp and energy meter.
2. Fluorescent lamp wiring.
3. Stair case wiring
4. Measurement of electrical quantities – voltage, current, power & power factor in RLC circuit.
5. Measurement of energy using single phase energy meter.
6. Measurement of resistance to earth of an electrical equipment.

ELECTRONICS

1. Study of Electronic components and equipments – Resistor, colour coding measurement of AC signal parameter (peak-peak, rms period, frequency) using CR.
2. Study of logic gates AND, OR, EX-OR and NOT.
3. Generation of Clock Signal.

4. Soldering practice – Components Devices and Circuits Using general purpose PCB.
5. Measurement of ripple factor of HWR and FWR.

TOTAL : 60 PERIODS

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

CIVIL

1. Assorted components for plumbing consisting of metallic pipes, plastic pipes, flexible pipes, couplings, unions, elbows, plugs and other fittings. 15Sets.
2. Carpentry vice (fitted to work bench) 15Nos.
3. Standard woodworking tools 15 Sets.
4. Models of industrial trusses, door joints, furniture joints 5each
5. Power Tools: (a) Rotary Hammer 2 Nos (b) Demolition Hammer 2 Nos (c) Circular Saw 2 Nos (d) Planer 2 Nos (e) Hand Drilling Machine 2 Nos (f) Jigsaw 2Nos

MECHANICAL

Arc welding transformer with cables and holders 5 Nos.

1. Welding booth with exhaust facility 5Nos.
2. Welding accessories like welding shield, chipping hammer, wire brush, etc. 5Sets.
3. Oxygen and acetylene gas cylinders, blow pipe and other welding outfit. 2Nos.
4. Centre lathe 2Nos.
5. Hearth furnace, anvil and smithy tools 2Sets.
6. Moulding table, foundry tools 2Sets.
7. Power Tool: Angle Grinder 2Nos
8. Study-purpose items: centrifugal pump, air-conditioner One each

ELECTRICAL

1. Assorted electrical components for house wiring 15Sets
2. Electrical measuring instruments 10Sets
3. Study purpose items: Iron box, fan and regulator, emergency lamp 1 each
4. Megger (250V/500V) 1No.
5. Power Tools:
   a) Range Finder 2Nos
   b) Digital Live-wire detector 2Nos
   c)

ELECTRONICS

1. Soldering guns 10Nos.
2. Assorted electronic components for making circuits 50Nos.
3. Small PCBs 10Nos.
4. Multimeters 10Nos.

Study purpose items: Telephone, FM radio, low-voltage power supply.

COURSE OUTCOMES:

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

CO1 : Draw pipe line plan; lay and connect various pipe fittings used in common household plumbing work; Saw; plan; make joints in wood materials used in common household wood work.

CO2 : Wire various electrical joints in common household electrical wire work.

CO3: Weld various joints in steel plates using arc welding work; Machine various simple processes like turning, drilling, tapping in parts; Assemble simple mechanical assembly of common Household equipments; Make a tray out of metal sheet using sheet metal work.

CO4: Solder and test simple electronic circuits; Assemble and test simple electronic components on PCB.

CO5: Apply fundamental engineering principles to analyze and solve real-world problems.

CO6: Demonstrate proficiency in using engineering tools and equipment.

SEMESTER II

		L	T	P	C
U23HST21	**PROFESSIONAL ENGLISH (COMMON TO ALL B.E. / B.TECH. PROGRAMMES)**	**2**	**0**	**0**	**2**

COURSE OBJECTIVES

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

1. To engage learners in meaningful language activities to improve their reading and writing skills.
2. To learn various reading strategies and apply in comprehending documents in professional context.
3. To help learners understand the purpose, audience, contexts of different types of writing.
4. To enable students write letters and reports effectively in formal and business situations.
5. To demonstrate an understanding of job applications and interviews for internship and placements.

UNIT I PREPARATORY DOCUMENTATIONS 6

Listening- Listening to formal conversations and Participating**. Speaking-** speaking about one's family. **Reading –** Summary of W.W Jacobs "The monkey's paw". **Writing –** Subject verb Agreement, Numerical -Adjectives, Kinds of sentences**,** Writing reviews (book / film), writing Instructions, Writing Recommendation.

UNIT II LECTURA ENRICHMENT AND PASSAGE COMPOSE 6

Listening- listening to lectures on academic topics; **Speaking-** Asking for and giving directions. **Reading -** Reading longer technical texts; **Writing -** Compound words, Homophones and Homonyms, Cause and Effect expressions. Essay Writing, Writing Letter to the Editor (complaint, acceptance, Requesting, Thanking).

UNIT III ANALYTICAL SKILL 6

Listening- Watching videos/documentaries and responding to questions based on them. **Speaking –**Speaking about ones favourite place**. Reading –** Summary of the poem – John keats "Ode to a Nightingale". **Writing-** Purpose statement, Extended Definitions. Writing Job/ Internship application – Cover letter & Resume.

UNIT IV REPORT WRITING 6

Listening- Listening to class room lectures/talks on engineering/technology. **Speaking–** Introduction to technical presentations. **Reading –** Newspaper articles; **Writing –** Comparative Adjectives Direct and Indirect speech**.** Report Writing- Fire Accident Report, Road Accident, Feasibility Report).

UNIT V ENABLING LINGUA IDEALITY & INFORMATION 6

Listening- TED/Ink talks. **Speaking –** Making presentation on a given topic. **Reading –**Company profiles, Statement of Purpose, (SOP), **Writing –** Relative Clauses, If conditions, Cause and Effect. Chart Interpretations - Bar Chart, Pie Chart, Flow Chart & Tables.

TOTAL: 30 PERIODS

COURSE OUTCOMES:

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

CO1 : Compare and contrast products and ideas in technical texts.

CO2 : Identify cause and effects in events, industrial processes through technical texts.

CO3: Analyze problems in order to arrive at feasible solutions and communicate them orally and in the written format.

CO4: Motivate students to write reports and winning job applications.

CO5: Recall and comprehend different discourses and genres of texts.

CO6: Making the students to become virtuous presenters.

TEXT BOOKS:

1. English for Engineers & Technologists (2020 edition) Orient Blackswan Private Ltd. Department of English, Anna University.
2. English for Science & Technology Cambridge University Press 2021.
3. Authored by Dr. VeenaSelvam, Dr. SujathaPriyadarshini, Dr. Deepa Mary Francis, Dr. KN. Shoba, and Dr. Lourdes Joevani, Department of English, Anna University.

REFERENCE BOOKS:

1. Raman. Meenakshi, Sharma. Sangeeta (2019). Professional English. Oxford university press. New Delhi.
2. Improve Your Writing ed. V.N. Arora and Laxmi Chandra, Oxford Univ. Press, 2001, New Delhi.
3. Learning to Communicate – Dr. V. Chellammal. Allied Publishers, New Delhi, 2003
4. Business Correspondence and Report Writing by Prof. R.C. Sharma & Krishna Mohan, Tata McGraw Hill & Co. Ltd., 2001, New Delhi.
5. Developing Communication Skills by Krishna Mohan, MeeraBannerji- Macmillan India Ltd. 1990, Delhi.

U23MAT22	STATISTICS AND NUMERICAL METHODS	L	T	P	C
		3	1	0	4

COURSE OBJECTIVES:

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

1. This course aims at providing the necessary basic concepts of a few statistical tools and give procedures for solving different kinds of problems occurring in engineering and technology.
2. To acquaint the knowledge of classifications of design of experiments in the field of agriculture.
3. To introduce the basic concepts of solving algebraic and transcendental equations.
4. To introduce the numerical techniques of interpolation in various intervals and numerical techniques of differentiation and integration which plays an important role in engineering and technology disciplines.
5. To acquaint the knowledge of various techniques and methods of solving ordinary differential equations.

UNIT I TESTING OF HYPOTHESIS 12

Introduction – Sampling distributions – Tests for single mean, proportion and difference of means (Large and small samples) – Tests for single variance and equality of variances – Chi square test for goodness of fit – Independence of attributes.

UNIT II DESIGN OF EXPERIMENTS 12

Introduction – Analysis of variance – One way and two way classifications – Completely randomized design – Randomized block design – Latin square design.

UNIT III SOLUTION OF EQUATIONS AND EIGEN VALUE PROBLEMS 12

Solution of algebraic and transcendental equations – Fixed point iteration method – Newton Raphson method – Solution of linear system of equations – Gauss elimination method – Gauss Jordan method – Iterative methods of Gauss Jacobi and Gauss Seidel - Eigen Value of a matrices by power method and jacobi's method for Symmetric matrices.

UNIT IV INTERPOLATION, NUMERICAL DIFFERENTIATION AND INTEGRATION 12

Lagrange's and Newton's divided difference interpolations – Newton's forward and backward difference interpolation – Approximation of derivatives using interpolation polynomials – Numerical single and double integrations using Trapezoidal and Simpson's 1/3 rules.

UNITV NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS 12

Single step methods : Taylor's series method – Euler's method – Modified Euler's method – Fourth order Runge – Kutta method for solving first order differential equations – Multi step methods : Milne's and Adams Bashforth predictor corrector methods for solving first order differential equations.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

CO1 : Apply the concept of testing of hypothesis for small and large samples in real life problems.

CO2 : Apply the basic concepts of classifications of design of experiments in the field of agriculture.

CO3: Solve the algebraic and transcendental equations.

CO4: Understand the knowledge of numerical techniques of interpolation in various intervals and apply the numerical techniques of differentiation and integration for engineering problems.

CO5: Solve the ordinary differential equations with initial and boundary conditions by using certain techniques with engineering applications.

CO6: Understand the knowledge of various techniques and methods for solving first and second order ordinary differential equations.

TEXT BOOKS:

1. Grewal, B.S., and Grewal, J.S., "Numerical Methods in Engineering and Science", Khanna Publishers, 10th Edition, New Delhi, 2015.
2. Johnson , R.A., Miller, I and Freund J., “Miller and Freund’s Probability and Statistics for Engineers", Pearson Education, Asia, 8th Edition, 2015.

REFERENCE BOOKS:

1. Burden,R.L and Faires, J.D, "Numerical Analysis”, 9th Edition, Cengage Learning, 2016.
2. Devore. J.L., "Probability and Statistics for Engineering and the Sciences”, Cengage Learning, New Delhi , 8th Edition, 2014.
3. Gerald. C.F. and Wheatley. P.O. "Applied Numerical Analysis” Pearson Education, Asia, New Delhi, 7th Edition, 2007.
4. Gupta S.C. and Kapoor V.K., “Fundamentals of Mathematical Statistics”, Sultan Chand & Sons, New Delhi,12th Edition, 2020.
5. Spiegel.M.R.,Schiller.J. and Srinivasan. R.A., "Schaum’s Outlines on Probability and Statistics", Tata McGraw Hill Edition, 4th Edition, 2012.

U23GET15	PROBLEM SOLVING AND PYTHON PROGRAMMING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

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

1. To understand the basics of algorithmic problem solving.
2. To learn to solve problems using Python conditionals and loops.
3. To define Python functions and use function calls to solve problems.
4. To use Python data structures - lists, tuples, dictionaries to represent complex data.
5. To do input/output with files in Python.

UNIT I COMPUTATIONAL THINKING AND PROBLEM SOLVING 9

Fundamentals of Computing – Identification of Computational Problems -Algorithms, building blocks of algorithms (statements, state, control flow, functions), notation (pseudo code, flow chart, programming language), algorithmic problem solving, simple strategies for developing algorithms (iteration, recursion). Illustrative problems: find minimum in a list, insert a card in a list of sorted cards, guess an integer number in a range, Towers of Hanoi.

UNIT II DATA TYPES, EXPRESSIONS, STATEMENTS 9

Python interpreter and interactive mode, debugging; values and types: int, float, boolean, string, and list; variables, expressions, statements, tuple assignment, precedence of operators, comments; Illustrative programs: exchange the values of two variables, circulate the values of n variables, distance between two points.

UNIT III CONTROL FLOW, FUNCTIONS, STRINGS 9

Conditionals: Boolean values and operators, conditional (if), alternative (if-else),chained conditional (if-elif-else);Iteration: state, while, for, break, continue, pass; Fruitful functions: return values, parameters, local and global scope, function composition, recursion; Strings: string slices, immutability, string functions and methods, string module; Lists as arrays. Illustrative programs: square root, gcd, exponentiation, sum an array of numbers, linear search, binary search.

UNIT IV LISTS, TUPLES, DICTIONARIES 9

Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters; Tuples: tuple assignment, tuple as return value; Dictionaries: operations and methods; advanced list processing - list comprehension; Illustrative programs: simple sorting, histogram, Students marks statement, Retail bill preparation.

UNITV FILES, MODULES, PACKAGES 9

Files and exceptions: text files, reading and writing files, format operator; command line arguments, errors and exceptions, handling exceptions, modules, packages; Illustrative programs: word count, copy file, Voter’s age validation, Marks range validation (0-100).

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- **CO1 :** Develop algorithmic solutions to simple computational problems.
- **CO2 :** Develop and execute simple Python programs.
- **CO3 :** Write simple Python programs using conditionals and loops for solving problems.
- **CO4 :** Decompose a Python program into functions.
- **CO5 :** Represent compound data using Python lists, tuples, dictionaries etc.
- **CO6 :** Read and write data from/to files in Python programs.

TEXT BOOKS:

1. Allen B. Downey, "Think Python: How to Think like a Computer Scientist", 2nd Edition, O'Reilly Publishers, 2016.
2. Karl Beecher, "Computational Thinking: A Beginner's Guide to Problem Solving and Programming", 1st Edition, BCS Learning & Development Limited, 2017.
3. Paul Deitel and Harvey Deitel, "Python for Programmers", Pearson Education, 1st Edition, 2021.
4. G Venkatesh and Madhavan Mukund, "Computational Thinking: A Primer for Programmers and Data Scientists", 1st Edition, Notion Press, 2021.

REFERENCE BOOKS:

1. John V Guttag, "Introduction to Computation and Programming Using Python'", Revised and expanded Edition, MIT Press , 2013
2. Robert Sedgewick, Kevin Wayne, Robert Dondero, "Introduction to Programming in Python: An Inter-disciplinary Approach", Pearson India Education Services Pvt. Ltd., 2016.
3. Kenneth A. Lambert, "Fundamentals of Python: First Programs", CENGAGE Learning, 2012.
4. Charles Dierbach, "Introduction to Computer Science using Python: A Computational Problem-Solving Focus", Wiley India Edition, 2013.

U23PHT23	APPLIED MATERIALS SCIENCE (COMMON TO AERO, AS, MECH, ROBO, CIVIL PROGRAMMES)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

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

1. To make the students to understand the basics of crystallography and its importance in studying materials properties.
2. To understand the electrical properties of materials including free electron theory, applications.
3. To expand their knowledge in applications of magnetic and superconducting materials.
4. To instill knowledge on physics of semiconductors, determination of charge carriersand device applications.
5. To inculcate an idea of significance of new materials, nanostructures ensuing nano device applications.

UNIT I CONDENSED MATTER PHYSICS 9

Introduction - Lattice - Unit Cell - Seven Crystal Systems -Bravai's Lattices - Lattice Planes - Calculation of Number of Atoms per Unit Cell, Atomic Radius, Coordination Number and Packing Factor for SC, BCC, FCC and HCP Structures. Miller Indices – Derivation for Inter-Planar Spacing in terms of Miller Indices-Crystal Growth Techniques: Melt Growth Technique (Bridgman and Czochralski Techniques).

UNIT II CONDUCTING AND INSULATING MATERIALS 9

Conducting Materials: Classical Free Electron Theory: Postulates – Derivation of Electrical Conductivity and Thermal Conductivity- Derivation. Wiedemann-Franz Law and Its Verification-Merits and Demerits of Classical Free Electron Theory. Density of States – Carrier Concentration in Metals.

Insulating Materials: Types of Polarization Mechanisms - Langevin- Debye Equation - Internal Field – Clausius - Mossotti Relation – Applications of Insulating Materials.

UNIT III MAGNETIC AND SUPERCONDUCTING MATERIALS 9

Magnetic Materials: Dia, Para and Ferromagnetic Materials and Its Properties – Ferromagnetic Domains – Wiess Theory of Ferromagnetism – Hysteresis - B-H Curve Studies – Soft and Hard Magnetic Materials- Applications.

Superconducting Materials: Properties – Type I and Type II Superconductors – London equations – Applications: Magnetic Levitated Train – Magnetic Resonance Imaging.

UNIT IV PHYSICS OF SEMICONDUCTOR 9

Introduction – Properties - Intrinsic Semiconductors – Energy Band Diagram – Direct and Indirect Band Gap Semiconductors – Carrier Concentration in Intrinsic Semiconductors – Extrinsic Semiconductors - Carrier Concentration in N-Type & P-Type Semiconductors – Variation of Carrier Concentration with Temperature – Carrier Transport in Semiconductors: Drift, Mobility and Diffusion – Hall Effect And Devices.

UNIT V MODERN ENGINEERING MATERIALS 9

Shape Memory Alloys – Structures – Properties – Applications. Metallic Glasses – Preparation and Applications. Ceramics – Types - Properties and Applications.

Nanomaterials – Types – Properties and Applications – Preparation Techniques: Electro deposition – Pulsed Laser Deposition. CNT – Structure – Types – Properties – Applications.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 : Know basics of crystallography and its importance for varied materials properties.

CO2 : Familiarize with theories of electrical and thermal conduction is solids, basic quantum mechanics, and energy bands.

CO3: Gain knowledge on the magnetic and superconductor properties of materials and theirapplications.

CO4: Acquire knowledge on basics of semiconductor physics and its applications in various devices.

CO5: Get knowledge on newly developed materials in micro and nano scale.

CO6: Understand the different structures of CNT in Nano range

TEXT BOOKS:

1. Charles Kittel, Introduction to Solid State Physics, Wiley India Edition, 2019.
2. Jasprit Singh, Semiconductor Devices: Basic Principles, Wiley (India), 2007.
3. G.W.Hanson. Fundamentals of Nanoelectronics. Pearson Education (Indian Edition), 2009.
4. Dr. P. Mani, “Physics for Electronics Engineering” Dhanam Publications, 2017.
5. Dr. G. Senthilkumar, “Engineering Physics II” VRB Publishers, 2013.

REFERENCE BOOKS:

1. R.Balasubramaniam, Callister’s Materials Science and Engineering. Wiley (Indian Edition), 2014.
2. Wendelin Wright and Donald Askeland, Essentials of Materials Science and Engineering, CL Engineering, 2013.
3. S. Rajivgandhi, Dr. I. Cicil Ignatius & A. Ravikumar, “ Engineering Physics II”, RK Publications, 2023
4. Robert F. Pierret, Semiconductor Device Fundamentals, Pearson, 2006.
5. Ben Rogers, Jesse Adams and Sumita Pennathur, Nanotechnology: Understanding Small Systems, CRC Press, 2017.

U23EET23	BASIC ELECTRICAL AND ELECTRONICS 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. To introduce the basics of electric circuits and analysis
2. To impart knowledge in the basics of working principles and application of electrical machines
3. To introduce analog devices and their characteristics
4. To educate on the fundamental concepts of digital electronics
5. To introduce the functional elements and working of measuring instruments

UNIT I ELECTRICAL CIRCUITS 9

DC Circuits: Circuit Components: Conductor, Resistor, Inductor, Capacitor – Ohm's Law - Kirchhoff's Laws –Independent and Dependent Sources – Simple problems- Nodal Analysis, Mesh analysis with Independent sources only (Steady state)

Introduction to AC Circuits and Parameters: Waveforms, Average value, RMS Value, Instantaneous power, real power, reactive power and apparent power, power factor – Steady state analysis of RLC circuits (Simple problems only)

UNIT II ELECTRICAL MACHINES 9

Construction and Working principle- DC Separately and Self excited Generators, EMF equation, Types and Applications. Working Principle of DC motors, Torque Equation, Types and Applications. Construction, Working principle and Applications of Transformer, Three phase Alternator, Synchronous motor and Three Phase Induction Motor

UNIT III ANALOG ELECTRONICS 9

Resistor, Inductor and Capacitor in Electronic Circuits- Semiconductor Materials: Silicon & Germanium – PN Junction Diodes, Zener Diode – Characteristics Applications – Bipolar Junction Transistor-Biasing, JFET, SCR, MOSFET,IGBT – Types, I-V Characteristics and Applications, Rectifier and Inverters

UNIT IV DIGITAL ELECTRONICS 9

Review of number systems, binary codes, error detection and correction codes, Combinational logic - representation of logic functions - SOP and POS forms, K-map representations - minimization using K maps (Simple Problems only)

UNITV MEASUREMENTS AND INSTRUMENTATION 9

Functional elements of an instrument, Standards and calibration, Operating Principle, types – Moving Coil and Moving Iron meters, Measurement of three phase power, Energy Meter, Instrument Transformers - CT and PT, DSO - Block diagram - Data acquisition.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Compute the electric circuit parameters for simple problems
CO2: Explain the working principle of electrical machines
CO3: Explain the applications of electrical machines
CO4: Analyze the characteristics of analog electronic devices
CO5: Explain the basic concepts of digital electronics
CO6: Explain the operating principles of measuring instruments

TEXT BOOKS:

1. Kothari DP and I.J Nagrath, "Basic Electrical and Electronics Engineering", Second Edition, McGraw Hill Education, 2020
2. S.K.Bhattacharya "Basic Electrical and Electronics Engineering", Pearson Education, Second Edition, 2017.
3. Sedha R.S., "A textbook book of Applied Electronics", S. Chand & Co., 2008.
4. James A .Svoboda, Richard C. Dorf, "Dorf's Introduction to Electric Circuits", Wiley, 2018.
5. A.K. Sawhney, Puneet Sawhney 'A Course in Electrical & Electronic Measurements & Instrumentation', Dhanpat Rai and Co, 2015.

REFERENCE BOOKS:

1. Kothari DP and I.J Nagrath, "Basic Electrical Engineering", Fourth Edition, McGraw Hill Education, 2019.
2. Thomas L. Floyd, 'Digital Fundamentals', 11th Edition, Pearson Education, 2017.
3. Albert Malvino, David Bates, 'Electronic Principles, McGraw Hill Education; 7th edition, 2017.
4. Mahmood Nahvi and Joseph A. Edminister, "Electric Circuits", Schaum' Outline Series, McGraw Hill, 2002.
5. H.S. Kalsi, 'Electronic Instrumentation', Tata McGraw-Hill, New Delhi, 2010

U23MET21	ENGINEERING MECHANICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

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

1. To Learn the use scalar and vector analytical techniques for analysing forces in statically determinate structures.
2. To introduce the equilibrium of rigid bodies, vector methods and free body diagram.
3. To study and understand the distributed forces, surface, loading on beam and intensity.
4. To learn the principles of friction, forces and to determine the apply the concepts of frictional forces at the contact surfaces of various engineering systems.
5. To develop basic dynamics concepts – force, momentum, work and energy.

UNIT I STATICS OF PARTICLES 9

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 9

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.

UNIT III DISTRIBUTED FORCES 9

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 9

The Laws of Dry Friction, Coefficients of Friction, Angles of Friction, Wedge friction, Wheel Friction, Rolling Resistance, Ladder friction.

UNITV DYNAMICS OF PARTICLES 9

Kinematics - Rectilinear Motion and Curvilinear Motion of Particles. Kinetics- Newton's Second Law of Motion -Equations of Motions, Dynamic Equilibrium, Energy and Momentum Methods - Work of a Force, Kinetic Energy of a Particle, Principle of Work and Energy, Principle of Impulse and Momentum, Impact of bodies.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- **CO1 :** Illustrate the vector and scalar representation of forces and moment
- **CO2 :** Analyse the rigid body in equilibrium
- **CO3:** Evaluate the properties of distributed forces
- **CO4:** Determine the friction and the effects by the laws of friction
- **CO5:** Calculate dynamic forces exerted in rigid body
- **CO6:** Apply the concepts of mechanics and work in force analysis

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., 12thEdition, 2019.
2. Vela Murali, "Engineering Mechanics-Statics and Dynamics", Oxford University Press, 2018.

REFERENCE BOOKS:

1. Boresi P and Schmidt J, Engineering Mechanics: Statics and Dynamics, 1/e, Cengage learning, 2008.
2. Hibbeller, R.C., Engineering Mechanics: Statics, and Engineering Mechanics: Dynamics, 13th edition, Prentice Hall, 2013.
3. Irving H. Shames, Krishna Mohana Rao G, Engineering Mechanics – Statics and Dynamics, 4thEdition, Pearson Education Asia Pvt. Ltd., 2005.

GE3252	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 Nayakar Mahal - Chetti Nadu Houses, Indo - Saracenic architecture at Madras during British Period.

UNIT III MANUFACTURING TECHNOLOGY 3

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

UNIT IV AGRICULTURE AND IRRIGATION TECHNOLOGY 3

Dam, Tank, ponds, Sluice, Significance of Kumizhi Thoompu of Chola Period, Animal Husbandry - Wells designed for cattle use - Agriculture and Agro Processing - Knowledge of Sea - Fisheries – Pearl - Conche diving - Ancient Knowledge of Ocean - Knowledge Specific Society.

UNIT V SCIENTIFIC TAMIL & TAMIL COMPUTING 3

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

TOTAL: 15 PERIODS

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 Civilization 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) (Published by: 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.

U23GEP13	PROBLEM SOLVING AND PYTHON PROGRAMMING LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES

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

1. To understand the problem solving approaches.
2. To learn the basic programming constructs in Python.
3. To practice various computing strategies for Python-based solutions to real world problems.
4. To use Python data structures - lists, tuples, dictionaries.
5. To do input/output with files in Python.

LIST OF EXPERIMENTS

1. Identification and solving of simple real life or scientific or technical problems, and developing flow charts for the same. (Electricity Billing, Retail shop billing, Sin series, weight of a motorbike, Weight of a steel bar, compute Electrical Current in Three Phase AC Circuit, etc.)
2. Python programming using simple statements and expressions (exchange the values of two variables, circulate the values of n variables, distance between two points).
3. Scientific problems using Conditionals and Iterative loops. (Number series, Number Patterns, pyramid pattern)
4. Implementing real-time/technical applications using Lists, Tuples. (Items present in a library/Components of a car/ Materials required for construction of a building –operations of list & tuples)
5. Implementing real-time/technical applications using Sets, Dictionaries. (Language, components of an automobile, Elements of a civil structure, etc.- operations of Sets & Dictionaries)
6. Implementing programs using Functions. (Factorial, largest number in a list, area of shape)
7. Implementing programs using Strings. (reverse, palindrome, character count, replacing characters)
8. Implementing programs using written modules and Python Standard Libraries (pandas, numpy. Matplotlib, scipy)
9. Implementing real-time/technical applications using File handling. (copy from one file to another, word count, longest word)
10. Implementing real-time/technical applications using Exception handling. (divide by zero error, voter’s age validity, student mark range validation)
11. Exploring Pygame tool.
12. Developing a game activity using Pygame like bouncing ball, car race etc.

TOTAL: 60 PERIODS

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

Sl no	Name of the Equipment	Quantity
1.	Intel Desktop System With Suitable software	30

COURSE OUTCOMES:

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

CO1 : Develop algorithmic solutions to simple computational problems

CO2 : Develop and execute simple Python programs.

CO3: Implement programs in Python using conditionals and loops for solving problems.

CO4: Deploy functions to decompose a Python program.

CO5: Process compound data using Python data structures.

CO6: Utilize Python packages in developing software applications.

U23EEP22	BASIC ELECTRICAL AND ELECTRONICS ENGINEERING LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES

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

1. Using experimental methods to verify the Ohm's.
2. Analysing the behaviour of digital devices.
3. Conducting load tests on electrical machines.
4. Gaining practical experience in characterizing electronic devices.
5. Using DSO for measurements.

LIST OF EXPERIMENTS

1. Verification of ohms and Kirchhoff's Laws.
2. Load test on DC Shunt Motor.
3. Load test on Self Excited DC Generator.
4. Load test on Single phase Transformer
5. Load Test on Induction Motor
6. Characteristics of PN and Zener Diodes
7. Characteristics of BJT, SCR and MOSFET
8. Half wave and Full Wave rectifiers
9. Study of Logic Gates
10. Implementation of Binary Adder and Subtractor
11. Study of DSO

TOTAL: 60 PERIODS

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

Sl. No.	Name of the Equipment	Quantity
1.	DC Regulated Power supply (0 - 30 V variable)	1
2.	DC shunt generator (0- 300V)	1
3.	Wattmeter – 300V, 30 A	1
4.	Single phase Induction motor	1
5.	PN Diodes and Zener diodes	As Required
6.	SCR, MOSFET and transistors	As Required
7.	IC 7400, 7402, 7404,7408,7432,7486	As Required
8.	Transistor	As Required
9.	Resistors	As Required
10.	Ammeter MC	As Required
11.	Voltmeter MC	As Required
12.	Rheostats	As Required
13.	Tachometer	As Required
14.	Connecting wires	As Required

COURSE OUTCOMES:

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

CO1 : Use experimental methods to verify the Ohm's Laws.
CO2 : Use experimental methods to verify the Kirchhoff's Laws.
CO3: Analyze experimentally the load characteristics of electrical machines.
CO4: Analyze the characteristics of basic electronic devices.
CO5: Analyze the behavior of digital devices.
CO6: Use DSO to measure the various parameters.

	L	T	P	C
U23HSP22 COMMUNICATION LABORATORY (COMMON TO ALL B.E. / B.TECH. PROGRAMMES)	**0**	**0**	**4**	**2**

COURSE OBJECTIVES:

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

1. To identify varied group discussion skills and apply them to take part in effective discussions in a professional context.
2. To be able to communicate effectively through writing.
3. Encouraging plan designing and decision making.
4. Understanding and writing technical instruction.
5. To understand the value of letter writing with correct format.

LIST OF EXPERIMENTS:

1. Speaking-Role Play Exercises Based on Workplace Contexts.
2. Talking about competition.
3. Discussing progress toward goals-talking about experiences.
4. Discussing likes and dislikes.
5. Discussing feelings about experiences.
6. Discussing imaginary scenarios.
7. Writing short essays.
8. Speaking about the natural environment.
9. Describing communication system.
10. Describing position and movement- explaining rules.
11. Understanding technical instructions-Writing: writing instructions.
12. Speaking: describing things relatively-describing clothing.
13. Discussing safety issues (making recommendations) talking about electrical devices.
14. Describing controlling actions.
15. Writing a job application (Cover letter + Resume).

TOTAL: 60 PERIODS

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

Sl no	Name of the Equipment	Quantity
1.	Communication laboratory with sufficient computer systems	**30**
2.	Server	**1**
3.	Head phone	**30**
4.	Audio mixture	**1**
5.	Collar mike	**1**
6.	Television	**1**
7.	Speaker set with amplifier	**1**
8.	Power point projector and screen	**1**
9.	Cordless mike	**1**

COURSE OUTCOMES:

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

CO1 : Distinguish their technical competency through language skill.

CO2 : Predict context effectively in-group discussions held in a formal / semi-formal discussions.

CO3: Understanding candidates' key characteristics.

CO4: Finding personality traits by sharing and comparing thoughts and ability.

CO5: Understanding the value of ethics.(rules and regulations).

CO6: Construct emails and effective job applications**.**

SEMESTER-III

U23MAT31	TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS	L	T	P	C
		3	1	0	4

COURSE OBJECTIVES

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

1. Introduce the basic concepts of PDE for solving standard partial differential equations.
2. Illustrate the concepts and techniques of Fourier series.
3. Discuss the concepts of Fourier transforms and Z-transforms.
4. Describe the solutions of partial differential equations.
5. Formulate and solve the boundary value problems.

UNIT I PARTIAL DIFFERENTIAL EQUATIONS 9+3

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

UNIT II FOURIER SERIES 9+3

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

UNIT III APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS 9+3

Classification of PDE – Method of separation of variables - Fourier series solutions of one-dimensional wave equation – One dimensional equation of heat conduction – Steady state solution of two-dimensional equation of heat conduction (Cartesian coordinates only).

UNIT IV FOURIER TRANSFORM 9+3

Statement of Fourier integral theorem– Fourier transform pair – Fourier sine and cosine transforms – Properties – Transforms of simple functions – Convolution theorem – Parseval's identity.

UNITV Z - TRANSFORMS AND DIFFERENCE EQUATIONS 9+3

Z-transforms - Elementary properties – Convergence of Z-transforms - – Initial and final value theorems - Inverse Z-transform using partial fraction and convolution theorem - Formation of difference equations – Solution of difference equations using Z - transforms.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

CO1 : Solve Linear Partial differential equations of first and second order.

CO2 : Identify the concepts of Fourier series expansion for even and odd functions.

CO3: Apply the concepts of Fourier series in solving boundary value problems.

CO4: Analyze Fourier Sine and Cosine transforms to identify the Fourier transform.

CO5: Make use of the concepts of the Z-Transform when dealing with discrete-time systems.

CO6: Apply transforms techniques in modeling physical processes like Heat Conduction, Communications systems and Electromagnetic Theory.

TEXT BOOKS:

1. Grewal B.S., “Higher Engineering Mathematics", 44th Edition, Khanna Publishers, New Delhi, 2018.
2. Kreyszig E, "Advanced Engineering Mathematics ", 10th Edition, John Wiley, New Delhi, India, 2018.

REFERENCE BOOKS:

1. Andrews. L.C and Shivamoggi. B, "Integral Transforms for Engineers" SPIE Press, 1999.
2. Bali. N.P and Manish Goyal, "A Textbook of Engineering Mathematics", 10th Edition, Laxmi Publications Pvt. Ltd, 2021.
3. James. G., "Advanced Modern Engineering Mathematics", 4thEdition, Pearson Education, New Delhi, 2016.
4. Narayanan. S., Manicavachagom Pillay.T.K and Ramanaiah.G "Advanced Mathematics for Engineering Students", Vol. II & III, S.Viswanathan Publishers Pvt. Ltd, Chennai, 1998.
5. Ramana. B.V., "Higher Engineering Mathematics", McGraw Hill Education Pvt. Ltd, New Delhi, 2018.
6. Wylie. R.C. and Barrett. L.C., “Advanced Engineering Mathematics “Tata McGraw Hill Education Pvt. Ltd, 6th Edition, New Delhi, 2012.

U23MET31	ENGINEERING THERMODYNAMICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

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

1. Impart knowledge on the basics and application of zeroth and first law of thermodynamics.
2. Impart knowledge on the second law of thermodynamics in analysing the performance of thermal devices.
3. Impart knowledge on availability and applications of second law of thermodynamics
4. Teach the various properties of steam through steam tables and Mollier chart.
5. Impart knowledge on the macroscopic properties of ideal and real gases.

(**Use of Standard and approved Steam Table, Mollier Chart, Compressibility Chart and Psychrometric Chart permitted)**

UNIT I BASICS, ZEROTH AND FIRST LAW 9

Review of Basics – 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 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.

UNIT III AVAILABILITY AND APPLICATIONS OF SECOND LAW 9

Ideal gases undergoing different processes - principle of increase in entropy. Applications of second Law. High-and low-grade energy. Availability and Irreversibility for open and closed system processes – First and Second law Efficiency.

UNIT IV PROPERTIES OF PURE SUBSTANCES 9

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

UNITV GAS MIXTURES AND THERMODYNAMIC RELATIONS 9

Properties of Ideal gas, real gas - comparison. Equations of state for ideal and real gases. vander Waal's relation - Reduced properties - Compressibility factor - Principle of Corresponding states - Generalized Compressibility Chart. 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 : Explain the basic concepts and laws of thermodynamics.

CO2 : Apply the second law of thermodynamics in analysing the performance of thermal devices through energy and entropy calculations.

CO3: Apply the second law of thermodynamics in evaluating the various properties of steam through steam tables and Mollier chart.

CO4: Apply the properties of pure substance in computing the macroscopic properties of ideal and real gases using gas laws and appropriate thermodynamic relations.

CO5: Apply the properties of gas mixtures in calculating the properties of gas mixtures

CO6: Apply thermodynamic laws for real time applications

TEXT BOOKS:

1. Nag.P.K., "Engineering Thermodynamics", 6th Edition, Tata McGraw Hill (2017), New Delhi.
2. R.K.Rajput, ―A Text Book Of Engineering Thermodynamics ―, Fifth Edition, 2017.

REFERENCE BOOKS:

1. Cengel, Y and M. Boles, Thermodynamics - An Engineering Approach, Tata McGraw Hill,9th Edition, 2019.
2. Chattopadhyay, P, "Engineering Thermodynamics", 2nd Edition Oxford University Press, 2016.
3. Rathakrishnan, E., "Fundamentals of Engineering Thermodynamics", 2nd Edition, Prentice Hall of India Pvt. Ltd, 2006.
4. Claus Borgnakke and Richard E. Sonntag, "Fundamentals of Thermodynamics", 10th Edition, WileyEastern, 2019.
5. Venkatesh. A, "Basic Engineering Thermodynamics", Universities Press (India) Limited, 2007

U23MET32	FLUID MECHANICS AND MACHINERY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

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

1. Classify various types of fluids with their properties and concept of control volume.
2. Apply the law of conservation to flow through pipes.
3. Discuss the importance of dimensional and model analysis.
4. Explain the various types of turbines and their performance.
5. Discuss the various types of pumps and draw their performance curve.

UNIT I FLUID PROPERTIES AND FLOW CHARACTERISTICS 9

Properties of fluids – Fluid statics - Pressure Measurements - Buoyancy and floatation - Flow characteristics - Eulerian and Lagrangian approach - Concept of control volume and system - Reynold's transportation theorem - Continuity equation, energy equation and momentum equation - Applications.

UNIT II FLOW THROUGH PIPES AND BOUNDARY LAYER 9

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

UNIT III DIMENSIONAL ANALYSIS AND MODEL STUDIES 9

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

UNIT IV TURBINES 9

Impact of jets - Velocity triangles - Theory of roto dynamic machines - Classification of turbines - Working principles - Pelton wheel - Modern Francis turbine - Kaplan turbine - Work done - Efficiencies - Draft tube - Specific speed - Performance curves for turbines - Governing of turbines.

UNITV PUMPS 9

Classification of pumps - Centrifugal pumps - Working principle - Heads and efficiencies– Velocity triangles - Work done by the impeller - Performance curves - Reciprocating pump working principle - Indicator diagram and it's variations - Work saved by fitting air vessels - Rotary pumps.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 : Solve the fluid properties and flow characteristics

CO2 : Build the flow of fluid in circular conduits

CO3: Explain the importance of dimensional and model analysis

CO4: Summarize the performance of impulse and reaction turbines

CO5: Classify the centrifugal and reciprocating pumps using velocity triangles

CO6: Develop the flow characteristics and performance of hydraulic machines for real time applications

TEXT BOOKS:

1. Modi P.N. and Seth, S.M. Hydraulics and Fluid Mechanics, Standard Book House, New Delhi, 22nd edition (2019).
2. Jain A. K. Fluid Mechanics including Hydraulic Machines, Khanna Publishers, New elhi, 2014.
3. Bansal, R.K., "Fluid Mechanics and Hydraulic Machines", Laxmi Publications (P) Ltd., 2019

REFERENCE BOOKS:

1. Fox W.R. and McDonald A.T., Introduction to Fluid Mechanics John-Wiley and Sons, Singapore, 2011.
2. Pani B S, Fluid Mechanics: A Concise Introduction, Prentice Hall of India Private Ltd, 2016.
3. Cengel Y A and Cimbala J M, Fluid Mechanics, McGraw Hill Education Pvt. Ltd., 2014.
4. S K Som; Gautam Biswas and S Chakraborty, Introduction to Fluid Mechanics and Fluid Machines, Tata McGraw Hill Education Pvt. Ltd., 2012.
5. Streeter, V. L. and Wylie E. B., Fluid Mechanics, McGraw Hill Publishing Co., 2010.

U23MET34	ENGINEERING MATERIALS AND METALLURGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

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

1. Explain the principles of constitution of alloys, phase diagrams, and Iron carbide Equilibrium Diagram.
2. Classify various types of Heat treatment process and its applications.
3. Discuss the properties and applications of Ferrous and Nonferrous metals.
4. Summarize the properties of Non-metallic materials and applications.
5. Select the suitable materials for various 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, Iron – Iron carbide equilibrium diagram. Classification of steel and cast-Iron microstructure, properties and application.

UNIT II HEAT TREATMENT 9

Definition – Full annealing, stress relief, recrystallisation and spheroidising –normalizing, hardening and tempering of steel. Isothermal transformation diagrams – cooling curves superimposed on I.T. diagram– continuous cooling Transformation (CCT) diagram – Austempering, Martempering – Hardenability, Jominy end quench test -case hardening, carburizing, Nitriding, cyaniding, carbonitriding – Flame and Induction hardening – Vacuum and Plasma hardening – Thermo-mechanical treatments- elementary ideas on sintering.

UNIT III FERROUS AND NON-FERROUS METALS 9

Effect of alloying additions on steel (Mn, Si, Cr, Mo, Ni, V, Ti & W) – stainless and tool steels – HSLA - Maraging 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-overview of materials standards.

UNIT IV NON-METALLIC MATERIALS 9

Polymers – types of polymers, commodity and engineering polymers – Properties and applications of PE, PP, PS, PVC, PMMA, PET, PC, PA, ABS, PAI, PPO, PPS, PEEK, PTFE, Thermoset polymers – Urea and Phenol formaldehydes –Nylon, Engineering Ceramics – Properties and applications of Al_2O_3, SiC, Si_3N_4, PSZ and SIALON – intermetallics- Composites- Matrix and reinforcement Materials-applications of Composites - Nano composites.

UNITV MECHANICAL PROPERTIES AND DEFORMATION MECHANISMS 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, Micro and nano-hardness tests, Impact test lzod and charpy, fatigue and creep failure mechanisms.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 : Explain alloys and phase diagram, Iron-Iron carbon diagram and steel classification.

CO2 : Explain isothermal transformation, continuous cooling diagrams and different heat treatment processes.

CO3: Clarify the effect of alloying elements on ferrous and non-ferrous metals.

CO4: Summarize the properties and applications of non-metallic materials.

CO5: Explain the testing of mechanical properties.

CO6: Explain fatigue and creep failure mechanisms.

TEXT BOOKS:

1. Kenneth G.Budinski and Michael K. Budinski, "Engineering Materials", Prentice Hall of India Private Limited, 9th edition ,2018.
2. Avner, S.H., ―Introduction to Physical Metallurgy‖, McGraw Hill Book Company, 2017.

REFERENCE BOOKS:

1. A. Alavudeen, N. Venkateshwaran, and J. T.WinowlinJappes, A Textbook of Engineering Materials and Metallurgy, Laxmi Publications, 2006.
2. Amandeep Singh Wadhwa, andHarvinder Singh Dhaliwal, A Textbook of Engineering Material and Metallurgy, University Sciences Press, 2008.
3. G.S. Upadhyay and Anish Upadhyay, "Materials Science and Engineering", Viva Books Pvt.Ltd, New Delhi, 2020.
4. Raghavan.V, "Materials Science and Engineering", Prentice Hall of India Pvt.Ltd. 6th edition, 2019.
5. Williams D Callister, "Material Science and Engineering" Wiley India Pvt Ltd, 2nd edition Re print 2019.

U23MET35	MANUFACTURING PROCESSES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

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

1. Illustrating the working principles of various metal casting processes
2. Learning and applying the working principles of various metal joining processes.
3. Analyzing the working principles of bulk deformation of metals.
4. Learning the working principles of the sheet metal forming process.
5. Studying and practicing the working principles of plastic molding.

UNIT I METAL CASTING PROCESSES 9

Sand Casting – Sand Mould – Type of patterns - Pattern Materials – Pattern allowances – Molding sand Properties and testing – Cores –Types and applications – Molding machines – Types and applications– Melting furnaces – Principle of special casting processes- Shell, investment – Ceramic mould – Pressure die casting – low pressure, gravity- Tilt pouring, high pressure die casting- Centrifugal Casting – CO_2 casting –-Defects in Sand casting process-remedies

UNIT II METAL JOINING PROCESSES 9

Fusion welding processes – Oxy fuel welding – Filler and Flux materials-–Arc welding, Electrodes, Coating and specifications – Gas Tungsten arc welding –Gas metal arc welding - Submerged arc welding – Electro slag welding– Plasma arc welding — Resistance welding Processes -Electron beam welding –Laser beam Welding Friction welding – Friction stir welding – Diffusion welding – Thermit Welding, Weld defects – inspection &remedies – Brazing - soldering – Adhesive bonding.

UNIT III BULK DEFORMATION PROCESSES 9

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

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 – Metal spinning – Introduction of Explosive forming, magnetic pulse forming, peen forming, Super plastic forming – Micro forming – Incremental forming.

UNITV MANUFACTURE OF PLASTIC COMPONENTS 9

Introduction, Types and characteristics of plastics – Molding of thermoplastics & Thermosetting polymers– 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 – Thermoforming – Bonding of Thermoplastics- duff moulding.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 : Explain the principle of different metal casting processes.

CO2 : Describe the various metal joining processes.

CO3: Illustrate the different bulk deformation processes.

CO4: Apply the various sheet metal forming process.

CO5: Apply suitable molding technique for manufacturing of plastics components

CO6: Explain the process involved in blow moulding.

TEXT BOOKS:

1. Kalpakjian. S, "Manufacturing Engineering and Technology", Pearson Education India,4th Edition, 2013.
2. P.N.Rao Manufacturing Technology Volume 1 Mc Grawhill Education 5th edition,2018.

REFERENCE BOOKS:

1. Roy. A. Lindberg, Processes and materials of manufacture, PHI / Pearson education, 2006.
2. S. Gowri P. Hariharan, A.Suresh Babu, Manufacturing Technology I, Pearson Education, 2008.
3. Paul Degarma E, Black J.T and Ronald A. Kosher, Eighth Edition, Materials and Processes, in Manufacturing, Eight Edition, Prentice – Hall of India, 1997.
4. Sharma, P.C., A Text book of production Technology, S.Chand and Co. Ltd., 2004.

U23MEP31	COMPUTER AIDED MACHINE DRAWING LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES

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

1. To acquaint the skills and practical experience in handling 2D drafting and 3D modelling software systems, standard drawing practices using fits and tolerances.
2. To prepare assembly drawings both manually and using standard CAD packages.
3. To Preparing standard drawing layout for modeled parts, assemblies with BoM.
4. To gain proficiency in 2D drafting techniques, including drawing, editing, dimensioning, layering, hatching, and detailing.
5. To apply acquired knowledge and skills to create assembly drawings manually and using CAD software, effectively communicating design intent.

PART I DRAWING STANDARDS & FITS AND TOLERANCES

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 IS919- Specification of Fits – Preparation of production drawings and reading of part and assembly drawings, basic principles of Geometric Dimensioning &Tolerancing.

PART II 2D DRAFTING

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, Lathe Tail 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: 60 PERIODS

COURSE OUTCOMES:

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

CO1 : Discuss the various CAD standards

CO2 : Explain the basic principles of geometric dimensioning & tolerance.

CO3: Show the Detailed drawing.

CO4: Classify the bearings and valves.

CO5: Explain the various feature used in 3D modeling.

CO6: Build the various components in 3D modeling.

U23MEP32	MANUFACTURING TECHNOLOGY LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES

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

1. Selecting appropriate tools, equipment's and machines to complete a given job.
2. Performing various welding process using GMAW and fabricating gears using gear making machines.
3. Performing various machining process such as rolling, drawing, turning, shaping, drilling, milling and analysing the defects in the cast and machined components.
4. Gain proficiency in lathe machine operations for thread cutting and knurling.
5. Acquire skills in pattern making and mould preparation for casting.

LIST OF EXPERIMENTS

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

TOTAL: 60 PERIODS

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

Sl no	Name of the Equipment	Quantity
1.	Centre Lathes	7 Nos
2.	Shaper	1Nos
3.	Horizontal Milling Machine	1Nos
4.	Vertical Milling Machine	1Nos
5.	Surface Grinding Machine	1Nos
6.	Cylindrical Grinding Machine	1Nos
7.	Radial Drilling Machine	1Nos
8.	Lathe Tool Dynamometer	1Nos
9.	Milling Tool Dynamometer	1Nos
10.	Gear Hobbing Machine	1Nos
11.	Gear Shaping Machine	1Nos
12.	Arc welding transformer with cables and holders	2 Nos
13.	Oxygen and Acetylene gas cylinders, blow pipe and other welding outfit	1Nos
14.	Moulding table, Moulding equipments	2 Nos

COURSE OUTCOMES:

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

CO1 : Demonstrate the working of lathe machine.

CO2 : Interpret the various operations performed in Lathe machines.

CO3: Identify tool life, tool wear and forces in metal cutting.

CO4: Choose suitable manufacturing techniques to manufacture different products.

CO5: Construct to join the metals using arc welding.

CO6: Make use of different moulding tools, patterns and prepare sand moulds.

GE3361 PROFESSIONAL DEVELOPMENT

L	T	P	C
0	0	2	1

COURSE OBJECTIVES

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

1. Gain proficiency in using MS WORD to create high-quality technical documents, effectively utilizing standard templates, widely accepted styles, and formats to enhance the content's presentability and overall utility value.
2. To be proficient Master data manipulation tasks in MS EXCEL, including common statistical, logical, and mathematical operations, as well as conversion, analytics, search, exploration, visualization, and the use of critical features.
3. To Acquire essential skills in creating top-notch presentations with MS PowerPoint, focusing on content organization, presentability, aesthetics, and the seamless integration of media elements to enhance the overall quality of the presentations.
4. Develop a thorough understanding of MS WORD's various features, such as document formatting, headers, footers, table creation, and effective use of graphics to enhance the visual appeal and readability of technical documents.
5. Explore advanced functionalities of MS EXCEL, including data analysis tools, pivot tables, macros, and data visualization techniques, to efficiently handle complex datasets and perform insightful data analysis.

MS WORD: **10**

- ✓ Create and format a document
- ✓ Working with tables
- ✓ Working with Bullets and Lists
- ✓ Working with styles, shapes, smart art, charts
- ✓ Inserting objects, charts and importing objects from other office tools.
- ✓ Creating and Using document templates
- ✓ Inserting equations, symbols and special characters
- ✓ Working with Table of contents and References, citations
- ✓ Insert and review comments
- ✓ Create bookmarks, hyperlinks, endnotes footnote
- ✓ Viewing document in different modes
- ✓ Working with document protection and security.
- ✓ Inspect document for accessibility

MS EXCEL: **10**

- ✓ Create worksheets, insert and format data
- ✓ Work with different types of data: text, currency, date, numeric etc.
- ✓ Split, validate, consolidate, Convert data
- ✓ Sort and filter data
- ✓ Perform calculations and use functions: (Statistical, Logical, Mathematical, date, Time etc.,)
- ✓ Work with Lookup and reference formulae
- ✓ Create and Work with different types of charts
- ✓ Use pivot tables to summarize and analyse data
- ✓ Perform data analysis using own formulae and functions
- ✓ Combine data from multiple worksheets using own formulae and built-in functions to generate results
- ✓ Export data and sheets to other file formats
- ✓ Working with macros
- ✓ Protecting data and Securing the workbook

MS POWERPOINT: **10**

- ✓ Select slide templates, layout and themes
- ✓ Formatting slide content and using bullets and numbering
- ✓ Insert and format images, smart art, tables, charts
- ✓ Using Slide master, notes and handout master
- ✓ Working with animation and transitions
- ✓ Organize and Group slides
- ✓ Import or create and use media objects: audio, video, animation
- ✓ Perform slideshow recording and Record narration and create presentable videos

TOTAL: 30 PERIODS

COURSE OUTCOMES:

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

CO1 : Utilize Microsoft Word to create and format professional documents, such as reports, memos, and letters.

CO2 : Create and manage spreadsheets using Microsoft Excel, including data entry, formula usage, and data analysis.

CO3: Design visually appealing presentations using Microsoft PowerPoint, incorporating multimedia elements and effective slide layouts.

CO4: Effectively communicate and collaborate with others using Microsoft Outlook for email management.

CO5: Develop and maintain organized databases using Microsoft Access, including data entry, query design, and report generation.

CO6: Create scheduling and task tracking in the working environment

SEMESTER IV

		L	T	P	C
U23MET41	**KINEMATICS OF MACHINERY**	**3**	**0**	**0**	**3**

COURSE OBJECTIVES

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

1. To understand the basic components and layout of linkages in the assembly of a system /machine.
2. To understand the principles in analyzing the assembly with respect to the displacement, velocity, and acceleration at any point in a link of a mechanism.
3. To understand the motion resulting from a specified set of linkages, design few linkage mechanisms and cam mechanisms for specified output motions.
4. To understand the basic concepts of toothed gearing.
5. To understand the kinematics of gear trains and the effects of friction in motion transmission and in machine components.

UNIT I BASICS OF MECHANISMS 9

Classification of mechanisms - Basic kinematic concepts and definitions - Degree of freedom, Mobility - Kutzbach criterion, Gruebler's criterion - Grashof's Law - Kinematic inversions of four-bar chain and slider crank chains - Limit positions - Mechanical advantage - Transmission Angle - Description of some common mechanisms - Quick return mechanisms, Straight line generators, Universal Joint - rocker mechanisms.

UNIT II KINEMATICS OF LINKAGE MECHANISMS 9

Displacement, velocity and acceleration analysis of simple mechanisms - Graphical method- Velocity and acceleration polygons - Velocity analysis using instantaneous centres - kinematic analysis of simple mechanisms - Coincident points - Coriolis component of Acceleration - Introduction to linkage synthesis problem.

UNIT III KINEMATICS OF CAM MECHANISMS 9

Classification of cams and followers - Terminology and definitions - Displacement diagrams - Uniform velocity, parabolic, simple harmonic and cycloidal motions - Derivatives of follower motions - Layout of plate cam profiles - Specified contour cams - Circular arc and tangent cams - Pressure angle and undercutting - sizing of cams.

UNIT IV GEARS AND GEAR TRAINS 9

Law of toothed gearing - Involutes and cycloidal tooth profiles -Spur Gear terminology and definitions -Gear tooth action - contact ratio - Interference and undercutting. Helical, Bevel, Worm, Rack and Pinion gears [Basics only]. Gear trains - Speed ratio, train value - Parallel axis gear trains - Epicyclic Gear Trains.

UNITV FRICTION IN MACHINE ELEMENTS 9

Surface contacts - Sliding and Rolling friction - Friction drives - Friction in screw threads -Bearings and lubrication - Friction clutches - Belt and rope drives - Friction in brakes- Band and Block brakes.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 : Explain the principles of kinematic pairs of planar mechanisms.

CO2 : Construct velocity and acceleration polygons and instantaneous centers.

CO3: Utilize various motion principles to draw cam profiles.

CO4: Interpret the terminology with the various gears (spur, helical, worm etc.).

CO5: Compare the effect of various friction involved in power transmission.

CO6: Explain the concepts of kinematics in predicting motion mechanism for given application

TEXT BOOKS:

1. Uicker, J.J., Pennock G.R and Shigley, J.E., "Theory of Machines and Mechanisms", siEdition, Oxford University Press, 2014.
2. Rattan, S.S, "Theory of Machines", 5th Edition, Tata McGraw-Hill, 2019.

REFERENCE BOOKS:

1. Thomas Bevan, "Theory of Machines", 3rd Edition, CBS Publishers and Distributors, 2005
2. Cleghorn. W. L, "Mechanisms of Machines", Oxford University Press, 2014.
3. Robert L. Norton, "Kinematics and Dynamics of Machinery", Tata McGraw-Hill, 2009.
4. Allen S. Hall Jr., "Kinematics and Linkage Design", Prentice Hall, 1961
5. Ghosh. A and Mallick, A.K., "Theory of Mechanisms and Machines", Affiliated East-West Pvt.Ltd., New Delhi, 2008.
6. Rao.J.S. and Dukkipati.R.V. "Mechanisms and Machine Theory", Wiley-Eastern Ltd., NewDelhi, 1992.

U23MET42 **THERMAL 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. Compute the appropriate energy transfers and system properties to analyze closed system processes and gas power cycles.
2. Analyzing the performance of steam nozzle, calculate critical pressure ratio.
3. Evaluating the performance of steam turbines through velocity triangles, understand the need for governing and compounding of turbines.
4. Analyzing the working of IC engines and various auxiliary systems present in IC engines.
5. Analyzing and designing the different RAC systems.

(Use of Steam Tables with Mollier Chart and Refrigeration and Air Conditioning tables with psychrometric chart is permitted)

UNIT I GAS POWER CYCLES 9

Otto, Diesel, Dual, Constant Pressure Joule cycles- air standard efficiency. Comparison of efficiencies, mean effective pressure Theoretical and Actual PV diagrams.

UNIT II STEAM NOZZLES AND INJECTOR 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.

UNIT III STEAM AND GAS TURBINES 9

Types, Impulse and reaction principles, Velocity diagrams, Work done and efficiency – optimal operating conditions. Multi-staging, compounding and governing. Gas turbine cycle analysis – open and closed cycle. Performance and its improvement - Regenerative, Intercooled, Reheated cycles and their combination.

UNIT IV INTERNAL COMBUSTION ENGINES – FEATURES AND COMBUSTION 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. Geometric, operating, and performance comparison of SI and CI engines. Desirable properties and qualities of fuels. Air-fuel ratio calculation – lean and rich mixtures. Combustion in SI & CI Engines – Knocking – phenomena and control.

UNITV REFRIGERATION AND AIR CONDITIONING 9

Vapour compression refrigeration cycle- super heat, sub cooling – Performance calculations, Principle and working of Ammonia–Water vapour absorption refrigeration system, Comparison between vapour compression and absorption systems.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 : Apply thermodynamic concepts to different air standard cycles and solve problems.

CO2 : To solve problems in steam nozzle and calculate critical pressure ratio.

CO3: Explain the flow in steam turbines, draw velocity diagrams, flow in Gas turbines and solve problems.

CO4: Explain the functioning and features of IC engine, components and auxiliaries.

CO5: Explain the working of refrigeration along with factors influencing its performance

CO6: Explain the working of air conditioning along with factors influencing its performance

TEXT BOOKS:

1. Kothandaraman. C.P., Domkundwar. S, Domkundwar. A.V., ―A course in thermal Engineering", Fifth Edition, Dhanpat Rai & sons, 2016
2. Rajput. R. K., ―Thermal Engineering‖ S. Chand Publishers, 2017

REFERENCE BOOKS:

1. Ballaney. P, "Thermal Engineering", 25th Edition, Khanna Publishers, 2017.
2. Ganesan. V ―Internal Combustion Engines‖, Fourth Edition, McGraw-Hill2017
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.

U23MET43 **STRENGTH OF MATERIALS**

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

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

1. Explain the concepts of stress, strain and deformation of solids.
2. Compute the shearing force and bending moment due to external loads on statically determinate beams and their effect on stresses.
3. Calculate the stresses and deformation in circular shafts and helical spring due to torsion.
4. Compute slopes and deflections in statically determinate beams by various methods.
5. Examine the stresses and deformations induced in thin cylindrical and spherical shells.

UNIT I STRESS, STRAIN AND DEFORMATION OF SOLIDS 9

Rigid bodies and deformable solids – Tensile, Compressive and Shear Stresses – Basics of Elasticity – Hooke‘s law - Stress-strain diagram - Deformation of simple and compound bars under axial load – Thermal stresses - Elastic constants - Volumetric strains - Strain energy due to axial load.

UNIT II TRANSVERSE LOADING ON BEAMS AND STRESSES IN BEAM 9

Shear force and bending moment diagrams for statically determinate beams. Theory of simple bending - Stress distribution along length and in beam section – Shear stresses in beams.

UNIT III TORSION 9

Torsion of circular bars – Torsion Equation - Stresses and deformations in circular and hollow shafts – Stepped shafts – Twist and torsion stiffness – Compound shafts – Deflection in shafts fixed at the both ends – Stresses in helical springs – Deflection of helical springs under axial load - carriage springs.

UNIT IV DEFLECTION OF BEAMS 9

Double Integration method – Macaulay‘s method – Area moment method for computation of slopes and deflections in beams - Conjugate beam method – Maxwell‘s reciprocal theorems.

UNITV THIN CYLINDERS, SPHERES AND THICK CYLINDERS 9

Biaxial state of stresses – Thin cylindrical and spherical shells – Stresses in thin cylindrical shell due to internal pressure - Deformation in thin cylindrical and spherical shells subjected to internal pressure - Biaxial stresses at a point – Stresses on inclined planes – Principal planes and stresses – Mohr‘s circle for biaxial stresses – Maximum shear stress.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 : Recall the concepts of stress and strain in simple and compound bars, the importance of principal stresses and principal planes.

CO2 : Explain the load transferring mechanism in beams and stress distribution due to shearing force and bending moment.

CO3: Apply basic equation of simple torsion in designing of shafts and helical spring

CO4: Solve the slope and deflection in beams using different methods.

CO5: Analyze and design thin and thick shells for the applied internal and external pressures.

CO6: Compare the deformation in members subjected to axial, flexural and torsional loads

TEXT BOOKS:

1. Rajput R.K. “Strength of Materials (Mechanics of Solids)", S.Chand & company Ltd., New Delhi, 7th edition, 2018.
2. Rattan S.S., “Strength of Materials", Tata McGraw Hill Education Pvt .Ltd., New Delhi, 2017.

REFERENCE BOOKS:

1. Singh. D.K., “Strength of Materials”, Ane Books Pvt Ltd., New Delhi, 2021.
2. Egor P Popov, “Engineering Mechanics of Solids”, 2nd edition, PHI Learning Pvt. Ltd., New Delhi, 2015.
3. Beer. F.P. & Johnston. E.R. “Mechanics of Materials”, Tata McGraw Hill, 8th Edition, New Delhi 2019.
4. Vazirani. V.N, Ratwani. M.M, Duggal .S.K “Analysis of Structures: Analysis, Design and Detailing of Structures-Vol.1”, Khanna Publishers, New Delhi 2014.

U23MET44	COMPUTER AIDED DESIGN	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

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

1. To provide knowledge of fundamentals of CAD and geometric transformations.
2. To understand the various geometric modelling concepts.
3. To identify the common visual realism algorithms.
4. To impart the knowledge on parts assembly logics and consideration factors.
5. To study the available data exchange formats for CAD model transportation.

UNIT I FUNDAMENTALS OF COMPUTER GRAPHICS 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.

UNIT II GEOMETRIC MODELING 9

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

UNIT III VISUAL REALISM 9

Hidden - Line-Surface-Solid removal algorithms - shading - colouring - computer animation.

UNIT IV ASSEMBLY OF PARTS 9

Assembly modelling - interferences of positions and orientation - tolerance analysis-mass property calculations - mechanism simulation and interference checking.

UNIT V CAD STANDARDS 9

Standards for computer graphics- Graphical Kernel System (GKS) - standards for exchange images- Open Graphics Library (OpenGL)- Data exchange standards- IGES, STEP, CALSetc.-communication standards.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 : Explain the basic concept of product design and 2D / 3D CAD manipulations.

CO2 : Discuss the representation of curves, surface and solid modeling techniques for various real time applications

CO3: Summarize the visual realism techniques

CO4: Discuss the various CAD standards

CO5: Apply NC & CNC programming concepts to develop part programme for Lathe & Milling Machines

CO6: Summarize the different types of techniques used in Cellular Manufacturing and FMS

TEXT BOOKS:

1. Ibrahim Zeid “Mastering CAD CAM” Tata McGraw-Hill Publishing Co.2009
2. Foley, Wan Dam, Feiner and Hughes - "Computer graphics principles & practice" Pearson Education - 2003.

REFERENCE BOOKS:

1. Chris McMahon and Jimmie Browne “CAD/CAM Principles", "Practice and Manufacturing management “ Second Edition, Pearson Education, 2000.
2. Donald Hearn and M. Pauline Baker “Computer Graphics”’. Prentice Hall, Inc, 1994.

U23MET45	MANUFACTURING TECHNOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

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

1. Studying the concepts and basic mechanics of metal cutting and the factors affecting machinability.
2. Learning working of basic and advanced turning machines.
3. To teach the basics of machine tools with reciprocating and rotating motions and abrasive finishing processes.
4. Studying the basic concepts of CNC of machine tools and constructional features of CNC.
5. Learning the basics of CNC programming concepts to develop the part programme for Machine centre and turning centre.

UNIT I MECHANICS OF METAL CUTTING 9

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

UNIT II TURNING MACHINES 9

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

UNIT III RECIPROCATING MACHINE TOOLS 9

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

UNIT IV CNC MACHINES 9

Computer Numerical Control (CNC) machine tools, constructional details, special features – Drives, Recirculating ball screws, tool changers; CNC Control systems – Open/closed, point-to-point/continuous - Turning and machining centres – Work holding methods in Turning and machining centres, Coolant systems, Safety features-Automatic tool changer.

UNITV PROGRAMMING OF CNC MACHINE TOOLS 9

Coordinates, axis and motion, Absolute vs Incremental, Interpolators, Polar coordinates, Program planning, G and M codes, Manual part programming for CNC machining centers and Turning centers – Fixed cycles, Loops and subroutines, Setting up a CNC machine for machining.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 : Apply the mechanism of metal removal process and to identify the factors involved in improving machinability.

CO2 : Describe the constructional and operational features of centre lathe and other special purpose lathes

CO3: Describe the constructional and operational features of reciprocating machine tools

CO4: Apply the constructional features and working principles of CNC machine tools.

CO5: Demonstrate the Program CNC machine tools through planning, writing codes and setting up CNC machine tools to manufacture a given component.

CO6: Apply suitable machine tool in machining of desired product.

TEXT BOOKS:

1. Kalpakjian. S, "Manufacturing Engineering and Technology", Pearson Education India,7th Edition, 2018.
2. Michael Fitzpatrick, Machining and CNC Technology, McGraw-Hill Education; 4th edition, 2018.

REFERENCE BOOKS:

1. Roy. A. Lindberg, Processes and materials of manufacture, PHI / Pearson education, 2006
2. Rao. P.N "Manufacturing Technology," Metal Cutting and Machine Tools, Tata McGraw-Hill, New Delhi, 2009.
3. A. B. Chattopadhyay, Machining and Machine Tools, Wiley, 2nd edition, 2017
4. Peter Smid, CNC Programming Handbook, Industrial Press Inc.; Third edition, 2007.

U23GET41	ENVIRONMENTAL SCIENCES AND SUSTAINABILITY	L	T	P	C
		2	0	0	2

COURSE OBJECTIVES

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

1. To introduce the basic concepts of environment, ecosystems and biodiversity and emphasize on the biodiversity of India and its conservation
2. To impart knowledge on the causes, effects and control or prevention measures of environmental pollution and natural disasters
3. To facilitate the understanding of global and Indian scenario of renewable and non renewable resources, causes of their degradation and measures to preserve them
4. To familiarize the concept of sustainable development goals and appreciate the interdependence of economic and social aspects of sustainability, recognize and analyze climate changes, concept of carbon credit and the challenges of environmental management.
5. To inculcate and embrace sustainability practices and develop a broader understanding on green materials, energy cycles and analyze the role of sustainable urbanization.

UNIT I ENVIRONMENT AND BIODIVERSITY 6

Definition, scope and importance of environment – need for public awareness. Eco-system and Energy flow– ecological succession. Types of biodiversity: genetic, species and ecosystem diversity– values of biodiversity, India as a mega-diversity nation – hot-spots of biodiversity – threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – endangered and endemic species of India – conservation of biodiversity: In-situ and ex-situ.

UNIT II ENVIRONMENTAL POLLUTION 6

Causes, Effects and Preventive measures of Water, Soil, Air and Noise Pollutions. Solid, Hazardous and E-Waste management. Case studies on Occupational Health and Safety Management system (OHASMS). Environmental protection, Environmental protection acts.

UNIT III RENEWABLE SOURCES OF ENERGY 6

Energy management and conservation, New Energy Sources: Need of new sources. Different types new energy sources. Applications of- Hydrogen energy, Ocean energy resources, Tidal energy conversion. Concept, origin and power plants of geothermal energy.

UNIT IV SUSTAINABILITY AND MANAGEMENT 6

Development, GDP, Sustainability- concept, needs and challenges-economic, social and aspects of sustainability-from unsustainability to sustainability-millennium development goals, and protocols-Sustainable Development Goals-targets, indicators and intervention areas Climate change- Global, Regional and local environmental issues and possible solutions-case studies. Concept of Carbon Credit, Carbon Footprint. Environmental management in industry-A case study.

UNITV SUSTAINABILITY PRACTICES 6

Zero waste and R concept, Circular economy, ISO 14000 Series, Material Life cycle assessment, Environmental Impact Assessment. Sustainable habitat: Green buildings, Green materials, Energy efficiency, Sustainable transports. Sustainable energy: Non-conventional Sources, Energy Cycles-carbon cycle, emission and sequestration, Green Engineering: Sustainable urbanization- Socio-economical and technological change.

TOTAL: 30 PERIODS

COURSE OUTCOMES:

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

CO1 : Recognize and understand the functions of environment, ecosystems and biodiversity and their conservation.

CO2 : Identify the causes, effects of environmental pollution and natural disasters and contribute to the preventive measures in the society.

CO3: Identify and apply the understanding of renewable and non-renewable resources and contribute to the sustainable measures to preserve them for future generations.

CO4: Recognize the different goals of sustainable development and apply them for suitable technological advancement and societal development.

CO5: Demonstrate the knowledge of sustainability practices and identify green materials, energy cycles and the role of sustainable urbanization.

CO6: Discuss scientific, technological, economic and social solutions to environmental problems

TEXT BOOKS:

1. Anubha Kaushik and C. P. Kaushik's "Perspectives in Environmental Studies", 6th Edition,New Age International Publishers ,2018
2. Benny Joseph, 'Environmental Science and Engineering', Tata McGraw-Hill, New Delhi, 2016.
3. Gilbert M.Masters, 'Introduction to Environmental Engineering and Science', 2nd edition,Pearson Education, 2004
4. Allen, D. T. and Shonnard, D. R., Sustainability Engineering: Concepts, Design and Case Studies, Prentice Hall.

REFERENCE BOOKS:

1. Environment Impact Assessment Guidelines, Notification of Government of India, 2006.
2. Mackenthun, K.M., Basic Concepts in Environmental Management, Lewis Publication,
3. R.K. Trivedi, 'Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards', Vol. I and II, Enviro Media. 38. Edition 2010.
4. Cunningham, W.P. Cooper, T.H. Gorhani, 'Environmental Encyclopedia', Jaico Publ., House,Mumbai, 2001
5. Dharmendra S. Sengar, 'Environmental law', Prentice hall of India PVT. LTD, New Delhi,2007.
6. Rajagopalan, R, 'Environmental Studies-From Crisis to Cure', Oxford University Press, Third Edition, 2015.

U23MEP41	STRENGTH OF MATERIALS AND FLUID MACHINERY LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES

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

1. Predict the mechanical properties of materials such as impact strength, tensile strength, compressive strength, hardness, ductility etc.
2. Demonstrate the basic principles in the area of mechanics of materials through a series of experiment
3. Compute the rate of flow through pipes using various flow measuring devices such as Venturimeter, orifice meter and rotameter
4. Discuss the performance characteristics of turbines and pump
5. Demonstrate the basic principles of fluid mechanics and working of hydraulic machine

LIST OF EXPERIMENTS

STRENGTH OF MATERIALS LABORATORY **30**

1. Tension test on mild steel rod.
2. Torsion test on mild steel rod.
3. Hardness test on metal (Rockwell and Brinell Hardness).
4. Compression test on helical spring.
5. Deflection test on carriage spring.

FLUID MECHANICS AND MACHINES LABORATORY **30**

1. Determination of coefficient of discharge of a venturimeter
2. Determination of friction factor for flow through pipes
3. Determination of the rate of flow using Rota meter.
4. Characteristics of centrifugal pump and reciprocating pump
5. Characteristics of Pelton wheel and Kapalan turbine

TOTAL: 60 PERIODS

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

Sl no	Name of the Equipment	Quantity
1.	Universal Tensile Testing machine with double 1 shear attachment 40 Ton Capacity	1Nos
2.	Torsion Testing Machine (60 NM Capacity)	1Nos
3.	Spring Testing Machine for tensile and compressive loads (2500 N)	1Nos
4.	Brinell Hardness Testing Machine	1Nos
5.	Rockwell Hardness Testing Machine	1Nos
6.	Venturi meter setup	1Nos
7.	Pipe Flow analysis setup	1Nos
8.	Rotameter setup	1Nos
9.	Centrifugal pump	1Nos
10.	Reciprocating pump setup	1Nos

COURSE OUTCOMES:

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

CO1 : Determine the tensile, torsion and hardness properties of metals by testing.

CO2 : Determine the stiffness properties of helical and carriage spring.

CO3: Apply the conservation laws to determine the coefficient of discharge of a venturimeter and finding the friction factor of given pipe.

CO4: Apply the fluid static and momentum principles to determine the forces due to impact of jet.

CO5: Determine the performance characteristics of turbine, rotodynamic pump and positive displacement pump.

CO6: Apply specific testing methods for material characterization

U23MEP42	THERMAL ENGINEERING LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES

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

1. Explain the value timing-V diagram and performance of IC Engines
2. Illustrate the characteristics of fuels/Lubricates used in IC Engines
3. Demonstrate the steam generator/ turbine
4. Experiment the heat transfer phenomena predict the relevant coefficient using implementation
5. Discuss the performance of refrigeration cycle / components

LIST OF EXPERIMENTS

1. Valve Timing and Port Timing diagrams.
2. Actual p-v diagrams of IC engines.
3. Performance Test on 4 – stroke Diesel Engine.
4. Heat Balance Test on 4 – stroke Diesel Engine.
5. Morse Test on Multi-Cylinder Petrol Engine.
6. Retardation Test on a Diesel Engine.
7. Determination of Flash Point and Fire Point of various fuels
8. A Study of Steam Generators and Turbines.
9. Performance test on a two stage Reciprocating Air compressor
10. Determination of COP of a vapour compression Refrigeration system
11. Experiments on Psychrometric processes

TOTAL: 60 PERIODS

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

Sl no	Name of the Equipment	Quantity
1.	I.C Engine - 2 stroke and 4 stroke model	1 set
2.	Apparatus for Flash and Fire Point	1 No.
3.	4-stroke Diesel Engine with mechanical loading.	1 No
4.	4-stroke Diesel Engine with hydraulic loading.	1 No.
5.	4-stroke Diesel Engine with electrical loading.	1 No.
6.	Multi-cylinder Petrol Engine	1 No.
7.	Single cylinder Petrol Engine	1 No.
8.	Data Acquisition system with any one of the above engines	1 No.
9.	Refrigeration test rig	1 No.
10.	Air-conditioning test rig	1 No.

COURSE OUTCOMES:

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

CO1 : Evaluate performance characteristics of IC engines
CO2 : Determine a Flash and Fire Point of the fuels
CO3: Identify the efficiency of 4-stroke Diesel Engine
CO4: Identify the efficiency of single & multi cylinder petrol Engine
CO5: Apply thermodynamics principles to find various parameters of refrigeration system
CO6: Apply thermodynamics principles to find various parameters of air conditioning system.

SEMESTER V

U23MET51	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:

1. Explain the various steps involved in the Design Process
2. Understand the principles involved in evaluating the shape and dimensions of a component like shaft and couplings to satisfy functional and strength requirements.
3. Learn to use catalogues and standard machine components like bearing.
4. Discuss the various steps involved in the optimization of energy storing devices.
5. Apply the standard practices and standard data.

(**Use of PSG Design Data book is permitted**)

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 – Eccentric loading – 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 FASTENERS 9

Threaded fasteners - Bolted joints including eccentric loading, Knuckle joints, Cotter joints – Welded joints, riveted joints for structures - theory of bonded joints.

UNIT IV DESIGN OF ENERGY STORING ELEMENTS AND ENGINE COMPONENTS 9

Types of springs, design of helical and concentric springs–surge in springs, Design of laminated springs - rubber springs – Flywheels - Connecting rods and crank shafts.

UNITV DESIGN OF BEARINGS AND MISCELLANEOUS ELEMENTS 9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 : Explain the design machine members subjected to static and variable loads.
CO2 : Apply the concepts design to shafts, key and couplings.
CO3: Apply the concepts of design to bolted, Knuckle, Cotter, riveted and welded joints.
CO4: Apply the concept of design helical, leaf springs, flywheels, connecting rods and crank shafts.
CO5: Prepare various type of bearings
CO6: Select a bearings for different applications

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.

REFERENCE BOOKS:

1. Ansel C Ugural, "Mechanical Design – An Integral Approach", 1st Edition, Tata McGraw-Hill Book Co, 2004
2. Merhyle Franklin Spotts, Terry E. Shoup, and Lee EmreyHornberger, "Design of Machine Elements"8th Edition, Printice Hall, 2004.
3. Robert C. Juvinall and Kurt M. Marshek, "Fundamentals of Machine component Design",6th Edition,Wiley, 2017.
4. Sundararajamoorthy T. V. and Shanmugam. N, "Machine Design", Anuradha Publications, Chennai,2003.
5. Design of Machine Elements | SI Edition | Eighth Edition | By Pearson by M. F. Spotts, Terry E. Shoup, et al. | 25 March 2019.

U23MET52	DYNAMICS OF MACHINES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

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

1. To impart knowledge in dynamic analysis of simple mechanism and design of flywheel.
2. To provide knowledge on balancing of rotating and reciprocating masses.
3. To study the working principle of governor and gyroscope.
4. To learn the concept of free and forced vibration.
5. To learn the concept of transverse and torsional vibration.

UNIT I FORCE ANALYSIS 9

Dynamic force analysis - Inertia force and Inertia torque- D Alembert's principle -Dynamic Analysis in reciprocating engines - Gas forces - Inertia effect of connecting rod- Bearing loads - Crank shaft torque - Turning moment diagrams -Fly Wheels - Flywheels of punching presses- Dynamics of Cam follower mechanism.

UNIT II BALANCING 9

Static and dynamic balancing - Balancing of rotating masses - Balancing a single cylinder engine - Balancing of Multi-cylinder inline, V-engines - Partial balancing in engines - Balancing of linkages -Balancing machines-Field balancing of discs and rotors.

UNIT III SINGLE DEGREE FREE VIBRATION 9

Basic features of vibratory systems - Degrees of freedom - single degree of freedom - Free vibration - Equations of motion - Natural frequency - Types of Damping - Damped vibration- Torsional vibration of shaft - Critical speeds of shafts - Torsional vibration - Two and three rotor torsional systems.

UNIT IV FORCED VIBRATION 9

Response of one degree freedom systems to periodic forcing – Harmonic disturbances –Disturbance caused by unbalance – Support motion –transmissibility – Vibration isolation vibration measurement.

UNITV MECHANISM FOR CONTROL 9

Governors – Types – Centrifugal governors – Gravity controlled and spring controlled centrifugal governors – Characteristics – Effect of friction – Controlling force curves. Gyroscopes –Gyroscopic forces and torques – Gyroscopic stabilization – Gyroscopic effects in Automobiles, ships and airplanes.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 : Predict the force analysis in mechanical system and related vibration issues and can able to solve the problem

CO2 : Solve balancing of rotating masses

CO3: Understand the vibration and damping

CO4: Solve the forced vibration

CO5: Knowledge of different types of governors and its characteristics

CO6: Compute the Gyroscopic effects in Automobiles, ships and airplanes.

TEXT BOOKS:

1. Uicker, J.J., Pennock G.R and Shigley, J.E., "Theory of Machines and Mechanisms" ,5th Edition, Oxford University Press, 2014.
2. Rattan, S.S, "Theory of Machines", 4th Edition, Tata McGraw-Hill, 2017

REFERENCE BOOKS:

1. Thomas Bevan, "Theory of Machines", 3rd Edition, CBS Publishers and Distributors, 2005.
2. Cleghorn. W. L, "Mechanisms of Machines", Oxford University Press, 2005
3. Benson H. Tongue, "Principles of Vibrations", Oxford University Press, 2nd Edition, 2007
4. Robert L. Norton, "Kinematics and Dynamics of Machinery", Tata McGraw-Hill, 2009.
5. Ghosh. A and Mallick, A.K., "Theory of Mechanisms and Machines", Affiliated East-West Pvt.Ltd., New Delhi, 1988.
6. John Hannah and Stephens R.C., "Mechanics of Machines", Viva Low-Prices Student Edition,1999.
7. William T. Thomson, Marie Dillon Dahleh, Chandramouli Padmanabhan, "Theory of Vibration with Application", 5th edition, Pearson Education, 2011
8. V.Ramamurthi, "Mechanics of Machines", Narosa Publishing House, 2002.
9. Khurmi, R.S.,"Theory of Machines", 14th Edition, S Chand Publications, 2005.

U23MET53	METROLOGY AND MEASUREMENTS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

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

1. Discuss the various Metrological equipment's for measurement.
2. Explain the various methods for linear and angular measurement.
3. Studying the tolerance analysis in manufacturing
4. Develop the fundamentals of GD & T and surface metrology.
5. Provide the knowledge of the advanced measurements for quality control in manufacturing

UNIT I BASICS OF METROLOGY 9

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

UNIT II MEASUREMENT OF LINEAR, ANGULAR DIMENSIONS, ASSEMBLY AND TRANSMISSION ELEMENTS 9

Linear Measuring Instruments – Vernier caliper, Micrometer, Vernier height gauge, Depth Micrometer, Bore gauge, Telescoping gauge; Gauge blocks – Use and precautions, Comparators – Working and advantages; Opto-mechanical measurements using measuring microscope and Profile projector - Angular measuring instruments – Bevel protractor, Clinometer, Angle gauges, Precision level, Sine bar, Autocollimator, Angle dekkor, Alignment telescope. Measurement of Screw threads - Single element measurements – Pitch Diameter, Lead, Pitch. Measurement of Gears – purpose – Analytical measurement – Runout, Pitch variation, Tooth profile, Tooth thickness, Lead – Functional checking – Rolling gear test.

UNIT III TOLERANCE ANALYSIS 9

Tolerancing– Interchangeability, Selective assembly, Tolerance representation, Terminology, Limits and Fits, Problems (using tables IS919); Design of Limit gauges, Problems. Tolerance analysis in manufacturing, Process capability, tolerance stackup, tolerance charting.

UNIT IV METROLOGY OF SURFACES 9

Fundamentals of GD & T- Conventional vs Geometric tolerance, Datums, Inspection of geometric deviations like straightness, flatness, roundness deviations; Simple problems – Measurement of Surface finish – Functionality of surfaces, Parameters, Comparative, Stylus based and Optical Measurement techniques, Filters, Introduction to 3D surface metrology- Parameters.

UNITV ADVANCES IN METROLOGY 9

Lasers in metrology - Advantages of lasers – Laser scan micrometers; Laser interferometers – Applications – Straightness, Alignment; Ball bar tests, Computer Aided Metrology - Basic concept of CMM– Types of CMM – Constructional features – Probes – Accessories – Software – Applications – Multi-sensor CMMs. Machine Vision - Basic concepts of Machine Vision System – Elements – Applications - On-line and in-process monitoring in production - Computed tomography – White light Scanners.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 : Discuss the concepts of measurements to apply in various metrological instruments.

CO2 : Apply the principle and applications of linear and angular measuring instruments, assembly and transmission elements.

CO3: Apply the tolerance symbols and tolerance analysis for industrial applications.

CO4: Apply the principles and methods of form and surface metrology.

CO5: Apply the advances in measurements for quality control in manufacturing Industries

CO6: Discuss a Basic concepts of Machine Vision System

TEXT BOOKS:

1. Gupta. I.C., ―Engineering Metrology‖, Dhanpatrai Publications, 2018.
2. Jain R.K. ―Engineering Metrology‖, Khanna Publishers, 2018.

REFERENCE BOOKS:

1. AmmarGrous, 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.

U23MEP51	METROLOGY AND MEASUREMENTS LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES

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

1. To study the different measurement equipment and use of this industry for quality inspection.
2. To develop comprehensive knowledge and practical skills in the calibration and proficient use of various linear measuring instruments
3. To acquire expertise in accurately measuring angles using bevel protractors
4. To gain proficiency in measuring assembly and transmission elements
5. To study the surface finishing measurements

LIST OF EXPERIMENTS

1. Calibration and use of linear measuring instruments – Vernier caliper, micrometer, Vernier height gauge, depth micrometer, bore gauge, telescopic gauge, Comparators.
2. Measurement of angles using bevel protractor, sine bar, precision level.
3. Measurement of assembly and transmission elements - screw thread parameters – Screw thread Micrometers, Three wire method, Toolmaker's microscope.
4. Measurement of gear parameters – Micrometers, Vernier caliper.
5. Non-contact (Optical) measurement using Measuring microscope / Profile projector and Video measurement system.
6. Surface metrology - Measurement of form parameters – Straightness, Flatness, – in the given component using Autocollimator
7. Measurement of Surface finish in components manufactured using various processes (turning, milling, grinding, etc.,) using stylus based instruments.

TOTAL: 60 PERIODS

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

Sl no	Name of the Equipment	Quantity
1.	Micrometer	5
2.	Vernier Caliper	5
3.	Vernier Height Gauge	2
4.	Vernier depth Gauge	2
5.	Slip Gauge Set	1
6.	Gear Tooth Vernier	1
7.	Sine Bar	1
8.	Floating Carriage Micrometer	1
9.	Profile Projector / Tool Makers Microscope	1
10.	Mechanical / Electrical Comparator	1
11.	Autocollimator	1
12.	Temperature Measuring Setup	1
13.	Force Measuring Setup	1

COURSE OUTCOMES:

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

CO1 : Demonstrate the correct methods for measurement and calibration of various measuring devices.

CO2 : Explain the effective methods of measuring straightness, flatness, gear profile, screw threads.

CO3: Compute the internal bore diameter measurement by bore gauge and telescope gauge.

CO4: Compare the force and torque using suitable measuring devices

CO5: Compute the temperature measurement using thermocouple

CO6: Apply the different measurement tools and perform measurements in quality Inspection

U23MEP52	DYNAMICS OF MACHINERY LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES

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

1. Develop skills for designing and analyzing linkages, cams, gears and other mechanisms.
2. Determine the technical parameters relevant to gyroscope, various types of governors, bifilar suspension, compound pendulum, turn table apparatus etc.
3. Experiment with various shafts, rotors, spring - mass system and compare it with the theoretical values.
4. Demonstrate the given rotor system dynamically with the aid of force polygon and couple polygon.
5. Construct the miniature projects from the concepts learnt in mechanisms and vibrations.

LIST OF EXPERIMENTS

1 Study of gear parameters.
2 Epicycle gear Train.
3 Determination of moment of inertia of flywheel and axle system.
4 Determination of mass moment of inertia of a body about its axis of symmetry.
5 Undamped free vibrations of a single degree freedom spring-mass system.
6 Torsional Vibration (Undamped) of single rotor shaft system.
7 Dynamic analysis of cam mechanism.
8 Experiment on Watts Governor.
9 Experiment on Porter Governor.
10 Experiment on Proell Governor.
11 Experiment on motorized gyroscope.
12 Determination of critical speed of shafts.

TOTAL: 60 PERIODS

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

Sl no	Name of the Equipment	Quantity
1.	Cam follower setup.	1 No.
2.	Motorised gyroscope.	1 No.
3.	Governor apparatus - Watt, Porter, Proell and Hartnell governors.	1 No.
4.	Whirling of shaft apparatus.	1 No.
5.	Two rotor vibration setup.	1 No.
6.	Spring mass vibration system.	1 No.
7.	Torsional Vibration of single rotor system setup.	1 No.
8.	Gear Models	1 No.
9.	Kinematic Models to study various mechanisms.	1 No.
10.	Turn table apparatus.	1 No.
11.	Transverse vibration setup of a) cantilever b) Free-Free beam c) Simply supported beam.	1 No.

COURSE OUTCOMES:

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

CO1 : Explain the gear parameters of various types of gear trains
CO2 : Find the Mass moment of inertia of Fly wheel and Axle system.
CO3: Solve the gyroscopic effect and couple.
CO4: Explain torsional natural frequency of single and Double Rotor systems.
CO5: Demonstrate the kinematic working models of various mechanisms and cam profile.
CO6: Identify the critical speed of shafts

SEMESTER-VI

U23MET61	HEAT AND MASS TRANSFER	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 mechanisms of heat transfer under steady and transient conditions.
2. Apply the fundamental concept and principles in convective heat transfer
3. Discuss the theory of phase change heat transfer and design of heat exchangers.
4. Explain the fundamental concepts and principles in radiation heat transfer
5. Describe the relation between heat and mass transfer and to solve simple mass transfer problems.

(Use of standard HMT data book permitted)

UNIT I CONDUCTION 9

General Differential equation – Cartesian, Cylindrical and Spherical Coordinates – One Dimensional Steady State Heat Conduction — plane and Composite Systems – Conduction with Internal Heat Generation – Extended Surfaces – Unsteady Heat Conduction – Lumped Analysis – Semi Infinite and Infinite Solids –Use of Heisler's charts – Methods of enhanced thermal conduction

UNIT II CONVECTION 9

Conservation Equations, Boundary Layer Concept – Forced Convection: External Flow – Flow over Plates, Cylinders Spheres and Bank of tubes. Internal Flow – Entrance effects. Free Convection – Flow over Vertical Plate, Horizontal Plate, Inclined Plate, Cylinders and Spheres. Mixed Convection.

UNIT III PHASE CHANGE HEAT TRANSFER AND HEAT EXCHANGERS 9

Nusselt's theory of condensation- Regimes of Pool boiling and Flow boiling - Correlations in boiling and condensation. Heat Exchanger Types – TEMA Standards - Overall Heat Transfer Coefficient – Fouling Factors. LMTD and NTU methods. Fundamentals of Heat Pipes and its applications.

UNIT IV RADIATION 9

Introduction to Thermal Radiation - Radiation laws and Radiative properties - Black Body and Gray body Radiation - Radiosity - View Factor Relations. Electrical Analogy. Radiation Shields.

UNITV MASS TRANSFER 9

Basic Concepts – Diffusion Mass Transfer – Fick's Law of Diffusion – Steady state and Transient Diffusion - Stefan flow –Convective Mass Transfer – Momentum, Heat and Mass Transfer Analogy – Convective Mass Transfer Correlations.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 : Apply heat conduction equations to different surface configurations under steady state and transient conditions and solve problems.

CO2 : Apply free and forced convective heat transfer correlations to internal and external flows through/over various surface configurations and solve problems.

CO3: Explain the phenomena of boiling and condensation, apply LMTD and NTU methods of thermal analysis to different types of heat exchanger configurations and solve problems.

CO4: Explain basic laws for Radiation and apply these principles to radiative heat transfer between different types of surfaces to solve problems.

CO5: Make the use of mass transfer and its correlations.

CO6: Apply the conduction and convection principles in product application by real time study.

TEXT BOOKS:

1. Holman, J.P., "Heat and Mass Transfer", Tata McGraw Hill, 10th Edition, 2017
2. Yunus A. Cengel, "Heat Transfer A Practical Approach", Tata McGraw Hill, 6th Edition 2020.

REFERENCE BOOKS:

1. Frank P. Incropera and David P. Dewitt, “Fundamentals of Heat and Mass Transfer”, John Wiley & Sons, 7th Edition, 2014.
2. Kothandaraman, C.P., “Fundamentals of Heat and Mass Transfer”, New Age International, New Delhi, 2012.
3. S.P. Venkateshan, “Heat Transfer”, Ane Books, New Delhi, 2014

U23MET62 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:

1. Understand the principles and procedure for the design of Mechanical power Transmission components.
2. Explain the standard procedure available for Design of Transmission of Mechanical elements.
3. Discuss the advanced transmission systems
4. Use the standard data and catalogs.
5. Apply the design procedures in the project work

(Use of P S G Design Data Book permitted)

UNIT I DESIGN OF FLEXIBLE ELEMENTS 9

Design of Flat belts and pulleys - Selection of V belts and pulleys – Selection of hoisting wire ropes and pulleys – Design of Transmission chains and Sprockets.

UNIT II SPUR GEARS AND PARALLEL AXIS HELICAL GEARS 9

Speed ratios and number of teeth-Force analysis -Tooth stresses - Dynamic effects – Fatigue strength - Factor of safety - Gear materials – Design of straight tooth spur & helical gears based on strength and wear considerations – Pressure angle in the normal and transverse plane Equivalent number of teeth-forces for helical gears.

UNIT III BEVEL, WORM AND CROSS HELICAL GEARS 9

Straight bevel gear: Tooth terminology, tooth forces and stresses, equivalent number of teeth. Estimating the dimensions of pair of straight bevel gears. Worm Gear: Merits and demerits terminology. Thermal capacity, materials-forces and stresses, efficiency, estimating the size of the worm gear pair. Cross helical: Terminology-helix angles-Estimating the size of the pair of cross helical gears.

UNIT IV GEAR BOXES 9

Geometric progression - Standard step ratio - Ray diagram, kinematics layout -Design of sliding mesh gear box - Design of multi speed gear box for machine tool applications - Constant mesh gear box - Speed reducer unit. – Variable speed gear box, Fluid Couplings, Torque Converters for automotive applications.

UNITV CLUTCHES AND BRAKES 9

Design of plate clutches –axial clutches-cone clutches-internal expanding rim clutches Electromagnetic clutches. Band and Block brakes - external shoe brakes – Internal expanding shoe brake.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 : Compute the design parameters of flexible transmission elements like belts, chains and wire ropes for given condition

CO2 : Compute the spur and helical gear terminology considering strength and wear

CO3: Compute the required parameters in designing worm, bevel and double helical gear power transmission

CO4: Calculate the speed ratio and gear box parameters for the given application

CO5: Select the parameters require to design cam, clutches and brakes for varied applications

CO6: Select the parameters to design power transmission elements using standard catalogue

TEXT BOOKS:

1. Bhandari V, "Design of Machine Elements", 4th Edition, Tata McGraw
2. Joseph Shigley, Charles Mischke, Richard Budynas and Keith Nisbett "Mechanical Engineering Design", 8th Edition, Tata McGraw

REFERENCE BOOKS:

1. Merhyle F. Spotts, Terry E. Shoup and Lee E. Hornberger, "Design of Machine Elements" 8th Edition, Printice Hall, 2003.
2. Orthwein W, "Machine Component Design", Jaico Publishing Co, 2003.
3. Prabhu. T.J., "Design of Transmission Elements", Mani Offset, Chennai, 2000.
4. Robert C. Juvinall and Kurt M. Marshek, "Fundamentals of Machine Design", 4th Edition, Wiley, 2005
5. Sundararajamoorthy T. V, Shanmugam .N, "Machine Design", Anuradha Publications, Chennai, 2003.

GE3791	HUMAN VALUES AND ETHICS	L	T	P	C
		2	0	0	2

COURSE OBJECTIVES

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

1. Teach definition and classification of values.
2. Explain Purusartha.
3. Describe Sarvodaya idea.
4. Summarize sustenance of life.
5. Conclude views of hierarchy of values.

UNIT I DEFINITION AND CLASSIFICATION OF VALUES 6

Extrinsic values- Universal and Situational values- Physical- Environmental-Sensuous- Economic Social-Aesthetic-Moral and Religious values.

UNIT II CONCEPTS RELATED TO VALUES 6

Purusartha-Virtue- Right- duty- justice- Equality- Love and Good.

UNIT III IDEOLOGY OF SARVODAYA 6

Egoism- Altruism and universalism- The Ideal of Sarvodaya and Vasudhaiva Kutumbakam.

UNIT IV SUSTENANCE OF LIFE 6

The Problem of Sustenance of value in the process of Social, Political and Technological Changes.

UNIT V VIEWS ON HIERARCHY OF VALUES 6

The Problem of hierarchy of values and their choice, The views of Pt. Madan Mohan Malviya and Mahatma Gandhi.

TOTAL: 30 PERIODS

COURSE OUTCOMES:

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

CO1 : Understand definition and classification of values.
CO2 : Understand purusartha.
CO3: Understand sarvodaya idea.
CO4: Understand sustenance of life.
CO5: Understand the hierarchy of values.
CO6: Compare hierarchial views of Pt. Madan Mohan Malviya and Mahatma Gandhi.

TEXT BOOKS:

1. AwadeshPradhan : MahamanakeVichara. (B.H.U., Vanarasi-2007)
2. Little, William, : An Introduction of Ethics (Allied Publisher, Indian Reprint 1955)
3. William, K Frankena : Ethics (Prentice Hall of India, 1988)

U23MEP61	CAD/CAM LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES

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

1. To gain practical experience in handling 2D drafting and 3Dmodelling software systems.
2. Designing 3-Dimensional geometric model of parts, sub-assemblies, assemblies and exporting it to drawing.
3. Programming G & M Code programming and simulate the CNC program and Generating part programming data through CAM software.
4. To gain hands-on experience in creating 3D assembly models of machine elements to enhance design skills and understand component interactions.
5. To acquire practical knowledge of manual drawing techniques for machine components, facilitating a comprehensive understanding of progressive 3D arrangement.

3D GEOMETRIC MODELLING **30**

1. CAD Introduction Sketch:
   Solid modeling: Extrude, Revolve, Sweep, Variational sweep and Loft.
   Surface modeling: Extrude, Sweep, Trim, Mesh of curves and Free form.
   Feature manipulation: Copy, Edit, Pattern, Suppress, History operations.
   Assembly: Constraints, Exploded Views, Interference check
   Drafting: Layouts, Standard & Sectional Views, Detailing & Plotting
2. Creation of 3D assembly model of following machine elements using 3D Modelling software.
   a. Flange Coupling
   b. Plummer Block
   c. Screw Jack
   d. Lathe Tailstock
   e. Universal Joint
   f. Machine Vice
   g. Stuffing box
   h. Crosshead
   i. Safety Valves
   j. Non-return valves
   k. Connecting rod
   l. Piston
   m. Crankshaft
3. Students may also be trained in manual drawing of some of the above components (specify the number – progressive arrangement of 3D)

MANUAL PART PROGRAMMING **30**

1. **CNC Machining Centre**
   a. Linear Cutting.
   b. Circular cutting.
   c. Cutter Radius Compensation.
   d. Canned Cycle Operations.
2. **CNC Turning Centre**
   a. Straight, Taper and Radial Turning.
   b. Thread Cutting.
   c. Rough and Finish Turning Cycle.
   d. Drilling and Tapping Cycle.
3. **COMPUTER AIDED PART PROGRAMMING**
   a. Generate CL Data and Post process data using CAM packages for Machining and Turning Centre.
   b. Application of CAPP in Machining and Turning.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

CO1 : Utilize standard software tools to create part, assemblies and check for clearances.

CO2 : Modify 2D drafting to 3D using modeling software.

CO3: Summarize the modern control in manufacturing systems (FANUC, SIEMENS)

CO4: Utilize the concepts of G and M codes and manual part programming for modern manufacturing technology.

CO5: Utilize CAPP in machining and turning centre

CO6: Apply modern tools in design, manufacture and planning

U23MEP62	HEAT TRANSFER LABORATORY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

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

1. To gain experimental knowledge of Predicting the thermal conductivity of solids and liquids.
2. To gain experimental knowledge of Estimating the heat transfer coefficient values of various fluids.
3. To gain experimental knowledge of Testing the performance of tubes in tube heat exchangers
4. To learn the experimental procedures to determine the Stefan-Boltzmann constant and emissivity of a grey surface
5. To gain practical experience in studying heat transfer in pin-fin apparatus under both natural and forced convection modes.

LIST OF EXPERIMENTS

1. Thermal conductivity measurement using guarded plate apparatus.
2. Thermal conductivity measurement of pipe insulation using lagged pipe apparatus.
3. Determination of heat transfer coefficient under natural convection from a vertical cylinder.
4. Determination of heat transfer coefficient under forced convection from a tube.
5. Determination of Thermal conductivity of composite wall.
6. Determination of Thermal conductivity of insulating powder.
7. Heat transfer from pin-fin apparatus (natural & forced convection modes)
8. Determination of Stefan - Boltzmann constant.
9. Determination of emissivity of a grey surface.
10. Effectiveness of Parallel / counter flow heat exchanger

TOTAL: 60 PERIODS

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

Sl no	Name of the Equipment	Quantity
1.	Guarded plate apparatus	1 No.
2.	Lagged pipe apparatus	1 No.
3.	Natural convection-vertical cylinder apparatus	1 No.
4.	Forced convection inside tube apparatus	1 No.
5.	Composite wall apparatus	1 No.
6.	Thermal conductivity of insulating powder apparatus	1 No.
7.	Pin-fin apparatus	1 No.
8.	Stefan-Boltzmann apparatus	1 No.
9.	Emissivity measurement apparatus	1 No.
10.	Parallel/counter flow heat exchanger apparatus	1 No.

COURSE OUTCOMES:

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

CO1 : Conduct experiment on Predict the thermal conductivity of solids and liquids.

CO2 : Conduct experiment on Estimate the heat transfer coefficient values of various fluids.

CO3: Conduct experiment on Test the performance of tubes in tube heat exchangers.

CO4: Calculate Heat transfer from pin-fin apparatus

CO5: Identify the emissivity of a grey surface

CO6: Determine the effectiveness of Parallel / counter flow heat exchanger

SEMESTER-VII

U23MET71	MECHATRONICS 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. To make students get acquainted with the sensors and the actuators, which are commonly used in mechatronics systems.
2. To provide insight into the signal conditioning circuits, and also to develop competency in PLC programming and control
3. To make students familiarize with the fundamentals of IoT and Embedded systems.
4. To impart knowledge about the Arduino and the Raspberry Pi.
5. To inculcate skills in the design and development of mechatronics and IoT based systems.

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

UNIT II SIGNAL CONDITIONING CIRCUITS AND PLC 9

Operational Amplifiers – Inverting and Non-Inverting Amplifier – Wheatstone bridge Amplifier – 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.

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

UNIT IV CONTROLLERS 9

Foundation topics: Programming Languages: C++ and Python - The Linux Operating System. 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. (typical peripherals) 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

UNIT V MECHATRONICS AND IoT CASE STUDIES 9

Mechatronics systems: 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.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 : Explain Select suitable sensors and actuators to develop mechatronics systems.

CO2 : Discuss Devise proper signal conditioning circuit for mechatronics systems, and also able to implement PLC as a controller for an automated system.

CO3: Elucidate the fundamentals of Iot and Embedded Systems

CO4: Discuss Control I/O devices through Arduino and Raspberry Pi.

CO5: Design and develop an apt mechatronics/IoT based system for the given real-time application.

CO6: Design and development of mechatronics and iot based systems.

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.

REFERENCE BOOKS:

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", McGrawHill, 2005.
5. Bell C., "Beginning Sensor Networks with Arduino and Raspberry Pi", Apress, 2013

U23MET72	COMPUTER INTEGRATED MANUFACTURING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

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

1. To provide the overview of evolution of automation, CIM and its principles.
2. To learn the various Automation tools, include various material handling system.
3. To train students to apply group technology and FMS.
4. To familiarize the computer aided process planning in manufacturing.
5. To introduce to basics of data transaction, information integration and control of CIM

UNIT I INTRODUCTION 9

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

UNIT II AUTOMATED MANUFACTURING SYSTEMS 9

Automated production line – system configurations, work part transfer mechanisms – Fundamentals of Automated assembly system – System configuration, Part delivery at workstations – Design for automated assembly – Overview of material handling equipments – Consideration in material handling system design– The 10 principles of Material handling. Conveyor systems – Types of conveyors – Operations and features. Automated Guided Vehicle system – Types &applications – Vehicle guidance technology – Vehicle management and safety. Storage system performance – storage location strategies – Conventional storage methods and equipments – Automated storage/Retrieval system and Carousel storage system Deadlocks in Automated manufacturing systems – Petrinet models – Applications in Dead lock avoidance – smart manufacturing – Industry 4.0 - Digital manufacturing – Virtual manufacturing

UNIT III GROUP TECHNOLOGY AND FMS 9

Part families – Visual – Parts classification and coding – Production flow analysis – Grouping of parts and Machines by rank order clustering method – Benefits of GT – Case studies. FMS – Components – workstations – FMS layout configurations – Computer control systems – FMS planning and implementation issues – Architecture of FMS – flow chart showing various operations in FMS – Machine cell design – Composite part concept, Holier method, Key machine concept – Quantitative analysis of FMS – Bottleneck model – Simple and complicated problems – Extended Bottleneck model - sizing the FMS ─ FMS applications, Benefits.

UNIT IV PROCESS PLANNING 9

Process planning – Activities in process planning, Informations required. From design to process planning – classification of manufacturing processes – Selection of primary manufacturing processes – Sequencing of operations according to Anteriorities – various examples – forming of Matrix of Anteriorities – case study. Typical process sheet – case studies in Manual process planning. Computer Aided Process Planning – Process planning module and data base – Variant process planning – Two stages in VPP – Generative process planning – Flow chart showing various activities in generative PP – Semi generative process planning- Comparison of CAPP and Manual PP.

UNIT V PROCESS CONTROL AND DATA ANALYSIS 9

Introduction to process model formulation – linear feedback control systems – Optimal control – Adaptive control –Sequence control and PLC& SCADA. Computer process control – Computer process interface – Interface hardware – Computer process monitoring – Direct digital control and Supervisory computer control Overview of Automatic identification methods – Bar code technology –Automatic data capture technologies.- Quality management (SPC) and automated inspection

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 : Discuss the basics of computer aided engineering.
CO2 : Choose appropriate automotive tools and material handling systems.
CO3: Discuss the overview of group technology, FMS and automation identification methods.
CO4: Design using computer aided process planning for manufacturing of various components
CO5: Acquire knowledge in computer process control techniques.
CO6: Familiarize the computer aided process planning in manufacturing.

TEXT BOOKS:

1. Shivanand H K, Benal M M and Koti V, Flexible Manufacturing System, New Age, 2016.
2. CIM: Computer Integrated Manufacturing: Computer Steered Industry Book by August-Wilhelm Scheer

REFERENCE BOOKS:

1. Alavudeen and Venkateshwaran, Computer Integrated Manufacturing‖, PHI Learning Pvt. Ltd.,New Delhi, 2013.
2. Gideon Halevi and Ronald D. Weill, Principles of Process Planning‖, Chapman Hall, 1995.
3. James A. Retrg, Herry W. Kraebber, Computer Integrated Manufacturing‖, Pearson Education, Asia,3rdEdition,2004.
4. Mikell P. Groover, Automation, Production system and Computer integrated Manufacturing, Prentice Hall of India Pvt. Ltd., 4thEdition, 2014.
5. Radhakrishnan P, Subramanian S and Raju V, CAD/CAM/CIM, New Age International Publishers, 3rd Edition, 2008.

U23MET73	POWER PLANT 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. Explain overview of Steam Power Plant and its operation and maintenance.
2. Describe basic working principles of gas turbines and Diesel engine power plant
3. List the principal components and types of nuclear reactors
4. Applying the principle of various Solar, Wind and Ocean energy generating devices.
5. Describe the current energy, economic and environmental issues.

UNIT I COAL BASED THERMAL POWER PLANTS 9

Rankine cycle - improvisations, Layout of modern coal power plant, Super Critical Boilers, FBC Boilers, Turbines, Pressure vessel, Condensers, Steam & Heat rate, Subsystems of thermal power plants – Fuel and ash handling, Draught system, Feed water treatment. Binary Cycles and Cogeneration systems.

UNIT II DIESEL, GAS TURBINE AND COMBINED CYCLE POWER PLANTS 9

Otto, Diesel, Dual & Brayton Cycle - Analysis & Optimisation. Components of Diesel and Gas Turbine power plants. Combined Cycle Power Plants. Integrated Gasifier based Combined Cycle systems.

UNIT III NUCLEAR POWER PLANTS 9

Basics of Nuclear Engineering, Layout and subsystems of Nuclear Power Plants, Working of Nuclear Reactors Boiling Water Reactor (BWR), Pressurized Water Reactor (PWR), CANada Deuterium- Uranium reactor (CANDU), Breeder, Gas Cooled and Liquid Metal Cooled Reactors. Safety measures for Nuclear Power plants.

UNIT IV POWER FROM RENEWABLE ENERGY 9

Hydro Electric Power Plants – Classification, Typical Layout and associated components including Turbines. Principle, Construction and working of Wind, Tidal, Solar Photo Voltaic (SPV), Solar Thermal, Geo Thermal, Biogas and Fuel Cell power systems.

UNIT V ENERGY, ECONOMIC AND ENVIRONMENTAL ISSUES OF POWER PLANTS 9

Power tariff types, Load distribution parameters, load curve, Comparison of site selection criteria, relative merits & demerits, Capital & Operating Cost of different power plants. Pollution control technologies including Waste Disposal Options for Coal and Nuclear Power Plants, Safety measures.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 : Explain the layout, construction and working of the components inside a thermal power plant.

CO2 : Explain the layout, construction and working of the components inside a Diesel, Gas and Combined cycle power plants.

CO3: Explain the layout, construction and working of the components inside nuclear power plants.

CO4: Explain the layout, construction and working of the components inside Renewable energy power plants

CO5: Explain the applications of power plants while extend their knowledge to power plant economics and environmental hazards and estimate the costs of electrical energy production.

CO6: Explain overview of Steam Power Plant and its operation and maintenance.

TEXT BOOKS:

1. Nag. P.K., "Power Plant Engineering", Third Edition, Tata McGraw – Hill Publishing Company Ltd., 2017.
2. A Textbook of Power Plant Engineering by R.K. Rajput | 1 January 2016

REFERENCE BOOKS:

1. El-Wakil. M.M., "Power Plant Technology", Tata McGraw – Hill Publishing Company Ltd., 2010.
2. Godfrey Boyle, "Renewable energy", Open University, Oxford University Press in association with the Open University, 2004.
3. Power Plant Engineering by B. Vijaya Ramnath C. Elanchezhian, L. Saravanakumar | 1 November 2019
4. Power Plant Engineering, As per AICTE: Theory and Practice by Dipak Kumar Mandal, Somnath Chakrabarti, et al. | 1 January 2019
5. Bell C., “Beginning Sensor Networks with Arduino and Raspberry Pi”, Apress, 2013

U23MEP71	MECHATRONICS AND IoT LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES

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

1. To study the concept of mechatronics to design, modelling and analysis of basic electrical hydraulic systems.
2. To provide the hands on-training in the control of linear and rotary actuators.
3. To study the concepts and fundamentals of IoT, sensors, actuators and IoT boards
4. Learn communication protocols and networking concepts for IoT systems.
5. Acquire data acquisition and analysis techniques for mechatronics and IoT applications.

LIST OF EXPERIMENTS

1. Measurement of Linear/Angular of Position, Direction and Speed using Transducers.
2. Measurement of Pressure, Temperature and Force using Transducers.
3. Speed and Direction control of DC Servomotor, AC Servomotor and Induction motors.
4. Addition, Subtraction and Multiplication Programming in 8051.
5. Programming and Interfacing of Stepper motor and DC motor using 8051/PLC.
6. Programming and Interfacing of Traffic Light Interface using 8051.
7. Sequencing of Hydraulic and Pneumatic circuits.
8. Sequencing of Hydraulic, Pneumatic and Electro-pneumatic circuits using Software.
9. Electro-pneumatic/hydraulic control using PLC.
10. Vision based image acquisition and processing technique for inspection and classification
11. Familiarization with concept of IoT and its open source microcontroller/SBC.
12. Write a program to turn ON/OFF motor using microcontroller/SBC through internet.
13. Write a program to interface sensors to display the data on the screen through internet.
14. Interface the sensors with microcontroller/SBC and write a program to turn ON/OFF Solenoid valve through internet when sensor data is detected.
15. To interface sensor with microcontroller/SBC and write a program to turn ON/OFF Linear/Rotary Actuator through IoT when sensor data is detected.
16. To interface Bluetooth/Wifi with microcontroller/SBC and write a program to send sensor data to smart phone using Bluetooth/wifi.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

CO1 : Demonstrate proficiency in designing and building functional mechatronic systems and IoT devices.

CO2 : Apply programming skills to effectively control and automate mechatronic systems and IoT devices.

CO3: Integrate sensors and actuators to enable data acquisition and real-time monitoring in mechatronic and IoT applications.

CO4: Implement wireless communication protocols to enable connectivity and data exchange among IoT devices.

CO5: Analyze acquired data to extract meaningful insights and make informed decisions in mechatronics and IoT.

CO6: Efficiently troubleshoot and debug issues in mechatronic systems and IoT devices.

U23MEP72	SIMULATION AND ANALYSIS LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES

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

1. Understand the software tools needed to analyse engineering problems.
2. Experiment on MATLAB for solving dynamic problems.
3. Apply the simulation and analysis tools.
4. Experiment the structural and dynamic analysis using the FE tool.
5. Illustrate the time-variant analysis using a FE tool.

LIST OF EXPERIMENTS

1. MATLAB basics, Dealing with matrices, Graphing-Functions of one variable and two variables
2. Mechanism Simulation using Multibody Dynamic software
3. Force and Stress analysis using link elements in Trusses, cables etc.
4. Stress and deflection analysis in beams with different support conditions.
5. Stress analysis of flat plates and simple shells.
6. Stress analysis of axi – symmetric components.
7. Thermal stress and heat transfer analysis of plates.
8. Thermal stress analysis of cylindrical shells.
9. Vibration analysis of spring-mass systems.
10. Model analysis of Beams.
11. Harmonic, transient and spectrum analysis of simple systems.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

CO1 : Proficiency in using simulation software for modeling and analysis.

CO2 : Applied knowledge of simulation techniques for real-world problems.

CO3: Skills in data analysis and interpretation of simulation results.

CO4: Ability to validate and verify simulation models.

CO5: Utilization of simulation for system optimization and sensitivity analysis.

CO6: Assessment of risks and support for decision-making through simulation.

SEMESTER VIII

U23MET81	PRODUCTION PLANNING AND CONTROL	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 production planning and control principles and methodologies.
2. Analyze and optimize production systems for improved efficiency.
3. Develop production plans considering demand forecasting and inventory management.
4. Implement production control mechanisms to ensure smooth operations.
5. Utilize production planning tools and systems for streamlined processes.

UNIT I INTRODUCTION 9

Objectives and benefits of planning and control-Functions of production control-Types of production job- batch and continuous-Product development and design-Marketing aspect - Functional aspects- Operational aspect-Durability and dependability aspect aesthetic aspect. Profit consideration- Standardization, Simplification & specialization- Break even analysis-Economics of a new design.

UNIT II WORK STUDY 9

Method study, basic procedure-Selection-Recording of process - Critical analysis, Development - Implementation - Micro motion and memo motion study – work measurement - Techniques of work measurement - Time study - Production study - Work sampling - Synthesis from standard data - Predetermined motion time standards.

UNIT III PRODUCT PLANNING AND PROCESS PLANNING 9

Product planning-Extending the original product information-Value analysis-Problems in lack of product planning-Process planning and routing-Pre requisite information needed for process planning- Steps in process planning-Quantity determination in batch production-Machine capacity, balancing- Analysis of process capabilities in a multi product system.

UNIT IV PRODUCTION SCHEDULING 9

Production Control Systems-Loading and scheduling-Master Scheduling-Scheduling rules-Gantt charts-Perpetual loading-Basic scheduling problems - Line of balance – Flow production scheduling- Batch production scheduling-Product sequencing – Production Control systems-Periodic batch control-Material requirement planning kanban – Dispatching-Progress reporting and expediting- Manufacturing lead time-Techniques for aligning completion times and due dates.

UNIT V INVENTORY CONTROL AND RECENT TRENDS IN PPC 9

Inventory control-Purpose of holding stock-Effect of demand on inventories-Ordering procedures. Two bin system -Ordering cycle system-Determination of Economic order quantity and economic lot size- ABC analysis-Recorder procedure-Introduction to computer integrated production planning systems- elements of JUST IN TIME SYSTEMS-Fundamentals of MRP II and ERP.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 : Demonstrate an understanding of production planning and control principles, concepts, and methodologies.

CO2 : Analyze and optimize production systems to enhance operational efficiency and productivity.

CO3: Develop effective production plans considering factors such as demand forecasting, inventory management, and lead time optimization.

CO4: Implement production control mechanisms to ensure timely and efficient execution of production activities.

CO5: Utilize production planning tools and systems effectively to streamline processes and improve production performance.

CO6: Identify and address bottlenecks in production systems through data analysis and continuous improvement strategies.

TEXT BOOKS:

1. Martand Telsang, "Industrial Engineering and Production Management", First edition, S. Chand and Company, 2000.
2. James.B. Dilworth," Operations management – Design, Planning and Control for manufacturing and services" Mcgraw Hill International edition 1992.

REFERENCE BOOKS:

1. Elwood S.Buffa, and Rakesh K.Sarin, "Modern Production / Operations Management", 8th Edition, John Wiley and Sons, 2000.
2. Kanishka Bedi, "Production and Operations management", 2nd Edition, Oxford university press, 2007.
3. Melynk, Denzler, "Operations management – A value driven approach" Irwin Mcgraw hill.
4. Norman Gaither, G. Frazier, "Operations Management", 9th edition, Thomson learning IE, 2007
5. Upendra Kachru, "Production and Operations Management – Text and cases", 1st Edition, Excel books 2007.

U23MET82	INDUSTRIAL MANAGEMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

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

1. To study the basic concepts of management; approaches to management; contributors to management studies; various forms of business organization and trade unions function in professional organizations.
2. To study the planning; organizing and staffing functions of management in professional organization.
3. To study the leading; controlling and decision making functions of management in professional organization.
4. To learn the organizational theory in professional organization.
5. To learn the principles of productivity and modern concepts in management in professional organization.

UNIT I INTRODUCTION TO MANAGEMENT 9

Management: Introduction; Definition and Functions – Approaches to the study of Management – Mintzberg's Ten Managerial Roles – Principles of Taylor; Fayol; Weber; Parker – Forms of Organization: Sole Proprietorship; Partnership; Company (Private and Public); Cooperative – Public Sector Vs Private Sector Organization – Business Environment: Economic; Social; Political; Legal – Trade Union: Definition; Functions; Merits & Demerits.

UNIT II FUNCTIONS OF MANAGEMENT - I 9

Planning:Characteristics; Nature; Importance; Steps; Limitation; Planning Premises; Strategic Planning; Vision & Mission statement in Planning– Organizing: Organizing Theory; Principles; Types; Departmentalization; Centralization and Decentralization; Authority & Responsibility – Staffing: Systems Approach; Recruiting and Selection Process; Human Resource Development (HRD) Concept and Design

UNIT III FUNCTIONS OF MANAGEMENT - II 9

Directing (Leading): Leadership Traits; Style; Morale; Managerial Grids (Blake-Mounton, Reddin) – Communication: Purpose; Model; Barriers – Controlling: Process; Types; Levels; Guidelines; Audit (External, Internal, Merits); Preventive Control – Decision Making: Elements; Characteristics; Nature; Process; Classifications.

UNIT IV ORGANIZATION THEORY 9

Organizational Conflict: Positive Aspects; Individual; Role; Interpersonal; Intra Group; Inter Group; Conflict Management – Maslow's hierarchy of needs theory; Herzberg's motivation-hygiene theory; McClelland's three needs motivation theory; Vroom's valence-expectancy theory – Change Management: Concept of Change; Lewin's Process of Change Model; Sources of Resistance; Overcoming Resistance; Guidelines to managing Conflict

UNIT V PRODUCTIVITY AND MODERN TOPICS 9

Productivity: Concept; Measurements; Affecting Factors; Methods to Improve – Modern Topics (concept, feature/characteristics, procedure, merits and demerits): Business Process Reengineering (BPR); Benchmarking; SWOT/SWOC Analysis; Total Productive Maintenance; Enterprise Resource Planning (ERP); Management of Information Systems (MIS), Industry 4.0.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 : Discuss basic concepts of management; approaches to management; contributors to management studies.

CO2 : Discuss the planning; organizing and staffing functions of management in professional organization.

CO3: Apply the leading; controlling and decision making functions of management in professional organization.

CO4: Discuss the organizational theory in professional organization.

CO5: Apply principles of productivity and modern concepts in management in professional organization.

CO6: Discuss various forms of business organization and trade unions function in professional organizations.

TEXT BOOKS:

1. M. Govindarajan and S. Natarajan, "Principles of Management", Prentice Hall of India, New Delhi, 2009.
2. Koontz. H. and Weihrich. H., "Essentials of Management: An International Perspective", 8th Edition, Tata McGrawhill, New Delhi, 2010.

REFERENCE BOOKS:

1. Joseph J, Massie, "Essentials of Management", 4th Edition, Pearson Education, 1987.
2. Saxena, P. K., "Principles of Management: A Modern Approach", Global India Publications, 2009.
3. S.Chandran, "Organizational Behaviours", Vikas Publishing House Pvt. Ltd., 1994.
4. Richard L. Daft, "Organization Theory and Design", South Western College Publishing, 11th Edition, 2012.
5. S. TrevisCerto, "Modern Management Concepts and Skills", Pearson Education, 2018.

U23MEP81	PROJECT WORK	L	T	P	C
		0	0	12	6

COURSE OBJECTIVES

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

1. To develop the ability to solve a specific problem right from its identification and literature review till the successful solution of the same.
2. To train the students in preparing project reports and to face reviews and viva voce examination.
3. The students in a group of 3 to 4 works on a topic approved by the head of the department under the guidance of a faculty member and prepare a comprehensive project report after completing the work to the satisfaction of the supervisor.
4. The progress of the project is evaluated based on a minimum of three reviews. The review committee may be constituted by the Head of the Department. A project report is required at the end of the semester.
5. The project work is evaluated based on oral presentation and the project report jointly by external and internal examiners constituted by the Head of the Department.

TOTAL: 180 PERIODS

COURSE OUTCOMES:

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

CO1 : On Completion of the project work students will be in a position to take up any challenging practical problems and find solution by formulating proper methodology.

CO2 : Develop project management skills for effective planning and execution.

CO3: Collaborate in cross-functional teams to achieve project objectives.

CO4: Apply critical thinking and problem-solving techniques to address project challenges.

CO5: Foster creativity and innovation in project solutions and deliverables.

CO6: Communicate project progress and outcomes through effective presentations and reports.

VERTICAL 1: PROCESS EQUIPMENT AND PIPING DESIGN

U23MEV11	DESIGN OF PRESSURE VESSELS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

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

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.

UNITV PIPING **9**

Introduction – Flow diagram – piping layout and piping stress Analysis

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 : Explain Methods for determining stresses Terminology and Ligament Efficiency and Applications
CO2 : Analysis stress in pressure vessels
CO3: Design and analysis of pressure vessels.
CO4: Analysis of buckling and fracture analysis in vessels
CO5: Design piping layout
CO6: Analysis of stresses in piping

TEXT BOOKS:

1. John F. Harvey,& quot;Theory and Design of Pressure Vessels & quot; CBS Publishers and Distributors,1987.

REFERENCE BOOKS:

1. Henry H. Bedner, “Pressure Vessels, Design Hand Book & quot;, CBS publishers and Distributors,1987.
2. Stanley, M. Wales, “Chemical process equipment, selection and Design & quot;. 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.

U23MEV12	FAILURE ANALYSIS AND NDT TECHNIQUES	L	T	P	C
		2	0	2	3

COURSE OBJECTIVES

The main objectives of this course are to:

1. To introduce need and scope of failure analysis and fundamental sources of failures.
2. To learn about non-destructive testing and basic principles of visual inspection
3. To study about magnetic testing and principles, techniques.
4. To learn the principle of radiography testing and its inspection techniques and methods
5. To study the acoustic testing principle and technique and instrumentation.

UNIT I INTRODUCTION 9

Introduction and need and scope of failure analysis. Engineering Disasters and understanding failure analysis. Fundamental sources of failures. Deficient design. Improper Manufacturing & Assembly. Tree diagram and FMEA.

UNIT II VISUAL INSPECTION 9

Introduction to Non-Destructive Testing: An Introduction, Visual examination, Basic Principle, The Eye, Optical aids used for visual inspection, Applications. Liquid Penetrant Testing: Physical principles, Procedure for penetrant testing, Penetrant testing materials, Penetrant testing methods, Sensitivity, Applications, Limitations and Standards.

UNIT III MAGNETIC TESTING 9

Magnetic Particle Testing, Eddy Current Testing: Magnetism-basic definitions and principle of. magnetic particle testing, Magnetizing techniques, induced current flow, Procedure used for testing a component, Equipment Used for magnetic particle testing, Sensitivity, Limitations. Eddy Current Testing: Principles, Instrumentation for eddy current testing Techniques. Sensitivity Advanced Eddy Current Test Methods, Applications, Limitations.

UNIT IV RADIOGRAPHY TESTING 9

Radiography, Ultrasonic Testing: Basic principle, Electromagnetic radiation, Sources, Radiation attenuation in the specimen. Effect of radiation in film, Radiographic imaging, Inspection techniques, Applications of radiographic inspection, Limitations, Safety in Industrial Radiography, Standards, Neutron radiography. Ultrasonic Testing: Basic properties of sound beam, Ultrasonic transducers, Inspection methods, Techniques for Normal Beam Inspection, Techniques for Angle Beam Inspection, Flaw characterization techniques, Ultrasonic flaw detection equipment, Modes of Display, Immersion Testing, Applications of Ultrasonic Testing,
Advantages, Limitations.

UNIT V ACOUSTIC TESTING 9

Acoustic Emission Testing: Principle of Acoustic Emission Testing, Technique, Instrumentation, Sensitivity, Applications, Standards. Thermograph: Basic Principles, Detectors and Equipment, Techniques, Applications, Codes and Standards. In Situ Metallographic Examination: Approach to the Selection of Site for Metallographic examination, Replication process, Significance of Microstructure observation, Decision making, Applications, Codes and Standards.(digital signal process).

TOTAL: 45 PERIODS

NON-DESTRUCTIVE TESTING LABORATORY

1. Conducting experiment using liquid penetrant testing
2. Conducting experiment using magnetic particle testing
3. Conducting experiment using ultrasonic testing
4. Conducting experiment using electromagnetic testing
5. Conducting experiment using acoutistic emission testing

TOTAL :30 PERIODS

COURSE OUTCOMES:

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

CO1 : Discuss the need and scope of failure analysis and fundamental sources of failures.
CO2 : Describe about non-destructive testing and basic principles of visual inspection.
CO3: Explain about magnetic testing and principles, techniques.
CO4: Explain the principle of radiography testing and its inspection techniques and methods.
CO5: Describe the acoustic testing principle and technique and instrumentation
CO6: Compare non-destructive testing

TEXT BOOKS:

1. Baldev Raj, T.Jayakumar, M.Thavasimuthu Practical Non-Destructive Testing, Narosa Publishing House, 2014.
2. Ravi Prakash, Non-Destructive Testing Techniques, 1st revised edition, New Age International Publishers, 2010

REFERENCE BOOKS:

1. ASM Metals Handbook, Non-Destructive Evaluation and Quality Control, American Society of Metals, Metals Park, Ohio, USA, 200, Volume-17.
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. Charles, J. Hellier, Handbook of Non destructive evaluation, McGraw Hill, New York 2001.
4. Paul E Mix, Introduction to Non-destructive testing: a training guide, Wiley, 2nd Edition NewJersey, 2005
5. J.Prasad and C. G. K. Nair, Non-Destructive Test and Evaluation of Materials, Tata McGraw-Hill Education, 2nd edition (2011).

U23MEV13	MATERIAL HANDLING AND SOLID PROCESSING EQUIPMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

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

1. To provide knowledge on materials handling equipment.
2. To provide knowledge on Industrial Vehicles
3. To provide knowledge on conveyor equipment.
4. To provide knowledge on Auxiliary Equipment and Hoisting Equipment.
5. To provide knowledge on Bulk Handling Equipment and Systems

UNIT I INTRODUCTION TO MATERIALS HANDLING 9

Basic principles & objectives in material handling and its benefits - Classification of material handling equipment - selection of material handling equipments - guidelines for effective utilisation of material handling equipments -unit load concept.

UNIT II INDUSTRIAL VEHICLES 9

Introduction and types - Hand trucks - Two wheel Hand Trucks - Multiple wheel Hand Trucks - Hand Lift Trucks - Power Trucks - Fixed Platform Truck - Platform Lift Truck - Pallet Lift Truck - Walkie Truck - Straddle Carrier - Fork Lift Trucks - Specifications of FLT - FLT Attachments - Tractors - Industrial Tractor-Trailer-Self-propelled trucks and fork trucks - Automated guided vehicles Theory.

UNIT III CONVEYORS 9

Classification of conveyors- Definition - Description - General Characteristics - types and uses of belt Conveyors - Roller conveyors - Haulage Conveyors - Screw Conveyors - Bucket Conveyors - Chain Conveyors - Cable Conveyors - Pneumatic and Hydraulic conveyors – Computer controlled conveyor system.

UNIT IV AUXILIARY EQUIPMENTAND HOISTING EQUIPMENT 9

Hoppers - Gates- Feeders- Chutes-positioners- Ball Table- Weighing and Control Equipment- Pallet loaders and unloaders -applications and advancements. - Hoisting Equipment - parts of hoisting equipment - Description and uses of hoists - Description and uses of ropes – description and purpose of crane hooks - Elevators - Cranes - Derricks - and its types.

UNIT V BULK HANDLING EQUIPMENT AND SYSTEMS 9

Storage of bulk solids - bulk handling equipment - Robotic handling - Materials handling at the workplace - Robots and their classification - Major components of a robot - classification of Robotic manipulators - Robotic handling applications.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 : Discuss the basic concepts of material handling equipment.

CO2 : Explain the basic working principles of various industrial Vehicles.

CO3: Develop the basic working principles of various conveyors.

CO4: Elaborate the basic working principles of various Auxiliary Equipment and Hoisting Equipment.

CO5: Explain the basic working principles of various Bulk Handling Equipment and Systems.

CO6: Identify the various material handling equipments

TEXT BOOKS:

1. Allegri (Sr.), T.H., Material Handling – Principles and Practices, CBS Publishers and Distributors,Delhi, 1987.
2. Siddharta Ray, Introduction to Materials Handling, New Age International Publishers

REFERENCE BOOKS:

1. Bolz, H. A and Hagemann, G. E (ed.), ‘‘Materials Handling Handbook’’, Ronald Press 8005:1976, Classification of Unit Loads, Bureau of Indian Standards.
2. Apple, J.A., ‘‘Material Handling System Design’’, John Wiley & Sons
3. Theodore H., Allegre Sr., Material Handling Principles and Practice, CBS Publishers and Distributors
4. Immer J. R., Material Handling, Tata McGraw Hill Publication

U23MEV14	ROTATING MACHINERY DESIGN	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

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

1. To familiarize the course member with various operations of gas turbines and other driven rotating machines.
2. To familiarize students with the common problems associated with the mechanical design and the lifting of the major rotating components of the gas turbine engine.
3. To study the failure criteria of rotating machinery.
4. To learn the design of discs, blades for rotating machinery.
5. To study about blade vibrations Damage Mechanisms.

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 major loadings-rotating components and pressure casing components.

UNIT III FAILURE CRITERIA 9

Monotonic failure criteria: proof, ultimate strength. Theories of failure - bi-axial loads. Other failure mechanisms - gas turbine engines including creep and fatigue. Fatigue properties - SN and RM diagrams. Stress concentration, mean stress, Cumulative fatigue, Goodman diagram and safety factor for 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 turbo machine 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:

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

CO1 :	Differentiate the operational regimes and requirements related to different gas turbine applications.
CO2 :	Describe and distinguish the design requirements and loads encountered by gas turbine components during normal operation.
CO3:	Assess the creep and fatigue damage of gas turbine components based on design and operational parameters.
CO4:	Analyse, evaluate and assess the loads, stresses, failure criteria and factors of safety used in gas turbine engines.
CO5:	Design the turbine blade
CO6:	Evaluate impact of vibrations on design and operation of gas turbine.

TEXT BOOKS:

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

REFERENCE BOOKS:

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

U23MEV15 THERMAL AND FIRED EQUIPMENT DESIGN

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

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

1. To introduce the concepts of thermal and fired equipment.
2. To study the basis, design and construction of boilers.
3. To study of typical fuel firing systems in the boiler.
4. To study of materials requirements for pressure parts.
5. To study of various boiler auxiliaries system.

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

COURSE OUTCOMES:

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

CO1 : Explain the concepts of thermal and fired equipment.
CO2 : Discuss the basis, design and construction of boilers.
CO3: Describe of typical fuel firing systems in the boiler.
CO4: Discuss the materials requirements for pressure parts.
CO5: Design various pressure parts
CO6: Discuss of various boiler auxiliaries system.

TEXT BOOKS:

1. A Course in Power Plant Engineering; Dhanapat Rai and Sons – Domkundwar 2005.
2. 2Power Plant Engineering by B. Vijaya Ramnath C. Elanchezhian, L. Saravanakumar

REFERENCE BOOKS:

1. 1. Elwakil M, Power Plant Technology, McGraw Hill, New York, 1964
2. 2. Steam Generators and Waste Heat Boilers: For Process and Plant Engineers
3. (Mechanical Engineering) by V. Ganapathy
4. 3. Steam Generators: Description and Design by Donatello Annaratone

U23MEV16	INDUSTRIAL LAYOUT DESIGN AND SAFETY	L	T	P	C
		2	0	2	3

COURSE OBJECTIVES

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

1. To introduce the industrial facility layout design principles, process and material flow analysis and product and equipment analysis.
2. To learn the facilities layout design algorithms and selecting appropriate software.
3. To study the facilities layout problem modelling tools and algorithms for production, warehouse, and material handling.
4. To learn the safety planning and management principles in industries.
5. To learn the various safety management approaches in industries.

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

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 PERIODS

COURSE OUTCOMES:

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

CO1 : Explain the industrial facility layout design principles, process and material flow analysis and product and equipment analysis.
CO2 : Discuss the facilities layout design algorithms and selecting appropriate software.
CO3: Describe the facilities layout problem modeling tools and algorithms for production, warehouse, and material handling.
CO4: Explain the safety planning and management principles in industries.
CO5: Illustrate the various safety management approaches in industries.
CO6: Design various industrial layout

TEXT BOOKS:

1. Sunderesh S. Heragu, “Facilities Design”, 3 rd 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.

REFERENCE BOOKS:

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”, 4 th Edition, John Wiley & Sons, 2010.
3. Matthew P. Stevens and Fred E. Meyers, “Manufacturing Facilities Design and Material Handling”, 5 th 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 impression by Ralph W King and John Magid | 24 September 2013

U23MEV17 **DESIGN CODES AND STANDARDS**

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

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

1. To study the Codes and Standards and Need for them in the Industry
2. To know the different sources and the bodies that publish Codes and Standards
3. To familiarize the Government Regulations and its applicability
4. To familiarize with different codes used in Different Industry
5. To familiarize the Codes and Standards used in Process Industry

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

COURSE OUTCOMES:

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

CO1 :	Explain the need for codes and Standards in Industry.
CO2 :	Discuss the different codes and standards used in different industry.
CO3:	Discuss the Process of Standardisation and Code publishing in Professional Bodies and Companies
CO4:	Explain need for Government regulations and Certification authorities and familiar with common regulations in India and International
CO5:	Discuss knowledge of codes and standards used in Process equipment design for Oil and Gas Industry.
CO6:	**Identify the various testing committee and its standards**

TEXT BOOKS:

1. Perry, R.H. and Green, D.W. Publisher: McGraw-Hill Great reference book in Chemical Engineering.

REFERENCES:

1. ASME
2. API
3. ISO, IBR, OISD
4. AWS
5. ISHRAE

VERTICAL 2: ROBOTICS AND AUTOMATION

U23MEV21	SENSORS AND INSTRUMENTATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

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

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

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 8

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 10

Photo conductive cell, photo voltaic, Photo resistive, LDR – Fiber optic sensors – Pressure – Diaphragm, Bellows, Piezoelectric – Tactile sensors, Temperature – IC, Thermistor, RTD, Thermocouple. Acoustic Sensors – flow and level measurement, Radiation Sensors - Smart Sensors - Film sensor, MEMS & Nano Sensors, LASER sensors.

UNIT V SIGNAL CONDITIONING AND DAQ SYSTEMS 9

Amplification – Filtering – Sample and Hold circuits – Data Acquisition: Single channel and multi-channel data acquisition – Data logging - applications - Automobile, Aerospace, Home appliances, Manufacturing, Environmental monitoring.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 : Recognize with various calibration techniques and signal types for sensors.
CO2 : Describe the working principle and characteristics of motion and proximity sensors
CO3: Describe the working principle and characteristics of range sensors
CO4: Apply the various sensors and transducers in various applications
CO5: Select the appropriate sensor for different applications.
CO6: Acquire the signals from different sensors using Data acquisition systems.

TEXT BOOKS:

1. Ernest O Doebelin, "Measurement Systems – Applications and Design", Tata McGraw-Hill, 2009.
2. Sawney A K and Puneet Sawney, "A Course in Mechanical Measurements and Instrumentation and Control", Dhanpat Rai & Co, 12th edition New Delhi, 2013.

REFERENCE BOOKS:

1. C. Sujatha ... Dyer, S.A., Survey of Instrumentation and Measurement, John Wiley & Sons, Canada, 2001.
2. Hans Kurt Tönshoff (Editor), Ichiro, "Sensors in Manufacturing" Volume 1, Wiley-VCH April 2001.
3. John Turner and Martyn Hill, "Instrumentation for Engineers and Scientists", Oxford Science Publications, 1999.
4. Patranabis D, "Sensors and Transducers", 2nd Edition, PHI, New Delhi, 2011.
5. Richard Zurawski, "Industrial Communication Technology Handbook" 2nd edition, CRC Press, 2015.

U23MEV22 ELECTRICAL DRIVES AND ACTUATORS

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

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

1. To familiarize a relay and power semiconductor devices
2. To get a knowledge on drive characteristics
3. To obtain the knowledge on DC motors and drives.
4. To obtain the knowledge on AC motors and drives.
5. To obtain the knowledge on Stepper and Servo motor.

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.

UNITV STEPPER AND SERVO MOTOR 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

CO1 : Recognize the principles and working of relays, drives and motors.

CO2 : Explain the working and characteristics of various drives and motors.

CO3: Apply the solid state switching circuits to operate various types of Motors and Drivers

CO4: Interpret the performance of Motors and Drives.

CO5: Discuss the stepper motors and its applications

CO6: Discuss the servo motors and its applications

TEXT BOOKS:

1. Bimbhra B.S., "Power Electronics", 5th Edition, Kanna Publishers, New Delhi, 2012.
2. Mehta V.K. & Rohit Mehta, "Principles of Electrical Machines", 2nd Edition, S.Chand& Co. Ltd., New Delhi, 2016.

REFERENCE BOOKS:

1. Gobal K. Dubey, "Fundamentals of Electrical Drives", 2nd Edition, Narosal Publishing House, New Delhi, 2001.
2. Theraja B.L. &Theraja A.K., "A Text Book of Electrical Technology", 2nd Edition, S. Chand& Co. Ltd., New Delhi, 2012.
3. Singh M.D. &Kanchandhani K.B., "Power Electronics", McGraw Hill, New Delhi, 2007

U23MEV23	EMBEDDED SYSTEMS AND PROGRAMMING	L	T	P	C
		2	0	2	3

COURSE OBJECTIVES

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

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

UNIT I INTRODUCTION TO MICROCONTROLLER 6

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 6

Fundamentals of Assembly Language Programming – Instruction to Assembler – Compiler and IDE 715.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 6

I/O Programming – Interfacing of Memory, Key Board 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 6

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.

UNITV SINGLE BOARD COMPUTERS AND PROGRAMMING 6

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: 30 PERIODS

LIST OF EXPERIMENTS

1. Assembly Language Programming and Simulation of 8051.
2. Alphanumeric and Graphic LCD Interfacing using 8051 Microcontroller.
3. Input switches and keyboard interfacing of 8051.
4. Sensor Interfacing with ADC to 8051 and DAC & RTC Interfacing with 8051. .
5. Timer, Counter and Interrupt Program Application for 8051.
6. Step Motor (Unipolar & Bipolar Motor) and PWM Servo Motor Control to Interfacing with 8051.
7. UART Serial and Parallel Port Programming of 8051.
8. I2C, SPI and CAN Programming of 8051.
9. Interfacing and Programming of Bluetooth and Wi-Fi with 8051
10. Programming of ARM Processor for Sensor Interface.
11. Stepper Motor and Servo Motor Control Using ARM Processor.
12. Serial Communication of ARM Processor with Computation Platform.
13. Wireless Communication of ARM Processor with Computation Platform.
14. GPIO Programming of Real Time Embedded Operating Systems.
15. IOT application using SBC

TOTAL: 30 PERIODS

COURSE OUTCOMES:

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

CO1: Know the various functional units of microcontroller, processors and system-on-chip based on the features and specifications.

CO2 : Recognize the role of each functional units in microcontroller, processors and system-on-chip based on the features and specifications.

CO3: Interface the sensors, actuators and other I/O's with microcontroller, processors and system on chip based interfacing

CO4: Design the circuit and write the programming microcontroller, processors and system on chip

CO5: Develop the applications using Embedded system

CO6: Write programs in Embedded Systems

TEXT BOOKS:

1. Frank Vahid and Tony Givagis, "Embedded System Design", 2011, Wiley.
2. Kenneth J. Aylala, "The 8051 Microcontroller, the Architecture and Programming Applications", 2003

REFERENCE BOOKS:

1. Muhammad Ali Mazidi and Janice GillispicMazdi, "The 8051 Microcontroller and Embedded Systems", Pearson Education, 2006.
2. Simon Monk, Programming the Raspberry Pi, Second Edition: Getting Started with Python McGraw Hill TAB; 2nd edition,2015
3. James W. Stewart, "The 8051 Microcontroller Hardware, Software and Interfacing", Regents Prentice Hall, 2003.
4. John B. Peatman, "Design with Microcontrollers", McGraw Hill International, USA, 2005.

U23MEV24	MODELING AND CONTROL OF ROBOT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

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

1. To learn about basics of robots and their classifications
2. To understand the robot kinematics in various planar mechanisms
3. To learn about the concepts in robot dynamics
4. To understand the concepts in trajectory planning and programming
5. To know about the various applications of robots

UNIT I INTRODUCTION 9

Introduction to Robotics. Mechanical structure: Robot Configuration - Robot Anatomy, Sub-systems/Elements of Industrial Robot - Performance characteristics of industrial Robots. Mobile robot locomotion: Introduction, key issues for locomotion, wheeled locomotion-wheel design, geometry, stability, manoeuvrability and controllability. Applications - Progressive advancement in Robots Point to point and continuous motion applications - Mobile manipulators and its applications.

UNIT II KINEMATICS OF ROBOT 9

Kinematic model - Forward Kinematics for two DOF manipulator Algebraic method, Mechanical structure and notations, Coordinate frames, Description of objects in space, Transformation of vectors, Fundamental rotation matrices (principal axes and fixed angle rotation) Description of links and joints, Denavit-Hartenberg (DH) notation, Forward Kinematics for multi-Degrees of Freedom (DOF) manipulator. Inverse kinematics of two DOF planar manipulator – Manipulator workspace. Mobile Robot kinematics: kinematic model and constraints, Mobile robot workspace-motion control.

UNIT III MODELING OF ROBOT 9

Static model: Differential relationship - Velocity analysis Jacobian matrix Determination of forces and equivalent torques for joints of two link planar robot arm.

Dynamic model: Euler Lagrangian formulation - Forward and inverse dynamic model for two DOF planar manipulator.

Trajectory planning: Definitions and planning tasks, Joint space techniques Motion profiles Cubic polynomial, and cycloidal motion - Cartesian space techniques. Navigation: Graph search and potential field path planning - navigation architecture - offline and online planning.

UNIT IV PLANNING, NAVIGATION AND CONTROL OF MOVEMENTS 9

Trajectory planning: Definitions and planning tasks, Joint space techniques Motion profiles Cubic polynomial, and cycloidal motion - Cartesian space techniques. Navigation: Graph search and potential field path planning - navigation architecture - offline and online planning.

Robot Task Planning Modeling and Task Specification - Problems in task planning: Spatial relationship, obstacle avoidance and grasp planning Expert System and Knowledge Engineering: Construction of expert system, Rule-based systems Knowledge representation.

UNITV CONTROL SYSTEM 9

Control System: The manipulator control problem, Linear second-order model of manipulator. Functions of controller and power amplifier. Joint actuators- stepper motor, servo motor. Control Schemes: PID control scheme Position and force control schemes. Robotic sensors and its classification, Internal sensors Position, velocity, acceleration and force information, External

Sensors Contact sensors-Limit switches, piezo-elcetric, pressure pads, Non-contact sensors Range sensors, Vision sensor- robotic vision system, Description of components of vision system.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- **CO1 :** Describe the working of the subsystems of robotic manipulator and wheeled mobile robot
- **CO2 :** Develop the forward kinematic model of multi-degree of freedom (DOF) manipulator and inverse kinematic model of two and three degrees of freedom planar robot arm and wheeled robot
- **CO3:** Develop the static force and dynamic model of two degrees of freedom planar robot arm
- **CO4:** Generate a trajectory in joint space using cubic polynomial and trigonometric functions with given kinematic constraints of two and three degree of freedom (DOF) manipulator
- **CO5:** Develop a knowledge representation for task planning of robotic applications such as pick and place, palletizing, sorting and inspection of work-parts
- **CO6:** Identify various sensors used in control system

TEXT BOOKS:

1. K.S. Fu, R.C Gonzalez and C.S. Lee, Robotics- Control, Sensing, Vision and Intelligence, Tata McGraw-Hill Editions, 2008.
2. Siciliano, B., Sciavicco, L., Villani, L., Oriolo, G., Robotics: Modelling, Planning and Control, First edition, Springer-Verlag London,2009

REFERENCE BOOKS:

1. Mark W.Spong, M.Vidyasagar, Robot dynamics and control, Wiley India, 2009.
2. Hertzberg J., Chatila R. (2008) AI Reasoning Methods for Robotics. In: Siciliano B., Khatib O. (eds) Springer Handbook of Robotics. Springer, Berlin, Heidelberg Machine Learning. Tom Mitchell. First Edition, McGraw- Hill, 1997.

U23MEV25	SMART MOBILITY AND INTELLIGENT VEHICLES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

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

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

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

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 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 PERIODS

COURSE OUTCOMES:

At the end of the course the students would 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
- **CO5:** Analyze the concept of the connected vehicle and its role in automated vehicles
- **CO6:** Identify various issues in connected cars

TEXT BOOKS:

1. "Intelligent Transportation Systems and Connected and Automated Vehicles", 2016, Transportation Research Board
2. Radovan Miucic, "Connected Vehicles: Intelligent Transportation Systems", 2019, Springer.

REFERENCE BOOKS:

1. Tom Denton, "Automobile Electrical and Electronic systems, Roultedge", Taylor & Francis Group,5th Edition,2018.

U23MEV26 HAPTICS AND IMMERSIVE TECHNOLOGIES

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

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

1. To learn various immersive technologies of VR, AR and MR.
2. To learn software related to immersive technologies.
3. To learn the concepts of developing AR applications.
4. To learn the concepts of developing VR and unreal engine.
5. To study the haptic perception and extended reality.

UNIT I INTRODUCTION TO IMMERSIVE TECHNOLOGIES 9

Introduction on Virtual reality – Augmented reality – Mixed reality – Extended reality – VR Devices– AR Devices – Applications.

UNIT II SOFTWARE TOOLS 9

Intro to Unity – Unity editor workspace – Intro to C# and visual studio - Programming in Unity – Intro to Unreal Engine – UE4 Editor workspace – Intro to Blueprint programming – Programming in Ue4.

UNIT III BUILDING AR APPLICATION WITH UNITY 9

AR SDKs for unity and unreal engine – Working with SDKs for unity – Developing AR application in unity - Building AR application.

UNIT IV BUILDING VR APPLICATION WITH UNREAL ENGINE 9

VR SDKs for unity and unreal engine – Developing VR application in Ue4 – Building VR application

UNIT V HAPTIC PERCEPTION AND EXTENDED REALITY 9

Extended Reality - Introduction to Haptics – Devices and possibilities – Custom Device development – Device Integration

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 : Describe the Virtual reality and Augmented reality
CO2 : Gaining the knowledge of different types of Tools and Devices
CO3: Acquiring the knowledge about Unity and Unreal Engine
CO4: Explain the developing application in immersive technologies
CO5: Discuss about haptics in immersive technologies
CO6: Apply detailed knowledge about immersive technology

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 , Rafal Pijewski, March 13, 2022

REFERENCE BOOKS:

1. Practical Augmented Reality, by Steve Aukstakalnis, Addison-Wesley Professional; 1st edition (8 September 2016)
2. Augmented Reality - Theory, Design and Development, by Chetankumar G Shetty.
3. Strategic Communication and AI, by Simon Moore , Roland Hübscher, Routledge; 1st edition (10 September 2021), ISBN-10 : 0367627795
4. Immersive Analytics, by Kim Marriott , Falk Schreiber, Springer; 1st ed. 2018 edition (15 October 2018).
5. Immersive Analytics A Clear and Concise Reference, by Gerardus Blokdyk, 5STARCooks (5 September 2018).

U23MEV27	DRONE TECHNOLOGIES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

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

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

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:

At the end of the course the students would 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
- **CO6:** Explain the safety risks and guidelines of fly safely

TEXT BOOKS:

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

REFERENCE BOOKS:

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

VERTICAL 3: CLEAN AND GREEN ENERGY TECHNOLOGIES

U23MEV31	BIO ENERGY CONVERSION TECHNOLOGIES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

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

1. To elucidate on biomass, types, availability, and characteristics
2. To study the bio-meth nation process.
3. To impart knowledge on combustion of bio fuels
4. To describe on the significance of equivalence ratio on thermo chemical conversion of biomass
5. To provide insight to the possibilities of producing liquid fuels from biomass

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

Biomethanation 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 CARBONISATIO004E 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 carbonisation

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 PERIODS

COURSE OUTCOMES:

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

CO1 : Estimate the surplus biomass availability of any given area.

CO2 : Design a biogas plant for a variety of biofuels.

CO3: Determine and compare the cost of steam generation from biofuels with that of coal and petroleum fuels.

CO4: Analyse the influence of process governing parameters in thermo chemical conversion of biomass.

CO5: Synthesize liquid biofuels for power generation from biomass.

CO6: Contrast the alcoholic fuels from biomass

TEXT BOOKS:

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).

REFERENCE BOOKS:

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

U23MEV32	CARBON FOOTPRINT ESTIMATION AND REDUCTION TECHNIQUES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

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

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

COURSE OUTCOMES:

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

CO1 : Explain the climate change and carbon footprint

CO2 : Discuss the principle of product life cycle and Green House Gas emissions accounting

CO3: Explain the Methodology for Carbon Footprint Calculation

CO4: Discuss emission mitigation and carbon sink

CO5: Explain the case study of carbon footprint.

CO6: Deduce the green house gas emission

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

REFERENCE BOOKS:

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.

U23MEV33	ENERGY CONSERVATION IN INDUSTRIES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

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

1. To learn Quantifying the energy demand and energy supply scenario of nation and explaining the need for energy auditing for becoming environmentally benign
2. To Analyzing factors behind energy billing and applying the concept of demand side management for lowering energy costs
3. To learn Computing the stoichiometric air requirement for any given fuel and quantifying the energy losses associated with thermal utilities of industries.
4. To Diagnosing the causes for under performance of various electrical utilities and suggesting remedies for improving their efficiency
5. To Applying CUSUM and other financial evaluation techniques to estimating the accruable energy savings/monetary benefits for any energy efficiency project

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

COURSE OUTCOMES:

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

CO1 : Discuss Quantify the energy demand and energy supply scenario of nation and appreciate the need for energy auditing for becoming environmentally benign

CO2 : Analyse factors behind energy billing and apply the concept of demand side management for lowering energy costs

CO3: Compute the stoichiometric air requirement for any given fuel and quantify the energy losses associated with thermal utilities of industries

CO4: Diagnose the causes for under performance of various electrical utilities and suggest remedies for improving their efficiency

CO5: Explain the elements of monitoring & targeting system

CO6: Apply CUSUM and other financial evaluation techniques to estimate the accruable energy savings/monetary benefits for any energy efficiency project

TEXT BOOKS:

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

REFERENCE BOOKS:

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.

U23MEV34	ENERGY EFFICIENT BUILDINGS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

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

1. To learn the climate and buildings, building efficiency rating and standards
2. Developing energy efficiency in building envelopes through alternate methods
3. To study the thermal comfort, passive heating and cooling techniques
4. To apply various energy saving concepts in buildings.
5. To incorporate Renewable energy systems in buildings

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 PERIODS

COURSE OUTCOMES:

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

CO1 : Familiar with climate responsive building design and basic concepts
CO2 : Explain the basic terminologies related to buildings
CO3: Discuss the energy efficient air conditioning techniques
CO4: Indicate the Electrical distribution systems in buildings
CO5: Express the Water and Waste Management systems
CO6: Consider Renewable energy systems in buildings

TEXT BOOKS:

1. Advanced Decision Making for HVAC Engineers, by Javad Khazaii, Springer; Softcover reprint of the original 1st ed. 2016 edition (23 June 2018), ISBN-10: 3319814869
2. Thermal Comfort and Energy-Efficient Cooling of Nonresidential Buildings, by Doreen E. Kalz, Jens Pfafferott, Springer; 2014th edition (8 April 2014), ISBN-10: 9783319045818

REFERENCE BOOKS:

1. JA Duffie and WA Beckman: Solar Engineering of Thermal Processes, Third Edition, John Wiley & Sons, 2006.
2. Jan F. Kreider, Peter S. Curtiss, Ari Rabl, Heating and Cooling of buildings: Design for Efficiency, Revised Second Edition, CRC Press, 28-Dec-2009.

U23MEV35	ENERGY STORAGE DEVICES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

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

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

COURSE OUTCOMES:

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

CO1 : Discuss the need and identify the suitable energy storage devices for applications.
CO2 : Explain the working of various energy storage devices and their importance.
CO3: Explain the basic characteristics of batteries for mobile and hybrid systems.
CO4: Discuss the storage of renewable energies and management systems.
CO5: Explain the need for other energy devices and their scope for applications
CO6: Discuss the need and identify the suitable energy storage devices 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

REFERENCE BOOKS:

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

U23MEV36 RENEWABLE ENERGY TECHNOLOGIES

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

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

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

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

COURSE OUTCOMES:

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

CO1 : Discuss the Indian and global energy scenario.
CO2 : Describe the various solar energy technologies and its applications.
CO3: Explain the various wind energy technologies.
CO4: Explore the various bio-energy technologies.
CO5: Discuss the ocean and geothermal technologies
CO6: Discuss the Indian and global energy scenario.

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

REFERENCE BOOKS:

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

U23MEV37 EQUIPMENT FOR POLLUTION CONTROL

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

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

1. To study the pollution control regulation and standards, water and wastewater.
2. To study the equipment for various water pollution.
3. To study the equipment for air pollution control.
4. To study the equipment for solid waste processing
5. To study the pollution monitoring equipment

UNIT I POLLUTION CONTROL REGULATIONS AND STANDARDS 9

Pollutants in water and wastewater – sources and impacts- Characteristics and impacts of solid and hazardous wastes - Indian Constitution and Environmental Protection Legislations - Environmental Standards under different Environmental legislations - Water Act, Air Act, Environmental Protection Act and major Notifications, Municipal solid Wastes (Management and Handling) Rules -Bio Medical Wastes (Management and Handling) Rules - Hazardous Wastes (Management and Handling Rules),Environment Impact Assessment Notifications - Unit operations and unit processes in Pollution Control- - Selection criteria for Pollution Control Equipment.

UNIT II EQUIPMENT FOR WATER POLLUTION CONTROL 9

Operational principles and Design criteria of Flash mixers, Flocculators, Clarifiers, Sand Filters, Adsorption Columns, Aerators, Air blowers, Distillation units, Centrifugal and Reciprocating Pumps, Chemical dosing systems, Motors, Pipes, valves and Fittings.- Filed visit to a wastewater treatment plant

UNIT III EQUIPMENT FOR AIR POLLUTION CONTROL 9

Operational principles and Design criteria of Cyclone separators, gravity settlers, Wet Scrubbers, Air strippers, Bag Filters, Electrostatic precipitators, Biofilters - Filed visit to an industry with air pollution control systems

UNIT IV EQUIPMENT FOR SOLID WASTE PROCESSING 9

Operational principles and Design criteria of Dewatering equipment – centrifuge, Vaccum Filter, Filter Press- Size Reduction equipment – shredders, grinders – Trommel and Disc Screens – Air Classifiers - bailing and briquetting – incinerators –Pyrolysis – field visit to a solid waste processing facility

UNIT V POLLUTION MONITORING EQUIPMENT 9

Equipment's for sampling of water, solids and air- Sample preservation Equipment – incubators – Cold Storage systems- equipment for analysis of water and air samples- Ambient air and flue gas sampling and monitoring equipment

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 : Explain the different types of pollution, their sources and effects.

CO2 : Discuss the pollution control regulations and standards

CO3: Design equipment for pollution control

CO4: Discuss different methods of pollution control from various sources in air, water and soil

CO5: Discuss the Conduct performance assessment of pollution control equipment

CO6: Explain the different types of pollution, their sources and effects.

TEXT BOOKS:

1. George Tchobanoglous, Hilary Theisen and Samuel A, Vigil, "Integrated Solid Waste Management, Mc-Graw Hill India, First edition, 2015.
2. Rao. C.S (2006)., "Environmental Pollution and Control Engineering", 2nd Edition, Revised,Wiley Eastern Limited, India.

REFERENCE BOOKS:

1. Shyam Diwan and Armin Rosencranz, Enviromental Law and Policy in India, Oxford, 2001
2. Metcalf & Eddy, INC, „Wastewater Engineering – Treatment and Reuse, Fourth Edition, Tata
3. Noel de Nevers, "Air Pollution Control Engg", Mc Graw Hill, New York, 2016.
4 CPCB (2021), "Pollution Control Acts, Rules and Notifications issued thereunder, PCL Series- Central Pollution Control Board, Delhi
5 CPHEEO, "Manual on Municipal Solid waste management,Vol I, II and III, Central Public
6 Health and Environmental Engineering Organisation , Government of India, New Delhi, 2016.

VERTICAL- 4: 3D PRINTING

U23MEV41	INTRODUCTION TO PRODUCT DESIGN	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

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

1. To comprehend design phases, product life cycle, and customer needs through Quality Function Deployment for effective engineering characteristics.
2. To explore innovation techniques and problem-solving tools to enhance design processes.
3. To acquire creative thinking methods to generate innovative design concepts.
4. To learn about product architecture and parametric design principles for efficient product development.
5. To gain insights into cost evaluation, ethical considerations, and economic decision-making in product design

UNIT I INTRODUCTION AND PROBLEM DEFINITION 9

Design as a Discipline-Cost reduction & Higher Sophistication-The Morphology of Design (seven phases) - Product Life Cycle. Problem Definition & Need Identification-Identifying customer needs-Establishing the engineering characteristics- Quality Function Deployment-Product Design Specifications-Case studies.

UNIT II INNOVATION 9

Time management – Problem Solving tools: Pareto charts, Cause and effect diagrams, Force field analysis – Planning and Scheduling – Tools for Planning and Scheduling: Gantt charts, critical path method. Case Studies. Criticality of data in design – Data sources: Library sources, Government sources, Internet sources, Information from Intellectual property rights – Company centred information

UNIT III DECISION MAKING 9

Creative thinking methods – Generating design concepts – Functional decomposition and synthesis – Inventive problem solving – Axiomatic design. Concept Evaluation: Pugh Concept Selection Method-Measurement Scales, Weighted Decision Matrix, Analytic Hierarchy Process – Concept Selection

UNIT IV EMBODIMENT DESIGN 9

Product Architecture – configuration design and best practices – Parametric design – Design for Assembly - Failure Mode Effect Analysis. Design for Environment – DFE Scoring Methods- Role of Prototyping in design – Concept of Rapid Prototyping- Detail design – Design communication-Bill of Materials-Common challenges in Technical Writing.

UNIT V ECONOMIC DESIGN 9

Cost evaluation – Methods of developing cost estimates – Make or Buy decision – Design to Cost: Order of magnitude estimates, Costing in Conceptual Design. Legal and ethical issues in design – Tort Law - Product liability – Protecting intellectual property – Solving Ethical conflicts - Economic decision making: benefit cost analysis

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 :	Develop a product with an understanding of product life cycle
CO2 :	judiciously make correct decision while designing products
CO3:	apply problem solving tools in the process of design
CO4:	Identify and categorize different types of embodiment intractions.
CO5:	Discuss the methods of developing cost estimates
CO6:	Evaluate Legal and ethical aspects in design.

TEXT BOOKS:

1. George E. Dieter & Linda C. Schmidt, "Engineering Design" 4th edition, McGraw-Hill, 2009

REFERENCE BOOKS:

1. Nigel Cross, "Engineering Design Methods – Strategies for Product Design", Wiley, 2005.
2. Philip Kosky, George Wise& Robert Balmer, "Exploring Engineering An Introduction to Engineering and Design",Academic Press, 2009.
3. Ernst Eder, Stanislav Hosnedl, "Introduction to Design Engineering: Systematic creativity and managemenroduct Design-Creativity, Concepts and Usability", PHI LearrningPvt. Ltd., New Delhi, 2012

U23MEV42	ADDITIVE MANUFACTURING PROCESSES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

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

1. To learn about the general additive manufacturing process.
2. To study the different additive manufacturing processes.
3. To know post processing and finishing steps for each AM process.
4. To provide comprehensive knowledge of the wide range of additive manufacturing processes, capabilities and materials
5. To understand the software tools and techniques used for additive manufacturing.

UNIT I BASIC PRINCIPLES OF ADDITIVE MANUFACTURINGS 9

Additive Manufacturing (AM) – additive vs subtractive manufacturing processes – Generic AM Process – Benefits – Related and associated Technologies – Classification of AM Processes (Liquid Polymer, Discrete Particle, Molten Material and Solid Sheet systems) – Metal system – Variations of different processes – Maintenance and material handling issues – Design considerations.

UNIT II VAT PHOTOPOLYMERIZATION AND POWDER BED FUSION PROCESSES **9**

Vat Photopolymerization – Materials and photopolymer chemistry – reaction formulation and mechanisms – Reaction rates – Laser Scan Vat Photopolymerization –Modeling– Irradiance and Exposure – vector scanning – scan patterns – Mask Projection systems – Two-Photon Vat Photopolymerization – Process Benefits and Drawbacks.Powder bed fusion – Materials– Powder Fusion Mechanisms – Process Parameters – Powder Handling – Process Variants – Process Benefits and Drawbacks

UNIT III EXTRUSION AND JETTING SYSTEMS **9**

Extrusion – Basic principles – Plotting and Path Control – Materials– Fused Deposition Modeling, limitations – Bio- extrusion – Contour Crafting and non-planar systems.Material jetting– materials and processes – Material Jetting Machines – Process Benefits and Drawbacks – Binder jetting – materials –BJ Machines– Process Variations – Process Benefits and Limitations

UNIT IV SHEET LAMINATION AND DIRECTED ENERGY DEPOSITION PROCESSES **9**

Sheet lamination – Gluing or Adhesive Bonding, Bond-Then-Form and Form-Then-Bond Processes – Materials and processing – process parameters – Ultrasonic additive manufacturing (UAM) – Effect of micro-structures – UAM ApplicationsDirected Energy Deposition Processes – Description – Material Delivery – Laser and electron beam Based Metal Deposition – Process parameters – Materials and Micro-structure – Benefits of DED.

UNIT V POST PROCESSING, SOFTWARE CHALLENGES AND APPLICATIONS **9**

Need for post processing – Support structure removal – Surface Texture Improvement – Accuracy Improvement – Aesthetic Improvement – Preparation for Use as a Pattern – Property Enhancements Using Non–thermal Techniques and Thermal Techniques. Software Issues in AM – Preparation of CAD Models – STL File Format – Problems with STL Files – STL File Manipulation – STL file with multiple materials – STL for machining – newer file formats and their capabilities – Applications in Medical, Aerospace, Automotive field.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 :	Understand the basics of Additive Manufacturing.
CO2 :	Describe the various Vat polymerization and powder bed fusion systems
CO3:	Illustrate about extrusion and material jetting based systems
CO4:	Expound sheet lamination and directed energy deposition processes
CO5:	List out the post processing techniques
CO6:	Explain the various software issues

TEXT BOOKS:

1. Ian Gibson, David Rosen and Brent Stucker, "Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing", Second Edition, Springer, 2015.

REFERENCE BOOKS:

1. Chee Kai Chua, "3D Printing and Additive Manufacturing: Principles and Applications", World Scientific, 2017.
.
2. Jyothish Kumar, "3D Printing and Additive Manufacturing Technologies", Springer, 2019.
3. Manu Srivastava, "Additive Manufacturing: Fundamentals and Advancements", CRC Press, 2019

U23MEV43	DESIGN FOR ADDITIVE MANUFACTURING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

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

1. To introduce the basics of design for additive manufacturing.
2. To demonstrate comprehensive knowledge of part consolidation and tooling design
3. To know the design requirements for Metal AM and Polymer AM technique.
4. To illustrate the implication of part design on build time and material strength
5. To realize the concept of the post processing treatments in AM

UNIT I STRATEGIC DESIGN IN ADDITVE MANUFACTURING 9

Design for additive manufacturing (DfAM) – Value addition with AM – General Guidelines for Designing AM parts – Design to Avoid Anisotropy – Design to Minimize Print Time – Design to Minimize Post–processing – Topology Optimisation.Design Analysis for AM – Considerations for Analysis of AM Parts – role of mesh, topology and size optimization –Build process simulation.

UNIT II PART CONSOLIDATION AND TOOLING DESIGN 9

Part Consolidation – Design for Function – Material Considerations – Number of Fasteners - Conventional DFM/DFA principles to DfAM – Assembly Considerations – Design of Moving PartsAM Tooling Design – Mounting Fixtures and Guides – Conformal Cooling – Coolant Flow Strategies – Coolant Channel Shape and Spacing – Steps to minimise Print Time in Tooling.

UNIT III DESIGN CONSIDERATIONS FOR METAL AM 9

Designing for Metal Powder Bed Fusion – Metal Powder Production – Powder Morphology – Powder Size Distribution – Other Powder Considerations – Potential Defects in AM Materials – Topology Optimisation – Lattice Structures – Overhangs and Support MaterialDesigning to Reduce Residual stress and Stress Concentrations – General Part Positioning Guidelines - Design for Laser Powder Bed Fusion, Electron Beam Melting and Metal Binder Jetting.

UNIT IV DESIGN FOR POLYMER AM PROCESS AND OTHER AM CONSIDERATIONS 9

Design considerations due to Anisotropy, Wall Thickness, Overhangs and Support Material, Holes, Ribs, fonts and intricate details – Design guidelines for Material Extrusion, Vat Photopolymerisation and Polymer Powder Bed Fusion. Designer Machine Operator Cooperation – Health and Safety – prevention of explosion – AM Part Certification.

UNIT V POST PROCESSING AND FUTURE OF AM 9

Post Processing: Support Material Removal - Polymer Surface Treatments - Metal Surface Treatments - Gluing and Welding AM Parts – Heat Treatment and Aging Future of AM: Functionally Graded Materials – Bio printing - Printed Electronics - Nano Printing - Food Printers.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 : Understand the basics of need for Design for Additive Manufacturing
CO2 : Exhibit the details about Part consolidation and Tooling Design
CO3: Describe design considerations for metal and ceramic based Additive
CO4: Manufacturing.Know the design guidelines for polymer based AM and other AM.
CO5: Interpret the post processing treatments
CO6: Identify Future of Additive Manufacturing

TEXT BOOKS:

1. Olaf Diesel, "A Practical Guide to Design for Additive Manufacturing", Springer, 2019.
2. Martin Leary, "Design for Additive Manufacturing", Elsevier, 2019.

REFERENCE BOOKS:

1. Ben Redwood, "The 3D Printing Handbook: Technologies, Design and Applications", 3D Hubs, 2017.

U23MEV44	REVERSE 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. To learn about reverse engineering systems
2. To know the selection process for reverse engineering systems
3. To understand reverse engineering and additive manufacturing
4. To study the application of reverse engineering in additive manufacturing
5. To know the legal issues in reverse engineering

UNIT I TECHNIQUES FOR REVERSE ENGINEERING 9

Reverse Engineering – Need for Reverse Engineering – The Generic Process – Scanning – Point Processing – Application Geometric Model Development – Computer-aided Reverse Engineering – Computer Vision and Reverse Engineering – Structured-light Range Imaging – Scanner Pipeline.

UNIT II SELECTION OF REVERSE ENGINEERING SYSTEMS 9

Reverse Engineering Hardware and Software – Selection Process for a Reverse Engineering system – Point Capture Devices – Triangulation Approaches – Ranging Systems – Structured-light and Stereoscopic Imaging Systems – Tracking Systems – X-ray Tomography – Probe positioning – Post processing the Captured Data – Handling Data Points – Inspection Applications.

UNIT III REVERSE ENGINEERING AND ADDITIVE MANUFACTURING 9

Modeling Cloud Data in Reverse Engineering – Data Processing for Rapid Prototyping – Integration of RE and AM for Layer-based Model Generation – Adaptive Slicing Approach for Cloud Data Modeling – Planar Polygon Curve Construction – Determination of Adaptive Layer Thickness – Application Examples

UNIT IV APPLICATION AREAS 9

Reverse Engineering-Workflow for Automotive Body Design – Virtual NASCAR Engine Block – Ferrari reverse engineering CFD simulations – Reverse Engineering for Better Quality.Reverse Engineering in the Aerospace Industry – Reducing Costs of Hard Tooling – Digitizing a NASA Space Vehicle –Inspection in Half the Time.Reverse Engineering in Medical Industry – Orthodontics – Digital Dentistry – Hearing Instruments – Knee Replacement – Total Artificial Heart – Mass Customization.

UNIT V GAL ISSUES AND BARRIERS TO REVERSE ENGINEERING 9

Copyright Law and Reverse Engineering – Case studies – Fair Use Statutory Defense – Barriers to adopting reverse engineering technology – Understanding the user needs for reverse engineering – Challenges in reverse Engineering.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 : Understand the various reverse engineering techniques
CO2 : Select a suitable reverse engineering system for a given application.
CO3: Describe the combination of reverse engineering and additive manufacturing
CO4: Systems. List out the key application areas of reverse engineering.
CO5: Illustrate the legal issues and the barriers to reverse engineering
CO6: Predict user needs and Challenges in reverse Engineering

TEXT BOOKS:

1. inesh Raja, Kiran J. Fernandes, "Reverse Engineering, An Industrial Perspective", Springer, London, 2008.
2. Wang W, "Reverse Engineering: Technology of Reinvention", CRC Press, 2010

REFERENCE BOOKS:

1. Ian Gibson, "Advanced Manufacturing Technology for Medical Applications: Reverse Engineering, Software Conversion and Rapid Prototyping", Wiley, 2006

U23MEV45	BUSINESS VALUE ENHANCEMENT WITH ADDITIVE MANUFACTURING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

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

1. To learn about the sustainable development with additive manufacturing
2. To know about the business value enhancement in different industries with additive manufacturing
3. To know about the operational values of additive manufacturing and their impact in various processes
4. To know about the various factors that are acting as driving force for additive manufacturing techniques
5. To know about the business values of additive manufacturing and their key application areas

UNIT I SUSTAINABILITY WITH ADDITIVE MANUFACTURING 9

Sustainable manufacturing – Economic Sustainability with AM – Environmental Sustainability – Impacts on Energy Consumption resources and pollution – Societal Sustainability with AM – Destructive implications and counter measures.

UNIT II BUSINESS VALUE **9**

AM as a Driver for Business Competitiveness, new services, creativity and Innovation – Impact on Manufacturing Paradigms, Product Lifecycle and Operational Costs and Supply Chain Management – Mass customization – Strategic Challenges and Barriers Ahead of AM.

UNIT III OPERATIONS VALUE **9**

Impact of AM on the Product Development Process – Evolution in Design Methodologies – Design Freedom – Impact on Production Process, Product Quality, Manufacturing Costs and Material Waste – Impact on Inventory Turnover, Spare Part Supply Chain and 3DP Online Platforms Supply Chain.

UNIT IV STRATEGIC ALIGNMENT OF ADDITIVE MANUFACTURING **9**

Framework for Strategic Alignment – Contingency Factors Driving AM Performance – Organizational Factors, Operational Factors and Product Characteristics – Economic Analysis – Technology Analysis – Selecting AM Technology – Organizational, Operational and Supply Chain Changes for implementation of AM.

UNIT V BUSINESS VALUE IN KEY APPLICATION AREAS **9**

The Role of Additive Manufacturing and business value in Industry of the Future – Industrial Diffusion – Business value addition in Healthcare, Automotive, Aerospace, Consumer Goods, Architecture, Food Industry and Research and Education industries – Case Studies.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- **CO1 :** Understand the need for sustainable manufacturing and realize how AM helps in that direction
- **CO2 :** Explain Business value improvement with additive manufacturing
- **CO3:** Describe the value addition due to reduced operations
- **CO4:** Plan a strategic alignment of additive Manufacturing
- **CO5:** Indicate the Role of Additive Manufacturing
- **CO6:** List out the applications of AM for value addition in key application areas

TEXT BOOKS:

1. Mojtaba Khorram Niaki, Fabio Nonino, “The Management of Additive Manufacturing: Enhancing Business Value”, (Springer Series in Advanced Manufacturing), Springer, 2018
2. David M. Dietrich, Michael Kenworthy,Elizabeth Cudney, “Additive Manufacturing Change Management: Best Practices”, CRC Press, 1st edition, 2019.

REFERENCE BOOKS:

1. Subramanian Senthilkannan," Handbook of Sustainability in Additive Manufacturing", Springer, 2016.

2. Olaf Diegel, Axel Nordin, Damien Motte "A Practical Guide to Design for Additive Manufacturing", Springer, 2019.

U23MEV46 **LITHOGRAPHIC PROCESSES** **L T P C**
3 0 0 3

COURSE OBJECTIVES

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

1. The fundamentals of clean room and nano fabrication by optical projection lithography.
2. Printing the pattern with a radiation source.
3. Printing with soft lithographic concepts.
4. To acquire knowledge about exposure tools, wafer steppers, masks, reticles, electron beam lithography, and mask writing techniques.
5. To understand radiation exposure and development stages, electron beam-resist interactions, proximity effects, and resist image development mechanisms.

UNIT I BASIC PROCESS 9

Introduction to micromachining and lithography - Overview of Lithography - introduction to semiconductor processing - necessity of a clean room - different types of clean rooms - maintenance of a clean room - Optical Pattern Formation - Aerial Images – light focus – Photoresists - Positive and Negative Resists -Adhesion Promotion - Resist Spin Coating, Soft bake, and Hard bake – Photochemistry – Acid Catalyzation - Development and Post- Exposure - Line-Edge Roughness - Multilayer Resist Processes - Methods for Addressing the Problems of Reflective Substrates

UNIT II PRE-EXPOSURE STAGE **9**

Wafer Steppers -Light Sources - Illumination Systems - Reduction Lenses - Autofocus Systems – Scanning - Dual- Stage Exposure Tools – Overlay Alignment Systems - Overlay Models – Matching – Process-Dependent Overlay Effects. Masks and Reticles – Mask Blanks – Mechanical Optical-Pattern Generators - Electron Beam Lithography and Mask Writers - Optical Mask Writers - Resists for Mask Making - Phase-Shifting Masks – Etching – Pellicles – Mask-Defect Inspection and Repair.

UNIT III RADIATION EXPOSURE AND DEVELOPMENT **9**

Radiation Exposure - Electron Beam Performance,Exposure Equipment - Electron Beam-Resist Interaction- Registration - Proximity Effects - Radiation Damage - Developing Resist Images - General Mechanisms - PMMA Developer Sensitivity - Development of Negative Resists - Dry Development - Post bake - Physical Chemistry of Postbake - Chemical Reactions in Postbake - Other Methods of Hardening.

UNIT IV ECONOMICS OF LITHOGRAPHY **9**

Metrology in lithography - Linewidth Measurement – Scatterometry - Measurement of Overlay - Capital costs – Consumables - Mask costs – Rework costs – Metrology costs - Maintenance costs - Labour costs - Facilities cost – Strategies to reduce cost.

UNIT V MODERN LITHOGRAPHIC TECHNIQUES **9**

Extreme Ultraviolet Lithography - Background and Multilayer Reflectors - EUV Masks, Sources, Illuminators, Optics, Resists - Proximity X-ray Lithography - Electron-Beam Direct-Write Lithography - Ion-Projection Lithography - Imprint Lithography - Directed Self-Assembly - Future of Lithography.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 : Emphasize about the importance of clean room and the necessity of photo masks
CO2 : Understand the lithographic process at the pre-exposure stage
CO3: Explain about the different exposure methods to achieve lithography
CO4: Develop economically viable lithography techniques.
CO5: Know the developments in the field of lithography.
CO6: Examine the various lithography techniques.

TEXT BOOKS:

1. Harry J. Levinson, "Principles of Lithography, 4th Edition" (SPIE Press Monograph, Vol. PM198), 2019
2. Wayne M. Moreau, "Semiconductor Lithography: Principles, Practices, and Materials", Springer, 2012

REFERENCE BOOKS:

1. Chris Mack, "Fundamental principles of optical lithography: The science of micro fabrication", Wiley 2008.
2. M. Madou, "Fundamentals of micro fabrication", 2nd Edition, CRC Press, e book 2018.
3. Stepanova, Maria, "Nano fabrication techniques and principles", Dew, Steven (Eds.) Springer, 2012.
4. John A. Rogers & Hong H. Lee, "Unconventional nano patterning techniques and applications", A John Wiley &Sons, Inc., 2009.
5. Sergey Edward Lyshevski, "MEMS and NEMS: Systems, devices and structures", CRC Press LLC, 2002.
6. Zheng Cui, "Nano fabrication – Principles, capabilities and limits", 2nd edition, Springer Science, 2017.
7. Mark J. Jackson, "Micro fabrication and nano manufacturing", CRC Press Taylor & Francis Group, 2006

U23MEV47	PRINTING TECHNOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

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

1. To understand the basic Principles of Contact and Non-Contact Printing.
2. To enable the students to learn about various processes involved in screen printing.
3. To enable the students to understand the concepts and methodology adopted in the Sheet-Fed Offset Machines
4. To enable the students to understand the concepts of Digital Printing
5. To understand the basics of 3D Printing and its applications

UNIT I PRINCIPLES OF CONTACT AND NON CONTACT PRINTING 9

Introduction - Printing Methods - The Printing System - Halftone Photography – Platemaking – Printing - Binding and Finishing - Inks for Letterpress and Lithography - Principles of Noncontact Printing.

UNIT II SCREEN PRINTING **9**

Select Correct Screen Printing Fabric - Screen Printing Frames - Stretching Equipment - Correct Stretching - Adhesives - The Manufacture of Diapositives – Stencils - The Diapositive - Screen Printing Accessories - Common Faults – Screen Printing on Different Surfaces - Inks for Screen Printing.

UNIT III SHEET- FED OFFSET MACHINES **9**

Mechanical Features – Lubrication - Sheet feeding mechanism - Sheet board - Functions of blowers - Sheet lifting and forwarding - Inking System - Distribution System - Multiroll System - Wash-up device - Plate Cylinder - Blanket Cylinder - Impression Cylinder - Adjustment of Cylinders - Advantages of Both Principles - Delivery Mechanism

UNIT IV DIGITAL PRINTING **9**

Introduction to Digital Printing - Types of Digital Printing - Important Features of Laser Printer - Advantages of Digital Printing – Benefits - Comparison between Digital Printing, screen printing and Press Printing - Trouble shooting and Maintenance

UNIT V 3D PRINTING **9**

History of 3D Printing Technology – types - 3D Printing Applications - Complex Designs - Weight Reduction - Improved Strength and Durability - Major Savings: Automotive/Jewellery/Art/Design/Sculpture - Benefits of 3D Printing - Advantages of 3D Printing in Manufacturing.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 : Explain the key components and processes involved in advanced printing technologies.

CO2 : Identify the different types of screens, inks, and substrates used in screen printing.

CO3: Identify the different components of a sheet-fed offset printing machine and their functions.

CO4: Analyze the impact of various printing substrates

CO5: Explain the process of 3D printing from start to finish.

CO6: Compare and contrast different types of 3D printers and their applications.

TEXT BOOKS:

1. Be familiar the basis of printing and its evolution
2. Understand the basic operations in screen printing
3 Get the clear domain knowledge about the various machineries involved in Sheet- Fed Offset
4 Be familiar the Digital Printing, Important Features of Laser Printer
5 Get the clear domain knowledge and understand the basics of 3D Printing

REFERENCE BOOKS:

1. J. Michael Adams, Penny Ann Dolin, "Printing Technology", Delmar Publications Inc., 2002.
2. Harry B. Smith, "Modern Gravure Technology", Pira reviews of Printing, Pira International, 1994
3. NIIR Board of Consultants & Engineers "The Complete Book on Printing Technology",
4 Asia Pacific Business Press Inc. 2003
5 Prakash Shetty, "Science and Technology of Printing Materials", MJP Publisher, 2019.
6 FFTA "Flexography: Principles & Practices", 6th Edition, FTA, 2014

VERTICAL 5: DIVERSIFIED COURSES GROUP

U23MEV51	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. To study the construction and working principle of various parts of an automobile.
2. To study the practice for assembling and dismantling of engine parts and transmission system
3. To study various transmission systems of automobile.
4. To study about steering, brakes and suspension systems
5. To study alternative energy sources.

UNIT I VEHICLE STRUCTURE AND ENGINES 9

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

UNIT II ENGINE AUXILIARY SYSTEMS 9

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

UNIT III TRANSMISSION SYSTEMS 9

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

UNIT IV STEERING, BRAKES AND SUSPENSION SYSTEMS 9

Steering geometry and types of steering gear box-Power Steering, Types of Front Axle, Types of Suspension Systems, Pneumatic and Hydraulic Braking Systems, Antilock Braking System (ABS),electronic brake force distribution (EBD) and Traction Control.

UNIT V ALTERNATIVE ENERGY SOURCES 9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 : Recognize the various parts of the automobile and their functions and materials.
CO2 : Discuss the engine auxiliary systems and engine emission control
CO3: Distinguish the working of different types of transmission systems
CO4: Explain the Steering, Brakes and Suspension Systems
CO5: Predict possible alternate sources of energy for IC Engines.
CO6: Dismantle and assemble the Engine parts and Transmission Systems

TEXT BOOKS:

1. Jain K.K. and Asthana .R.B, "Automobile Engineering" Tata McGraw Hill Publishers, New Delhi, 2002
2. Kirpal Singh, "Automobile Engineering", Vol 1 & 2, Seventh Edition, Standard Publishers, New Delhi, 13th Edition 2014.

REFERENCE BOOKS:

1. Ganesan V. "Internal Combustion Engines", Third Edition, Tata McGraw-Hill, 2012.
2. Heinz Heisler, "Advanced Engine Technology," SAE International Publications USA, 19
3. Joseph Heitner, "Automotive Mechanics," Second Edition, East-West Press, 1999.
4. Martin W, Stockel and Martin T Stockle , "Automotive Mechanics Fundamentals," The Good heart - Will Cox Company Inc, USA ,1978.
5. Newton, Steeds and Garet, "Motor Vehicles", Butterworth Publishers,1989.

U23MEV52 **MEASUREMENTS AND CONTROLS** **L T P C**
3 0 0 3

COURSE OBJECTIVES

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

1. To Identify measurement parameters and analyze errors of measurements
2. To Select and apply suitable transducer for a particular measurement
3. To identify measurement parameters and select the appropriate sensor for it.
4. To Explain the working of various types of control systems of apply for specific applications
5. To apply the principle of automatic control systems to control various parameter(s).

UNIT I MEASUREMENTS AND ERROR ANALYSIS 9

General concepts – Units and standards – Measuring instruments –sensitivity, readability, range, accuracy, precision – static and dynamic response – repeatability hysteresis – systematic and random errors –Statistical analysis of experimental data – Regression analysis – Curve fitting - calibration and Uncertainty

UNIT II INSTRUMENTS 9

Transducer, modifying (intermediate) and Terminal stages – Mechanical and electrical transducers, preamplifiers– charge amplifiers – filters – attenuators – D' Arsonval – CRO – Oscillographs – recorders – microprocessor-based data logging, processing and output.

UNIT III PARAMETERS FOR MEASUREMENT 9

Dimension, 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

UNIT V APPLICATION OF CONTROL SYSTEMS 9

Governing of speed, kinetic and process control – pressure, temperature, fluid level, flow-thrust and flight control – photo electric controls – designing of measurement and control systems for different applications

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- **CO1 :** Identify measurement parameters and analyze errors of measurements.
- **CO2 :** Select and apply suitable transducer for a particular measurement.
- **CO3:** Identify measurement parameters and select the appropriate sensor for it.
- **CO4:** Explain the working of various types of control systems of apply for specific applications
- **CO5:** Apply the principle of automatic control systems to control various parameter(s).
- **CO6:** Develop the control systems for different applications

TEXT BOOKS:

1. Venkateshan S P, Mechanical Measurements, 2ndEdition, John Wiley & Sons, Ltd, 2015.
2. William Bolton, Instrumentation and Control Systems, 2ndEdition, Newnes, 2015.

REFERENCE BOOKS:

1. Beckwith, Marangoni and Lienhard, Mechanical Measurements, Pearson, 2013.
2. Ernest Doebelin and Dhanesh Manik, 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. NakraB.C , and Chaudhry K.K, Instrumentation, Measurement, and Analysis, Tata McGraw Hill, 4th Edition, 2016

U23MEV53	NON-TRADITIONAL MACHINING PROCESSES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

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

1. To classify non-traditional machining processes and describe mechanical energy based non-traditional machining processes.
2. To differentiate chemical and electro chemical energy-based processes
3. To describe thermo-electric energy-based processes
4. To explain nano finishing processes.
5. To introduce hybrid non-traditional machining processes and differentiate hybrid non-traditional machining processes

UNIT I INTRODUCTION AND MECHANICAL ENERGY BASED PROCESSES 9

Introduction - Need for non-traditional machining processes - Classification of non-traditional machining processes - Applications, advantages and limitations of non-traditional machining processes - Abrasive jet machining, Abrasive water jet machining, Ultrasonic machining their principles, equipment, effect of process parameters, applications, advantages and limitations.

UNIT II CHEMICAL AND ELECTRO CHEMICAL ENERGY BASED PROCESSES 9

Principles, equipments, 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

Principles, equipments, effect of process parameters, applications, advantages and limitations of Electric discharge machining, Wire electric discharge machining, Laser beam machining, Plasma arc machining, Electron beam machining, Ion beam machining.

UNIT IV NANO FINISHING PROCESSES 9

Principles, equipments, effect of process parameters, applications, advantages and limitations of Abrasive flow machining – Chemo mechanical polishing, Magnetic abrasive finishing, Magnetorheological finishing, Magneto rheological abrasive flow finishing.

UNIT V HYBRID NON-TRADITIONAL MACHINING PROCESSES 9

Introduction - Various hybrid non-traditional machining processes, their working principles, equipments, effect of process parameters, applications, advantages and limitations. Selection and comparison of different non-traditional machining processes

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 : Formulate different types of non-traditional machining processes and evaluate mechanical energy based non-traditional machining processes.

CO2 : Illustrate chemical and electro chemical energy based processes.

CO3: Evaluate thermo-electric energy based processes.

CO4: Interpret nano finishing processes.

CO5: Analyse hybrid non-traditional machining processes

CO6: Select and comparison of different non-traditional machining processes

TEXT BOOKS:

1. Adithan. M., "Unconventional Machining Processes", Atlantic, New Delhi, India, 2009. ISBN 13:9788126910458
2. Anand Pandey, "Modern Machining Processes", Ane Books Pvt. Ltd., New Delhi, India, 2019.

REFERENCE BOOKS:

1. Benedict, G.F., "Non-traditional Manufacturing Processes", Marcel Dekker Inc., New York 1987
2. Carl Sommer, "Non-Traditional Machining Handbook", Advance Publishing., United States, 2000.
3. Golam Kibria, Bhattacharyya B. and Paulo Davim J., "Non-traditional Micromachining Processes: Fundamentals and Applications", Springer International Publishing., Switzerland, 2017.
4. Jagadeesha T., "Non-Traditional Machining Processes", I.K. International Publishing House Pvt. Ltd., New Delhi, India, 2017.
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

U23MEV54	COMPOSITE MATERIALS AND MECHANICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

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

1. To study the fundamentals of composite material strength and its mechanical behavior
2. To study the analysis of fiber reinforced Laminate design for different combinations of plies with different orientations of the fiber.
3. To study Thermo-mechanical behavior and study of residual stresses in Laminates during processing.
4. To Implementation of Classical Laminate Theory (CLT) to study and analysis for residual stresses in an isotropic layered structure such as electronic chips.
5. To study the fundamentals of composite material strength and its mechanical

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 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

COURSE OUTCOMES:

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

CO1 : Summarize the characteristics of fibers and matrices.
CO2 : Observe the lamina constitutive equations
CO3: Derive Flat plate Laminate equations
CO4: Analyze Lamina strength
CO5: Analyze the thermal behavior of Composite laminates
CO6: 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

REFERENCE BOOKS:

1. Agarwal, B.D., and Broutman L.J., "Analysis and Performance of Fiber Composites", John Wiley.
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
5. Mallick, P.K. and Newman, S., (edition), "Composite Materials Technology: Processes and Properties", Hansen Publisher, Munish, 1990.

U23MEV55 GAS DYNAMICS AND JET PROPULSION

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

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

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

UNITV 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

COURSE OUTCOMES:

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

CO1 : Apply the fundamentals of compressible flow concepts and the use of gas tables.
CO2 : Analyze the compressible flow behaviour in constant area ducts.
CO3: Analyze the development of shock waves and its effects
CO4: Explain the types of jet engines and their performance parameters.
CO5: Identify single and multistage rocket propulsion
CO6: 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.

REFERENCE BOOKS:

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, 1965.
5. Babu, V., "Fundamentals of Compressible Flow", CRC Press, 1st Edition, 2008.

U23MEV56 HYDRAULICS AND PNEUMATICS

L	T	P	C
3	0	0	3

COURSEOBJECTIVES:

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

1. To Gain knowledge about hydraulic pumps, their classification, construction, working, design, and selection criteria for both linear and rotary pumps.
2. To provide students with an understanding of the fluids and components utilized in modern industrial fluid power system
3. To develop a measurable degree of competence in the design, construction and operation of fluid power circuits.
4. To comprehend the properties of air, perfect gas laws, and the design of pneumatic circuits using elements like compressors, filters, regulators, lubricators, and valves.
5. To Gain practical skills in installing, selecting, maintaining, and troubleshooting hydraulic and pneumatic 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 Linear and Rotary – Fixed and Variable displacement pumps – Problems.

UNIT II HYDRAULIC ACTUATORS AND CONTROL COMPONENTS 9

Hydraulic Actuators: Cylinders – Types and construction, Application, Hydraulic cushioning – Hydraulic motors - Control Components: Direction Control, Flow control and pressure control valves – Types, Construction and Operation – Servo and Proportional valves – Applications – Accessories: Reservoirs, Pressure Switches – Applications – Fluid Power ANSI Symbols – Problems

UNIT III HYDRAULIC CIRCUITS AND SYSTEMS 9

Accumulators, Intensifiers, Industrial hydraulic circuits – Regenerative, Pump Unloading, Double-Pump, Pressure Intensifier, Air-over oil, Sequence, Reciprocation, Synchronization, Fail-Safe, Speed Control, Hydrostatic transmission, Electro hydraulic circuits, Mechanical hydraulic servo systems.

UNIT IV PNEUMATIC AND ELECTRO PNEUMATIC SYSTEMS 9

Properties of air – Perfect Gas Laws – Compressor – Filters, Regulator, Lubricator, Muffler, Air control Valves, Quick Exhaust Valves, Pneumatic actuators, Design of Pneumatic circuit – Cascade method – Electro Pneumatic System – Elements – Ladder diagram – Problems, Introduction to fluidics and pneumatic logic circuits.

UNITV TROUBLE SHOOTING AND APPLICATIONS 9

Installation, Selection, Maintenance, Trouble Shooting and Remedies in Hydraulic and Pneumatic systems, Design of hydraulic circuits for Drilling, Planning, Shaping, Surface grinding, Press and Forklift applications. Design of Pneumatic circuits for Pick and Place applications and tool handling in CNC Machine tools – Low cost Automation – Hydraulic and Pneumatic power packs.

TOTAL: 45 PERIODS

COURSEOUTCOMES:

CO1 :	Explain the Fluid power and operation of different types of pumps.
CO2 :	Summarize the features and functions of Hydraulic motors, actuators and Flow control valves
CO3:	Explain the different types of Hydraulic circuits and systems.
CO4:	Explain the working of different pneumatic circuits and systems
CO5:	Summarize the various trouble shooting methods
CO6:	Develop the hydraulic and pneumatic systems.

TEXT BOOKS:

1. Anthony Esposito, "Fluid Power with Applications", Pearson Education 2008.
2. Majumdar S.R., "Oil Hydraulics Systems- Principles and Maintenance", TataMcGrawHill, 2018.

REFERENCE BOOKS:

1. Anthony Lal, "Oil hydraulics in the service of industry", Allied publishers, 1982.
2. Dudelyt, A. Pease and John T. Pippenger, "Basic Fluid Power", Prentice Hall, 1987.
3. Majumdar S.R., "Pneumatic systems – Principles and maintenance", Tata McGraw Hill, 1995
4. Michael J, Prinches and Ashby J. G, "Power Hydraulics", Prentice Hall, 1989
5. Shanmugasundaram.K, "Hydraulic and Pneumatic controls", Chand & Co, 2006

U23MEV57 DYNAMICS OF GROUND VEHICLES

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

The objective of this course is to make the students to Develop physical and mathematical models to predict the dynamic response of vehicles

1. Acquire knowledge about vibration absorbers, measuring instruments, torsional vibration, critical speed, and the influence of base excitation on mechanical systems.
2. Understand power-limited acceleration and traction-limited acceleration in vehicle dynamics.
3. Gain insights into human response to vibration and the sources of vibration in vehicles
4. Study the stability of vehicles on banked roads and during turns, considering the effect of suspension on cornering performance.
5. Learn about the Minuro Plot for Lateral Transient Response and its application in analyzing lateral dynamics of vehicles.

UNIT CONCEPT OF VIBRATION 9

Definitions, Modeling and Simulation, Global and Vehicle Coordinate System, Free, Forced, Undamped and Damped Vibration, Response Analysis of Single DOF, Two DOF, Multi DOF, Magnification factor, Transmissibility ratio, Base excitation. Vibration absorber, Vibration measuring instruments, Torsional vibration, Critical speed

UNIT II TYRES 9

Tyre axis system, tyre forces and moments, tyre marking, tyre structure, hydroplaning, wheel and rim. Rolling resistance, factors affecting rolling resistance, Longitudinal and Lateral force at various slip angles, Tractive and cornering property of tire. Performance of tire on wet surface. Ride property of tyres. Various test carried on a tyre.

UNIT III VERTICAL DYNAMICS 9

Human response to vibration, Sources of Vibration. Suspension requirements – types. State Space Representation. Design and analysis of Passive, Semi active and Active suspension using Quarter car, Bicycle Model, half car and full car vibrating model. Influence of suspension stiffness, suspension damping, and tire stiffness. Control law. Suspension optimization techniques. Air suspension system and their properties.

UNIT IV LONGITUDINAL DYNAMICS AND CONTROL 9

Aerodynamic forces and moments. Equation of motion. Load distribution for three-wheeler and four-wheeler. Calculation of maximum acceleration, tractive effort and reaction forces for different drive vehicles. Power limited acceleration and traction limited acceleration. Estimation of CG location. Stability of vehicles resting on slope. Driveline dynamics. Braking and Driving torque. Prediction of Vehicle performance. ABS, stability control, Traction control.

UNIT V LATERAL DYNAMICS 9

Steady state handling characteristics. Steady state response to steering input – Yaw velocity gain, Lateral acceleration gain, curvature response gain. Testing of handling characteristics. Transient response characteristics. Steering dynamics. Direction control of vehicles. Roll center, Roll axis. Stability of vehicle on banked road, during turn. Effect of suspension on cornering. Minuro Plot for Lateral Transient Response.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 : Observe the basic concept of vibration

CO2 : Develop physical and mathematical models to predict the dynamic response of vehicles

CO3: Apply vehicle design performance criteria and how to use the criteria to evaluate vehicle dynamic response

CO4: Use dynamic analyses in the design of vehicles.

CO5: Evaluate the longitudinal dynamics and control in an automobile

CO6: Understand the principle behind the lateral dynamics

TEXT BOOKS:

1. Singiresu S. Rao, "Mechanical Vibrations," Fifth Edition, Prentice Hall, 2010
2. Thomas D. Gillespie, "Fundamentals of Vehicle Dynamics," Society of Automotive Engineers Inc, 2014

REFERENCE BOOKS:

1. Dean Karnopp, "Vehicle Dynamics, Stability, and Control", Second Edition, CRC Press, 2013
2. Hans B Pacejka, "Tyre and Vehicle Dynamics," Second edition, SAE International, 2005
3. John C. Dixon, "Tyres, Suspension, and Handling, " Second Edition, Society of Automotive Engineers Inc, 1996
4. Michael Blundell & Damian Harty, "The Multibody Systems Approach to Vehicle Dynamics",Elsevier Limited, 2004
5. R. Nakhaie Jazar, "Vehicle Dynamics: Theory and Application", Second edition, Springer, 2013.

OPEN ELECTIVE I

U23MEO11	APPLIED DESIGN THINKING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

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

1. Introduce tools & techniques of design thinking for innovative product development
2. Illustrate customer-centric product innovation using on simple use cases
3. Demonstrate development of Minimum usable Prototypes
4. Outline principles of solution concepts & their evaluation
5. Describe system thinking principles as applied to complex systems

UNIT I DESIGN THINKING PRINCIPLES 9

Exploring Human-centered Design - Understanding the Innovation process, discovering areas of opportunity, Interviewing & empathy-building techniques, Mitigate validation risk with FIR [Forge Innovation rubric] - Case studies

UNIT II ENDUSER-CENTRIC INNOVATION 9

Importance of customer-centric innovation - Problem Validation and Customer Discovery - Understanding problem significance and problem incidence - Customer Validation. Target user, User persona & user stories. Activity: Customer development process - Customer interviews and field visit

UNIT III APPLIED DESIGN THINKING TOOLS 9

Concept of Minimum Usable Prototype [MUP] - MUP challenge brief - Designing & Crafting the value proposition - Designing and Testing Value Proposition; Design a compelling value proposition; Process, tools and techniques of Value Proposition Design

UNIT IV CONCEPT GENERATION 9

Solution Exploration, Concepts Generation and MUP design- Conceptualize the solution concept; explore, iterate and learn; build the right prototype; Assess capability, usability and feasibility. Systematic concept generation; evaluation of technology alternatives and the solution concepts

UNIT V SYSTEM THINKING 9

System Thinking, Understanding Systems, Examples and Understandings, Complex Systems

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- **CO1 :** Define & test various hypotheses to mitigate the inherent risks in product innovations.
- **CO2 :** Design the solution concept based on the proposed value by exploring alternate solutions to achieve value-price fit.
- **CO3:** Develop skills in empathizing, critical thinking, analyzing, storytelling & pitching
- **CO4:** Design and develop Minimum Usable Prototypes (MUPs) for solution concepts, evaluating their capabilities, usability, and feasibility.
- **CO5:** Assess technology alternatives for the proposed solution concepts to ensure effective product development.
- **CO6:** Apply system thinking in a real-world scenario

TEXT BOOKS:

1. Steve Blank, (2013), The four steps to epiphany: Successful strategies for products that win, Wiley.
2. Alexander Osterwalder, Yves Pigneur, Gregory Bernarda, Alan Smith, Trish Papadakos, (2014), Value
3. Proposition Design: How to Create Products and Services Customers Want, Wiley
4. Donella H. Meadows, (2015), "Thinking in Systems -A Primer", Sustainability Institute.
5. Tim Brown,(2012) "Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation", Harper Business.

REFERENCE BOOKS:

1. https://www.ideou.com/pages/design-thinking#process
2. https://blog.forgeforward.in/valuation-risk-versus-validation-risk-in-product-innovations-49f253ca 8624
3. https://blog.forgefor ward.in/product-innovation-rubric-adf5ebdfd356
4. https://blog.forgefor ward.in/evaluating-product-innovations-e8178e58b86e
5. https://blog.forgefor ward.in/user-guide-for-product-innovation-rubric-857181b253dd
6. https://blog.forgefor ward.in/star tup-failure-is-like-true-lie-7812cdfe9b85

U23MEO12	REVERSE ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main objectives of this course are to:

1. Applying the fundamental concepts and principles of reverse engineering in product design and development.
2. Applying the concept and principles material characteristics, part durability and life limitation in reverse engineering of product design and development.
3. Applying the concept and principles of material identification and process verification in reverse engineering of product design and development.
4. Analysing the various legal aspect and applications of reverse engineering in product design and development.
5. Understand about 3D scanning hardware & software operations and procedure to generate 3D model

UNIT I INTRODUCTION & GEOMETRIC FORM 9

Definition – Uses – The Generic Process – Phases – Computer Aided Reverse Engineering - Surface and Solid Model Reconstruction – Dimensional Measurement – Prototyping.

UNIT II MATERIAL CHARACTERISTICS AND PROCESS IDENTIFICATION 9

Alloy Structure Equivalency – Phase Formation and Identification – Mechanical Strength – Hardness –Part Failure Analysis – Fatigue – Creep and Stress Rupture – Environmentally Induced Failure Material Specification - Composition Determination - Microstructure Analysis - Manufacturing Process Verification.

UNIT III DATA PROCESSING 9

Statistical Analysis – Data Analysis – Reliability and the Theory of Interference – Weibull Analysis – Data Conformity and Acceptance – Data Report – Performance Criteria – Methodology of Performance Evaluation – System Compatibility.

UNIT IV 3D SCANNING AND MODELLING 9

Introduction, working principle and operations of 3D scanners: Laser, White Light, Blue Light - Applications- Software for scanning and modelling: Types- Applications- Preparation techniques for Scanning objects- Scanning and Measuring strategies - Calibration of 3D Scanner- Step by step procedure: 3D scanning - Geometric modelling – 3D inspection- Case studies.

UNIT V INDUSTRIAL APPLICATIONS 9

Reverse Engineering in the Automotive Industry; Aerospace Industry; Medical Device Industry. Case studies and Solving Industrial projects in Reverse Engineering. Legality: Patent – Copyrights –Trade Secret – Third-Party Materials.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

the end of the course the students would be able to

- **CO1 :** Apply the fundamental concepts and principles of reverse engineering in product design and development.
- **CO2 :** Apply the concept and principles material characteristics, part durability and life limitation in reverse engineering of product design and development.
- **CO3:** Apply the concept and principles of material identification and process verification in reverse engineering of product design and development.
- **CO4:** Apply the concept and principles of data processing, part performance and system compatibility in reverse engineering of product design and development.
- **CO5:** Establish 3d scanning and modelling
- **CO6:** Solving Industrial projects in Reverse Engineering

TEXT BOOKS:

1. Robert W. Messler, Reverse Engineering: Mechanisms, Structures, Systems & Materials, 1st Edition, McGraw-Hill Education, 2014
2. Wego Wang, Reverse Engineering Technology of Reinvention, CRC Press, 2011

REFERENCE BOOKS:

1. Scott J. Lawrence , Principles of Reverse Engineering, Kindle Edition, 2022
2. Kevin Otto and Kristin Wood, Product Design: Techniques in Reverse Engineering and New Product Development, Prentice Hall, 2001.
3. Kathryn, A. Ingle, “Reverse Engineering”, McGraw-Hill, 1994.
4. Linda Wills, “Reverse Engineering”, Kluver Academic Publishers, 1996
5. Vinesh Raj and Kiran Fernandes, “Reverse Engineering: An Industrial Perspective”, Springer-Verlag London Limited 2008

U23MEO13 **QUALITY ENGINEERING**

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

The main objectives of this course are to:

1. Developing a clear knowledge in the basics of various quality concepts.
2. Facilitating the students in understanding the application of control charts and its techniques.
3. Developing thespecialcontrolproceduresforserviceandprocessorientedindustries.
4. Analyzing and understanding the process capability study.
5. Developing the acceptance sampling procedures for incoming raw material.

UNIT I INTRODUCTION **9**

Quality Dimensions–Quality definitions–Inspection-Quality control–Quality Assurance–Quality planning-Quality costs–Economics of quality– Quality loss function

UNIT II CONTROL CHARTS **9**

Chance and assignable causes of process variation, statistical basis of the control chart, control charts for variables- X , R and S charts, attribute control charts - p, np, c and u- Construction and application.

UNIT III SPECIAL CONTROL PROCEDURES **9**

Warning and modified control limits, control chart for individual measurements, multi-vari chart, Xchart with a linear trend, chart for moving averages and ranges, cumulative-sum and exponentially weighted moving average control charts.

UNIT IV STATISTICAL PROCESS CONTROL **9**

Process stability, process capability analysis using a Histogram or probability plots and control chart. Gauge capability studies, setting specification limits.

UNITV ACCEPTANCE SAMPLING **9**

The acceptance sampling fundamental, OC curve, sampling plans for attributes, simple, double, multiple and sequential, sampling plans for variables, MIL-STD-105DandMIL-STD-414E&IS2500 standards.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- **CO1 :** Classify the various quality concepts
- **CO2 :** Control the quality of processes using control charts for variables in manufacturing industries.
- **CO3:** Control the occurrence of defective product and the defects in manufacturing companies.
- **CO4:** Control the occurrence of defects in services.
- **CO5:** Analyzing and understanding the process capability study.
- **CO6:** Developing the acceptance sampling procedures for incoming raw material

TEXT BOOKS:

1. Total Quality Management – Dr. S. Kumar, Laxmi Publication Pvt. Ltd.
2. Statistical Quality Control by M. Mahajan, Dhanpat Rai & Co. (P) Ltd

REFERENCE BOOKS:

1. Total Quality Management by K C Arora, S K Kataria & Sons

U23MEO14 **FUNCTIONAL MATERIALS** **L T P C**
3 0 0 3

COURSE OBJECTIVES

The main objectives of this course are to:

1. The course emphasis on the molecular safe assembly and materials for polymer electronics.

UNIT I INTRODUCTION 9

Historical Perspectives, Lessons from the Nature, Engineering the Functions, Tuning the functions, Multiscale Modeling and Computation, Classification of Functional Materials, Functional Diversity of Materials, Hybrid Materials, Technological Relevance, Societal Impact.

UNIT II MOLECULAR SELF ASSEMBLY 9

Molecular Organization, Self-Assembly in Biology, Energetics of Self-Organization, A Few Case Studies, Synthetic Protocols and Challenges, Solvent-assisted Self-Assembly, Directed Assembly-Langmuir-Blodgett and Langmuir-Schaefer techniques, Technological Applications of SAMs.

UNIT III BIO-INSPIRED MATERIALS 9

Bio-inspired materials, Classification, Biomimicry, Spider Silk, Lotus Leaf, Gecko feet, Synovial fluid, 'Bionics'-Bio-inspired Information Technologies, Artificial Sensory Organs, Biomineralization- En route to Nanotechnology.

UNIT IV SMART OR INTELLIGENT MATERIALS 9

Criteria for Smartness, Significance of Smart Materials, Representative Examples like Smart Gels and Polymers, Electro/Magneto Rheological Fluids, Smart Electroceramics, Technical Limitations and Challenges, Functional Nanocomposites, Polymer-carbon nanotube composities.

UNITV MATERIALS FOR POLYMER ELECTRONICS 9

Polymers for Electronics, Organic Light Emitting Diodes, Working Principle of OLEDs, Illustrated Examples, Organic Field-Effect Transistors Operating Principle, Design Considerations, Polymer FETs vs Inorganic FETs, Liquid Crystal Displays, Engineering Aspects of Flat Panel Displays, Intelligent Polymers for Data Storage, Polymer-based Data Storage-Principle, Magnetic Vs. Polymer-based Data Storage.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- **CO1:** Differentiate among various functional properties
- **CO2:** Discuss molecular self assembly
- **CO3:** Analyze the nature and potential of functional material.
- **CO4:** Identify the smart or intelligent materials
- **CO5:** Choose the materials for polymer electronics
- **CO6:** Select appropriate material for certain functional applications

TEXT BOOKS:

1. Vijayamohanan K. Pillai and MeeraParthasarathy, "Functional Materials: A chemist's perpective", Universities Press Hyderabad (2012).

REFERENCE BOOKS:

1. Stephen Manne "Biomimetic Materials Chemistry" Wiley-VCH Newyork, 1966.

U23MEO15	FIRE SAFETY ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES:

The main objectives of this course are to:

1. To enable the students to acquire knowledge of Fire and Safety Studies
2. To learn about the effect of fire on materials used for construction, the method of test for non-combustibility & fire resistance
3. To learn about fire area, fire stopped areas and different types of fire-resistant doors
4. To learn about the method of fire protection of structural members and their repair due to fire damage.
5. To develop safety professionals for both technical and management through systematic and quality-based study programmes

UNIT I INHERENT SAFETY CONCEPTS 9

Compartment fire-factors controlling fire severity, ventilation controlled and fuel controlled fires; Spread of fire in rooms, within building and between buildings. Effect of temperature on the properties of structural materials- concrete, steel, masonry and wood; Behavior of non-structural materials on fire- plastics, glass, textile fibres and other house hold materials.

UNIT II PLANT LOCATIONS 9

Compartment temperature-time response at pre-flashover and post flashover periods; Equivalence of fire severity of compartment fire and furnace fire; Fire resistance test on structural elements- standard heating condition, Indian standard test method, performance criteria.

UNIT III WORKING CONDITIONS 9

Fire separation between building- principle of calculation of safe distance. Design principles of fire resistant walls and ceilings; Fire resistant screens- solid screens and water curtains; Local barriers; Fire stopped areas-in roof, in fire areas and in connecting structures; Fire doors- Low combustible, Non-combustible and Spark-proof doors; method of suspension of fire doors; Air-tight sealing of doors;

UNIT IV FIRE SEVERITY AND REPAIR TECHNIQUES 9

Fabricated fire proof boards-calcium silicate, Gypsum, Vermiculite, and Perlite boards; Fire protection of structural elements - Wooden, Steel and RCC.. Reparability of fire damaged structures-Assessment of damage to concrete, steel, masonry and timber structures, Repair techniques- repair methods to reinforced concrete Columns, beams and slabs, Repair to steel structural members, Repair to masonry structures.

UNIT V WORKING AT HEIGHTS 9

Safe Access - Requirement for Safe Work Platforms- Stairways - Gangways and Ramps-Fall Prevention & Fall Protection - Safety Belts - Safety nets - Fall Arrestors- Working on Fragile Roofs - Work Permit Systems-Accident Case Studies.

TOTAL : 45 PERIODS

OUTCOMES:

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

CO1: Understand the effect of fire on materials used for construction

CO2: Understand the method of test for non-combustibility and fire resistance; and will be able to select different structural elements and their dimensions for a particular fire resistance rating of a building.

CO3: To understand the design concept of fire walls, fire screens, local barriers and fire doors and able to select them appropriately to prevent fire spread.

CO4: To decide the method of fire protection to RCC, steel, and wooden structural elements and their repair methods if damaged due to fire.

CO5: Describe the safety techniques and improve the analytical and intelligence to take the right decision at right time.

TEXTBOOKS:

1. Roytman, M. Y,"Principles of fire safety standards for building construction". Amerind Publishing Co. Pvt. Ltd., New Delhi,1975

2. John A. Purkiss,"Fire safety engineering design of structures" (2nd edn.), Butterworth Heinemann, Oxford, UK,2009.

REFERENCES:

1. Smith, E.E. and Harmathy, T.Z. (Editors),"Design of buildings for fire safety". ASTM Special Publication 685, American Society for Testing and Materials, Boston, U.S.A,1979.

2. Butcher, E. G. and Parnell, A. C, "Designing of fire safety". JohnWiley and Sons Ltd., New York, U.S.A.1983.

3. Jain, V.K,"Fire safety in buildings" (2nd edn.). New Age International(P) Ltd., New Delhi,2010.

4. Hazop&Hazan,"Identifying and Assessing Process Industry Hazards", Fourth Edition ,1999

5. Frank R. Spellman, Nancy E. Whiting,"The Handbook of Safety Engineering: Principles and Applications", 2009

OPEN ELECTIVE II

		L	T	P	C
U23MEO21	INDUSTRIAL DESIGN & RAPID PROTOTYPING TECHNIQUES	3	0	0	3

COURSE OBJECTIVES

The course aims to

1. Outline Fundamental concepts in UI & UX
2. Introduce the principles of Design and Building an mobile app
3. Illustrate the use of CAD in product design
4. Outline the choice and use of prototyping tools
5. Understanding design of electronic circuits and fabrication of electronic devices

UNIT I UI/UX **9**

Fundamental concepts in UI & UX - Tools - Fundamentals of design principles - Psychology and Human Factors for User Interface Design - Layout and composition for Web, Mobile and Devices - Typography - Information architecture - Color theory - Design process flow, wireframes, best practices in the industry -User engagement ethics - Design alternatives

UNIT II APP DEVELOPMENT **9**

SDLC - Introduction to App Development - Types of Apps - web Development - understanding Stack - Frontend - backend - Working with Databases - Introduction to API - Introduction to Cloud services - Cloud environment Setup- Reading and writing data to cloud - Embedding ML models to Apps - Deploying application.

UNIT III INDUSTRIAL DESIGN **9**

Introduction to Industrial Design - Points, lines, and planes - Sketching and concept generation - Sketch to CAD - Introduction to CAD tools - Types of 3D modeling - Basic 3D Modeling Tools - Part creation – Assembly - Product design and rendering basics - Dimensioning & Tolerancing.

UNIT IV MECHANICAL RAPID PROTOTYPING **9**

Need for prototyping - Domains in prototyping - Difference between actual manufacturing and prototyping - Rapid prototyping methods - Tools used in different domains - Mechanical Prototyping; 3D Printing and classification - Laser Cutting and engraving - RD Works - Additive manufacturing

UNITV ELECTRONIC RAPID PROTOTYPING **9**

Basics of electronic circuit design - lumped circuits - Electronic Prototyping - Working with simulation tool - simple PCB design with EDA

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 :	Create quick UI/UX prototypes for customer needs
CO2 :	Develop web application to test product traction / product feature
CO3:	Develop 3D models for prototyping various product ideas
CO4:	Differentiate between actual manufacturing and prototyping
CO5:	Built prototypes using Tools and Techniques in a quick iterative methodology
CO6:	Design of electronic circuits and fabrication of electronic devices

TEXT BOOKS:

1. Peter Fiell, Charlotte Fiell, Industrial Design A-Z, TASCHEN America Llc(2003)
2. Samar Malik, Autodesk Fusion 360 - The Master Guide.
3. Steve Krug, Don't Make Me Think, Revisited: A Common Sense Approach to Web Usability, Pearson,3rd edition(2014)

REFERENCE BOOKS:

1. https://www.adobe.com/products/xd/learn/get-star ted.html
2. https://developer.android.com/guide
3. https://help.autodesk.com/view/fusion360/ENU/courses/
4. https://help.prusa3d.com/en/categor y/prusaslicer_204

U23MEO22	MICRO AND PRECISION ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The course aims to At the end of this course the student should be able to

1. Learn about the precision machine tools
2. Learn about the macro and micro components.
3. Understand handling and operating of the precision machine tools.
4. Learn to work with miniature models of existing machine tools/robots and other instruments.
5. Learn metrology for micro system

UNIT I INTRODUCTION TO MICROSYSTEMS 9

Design, and material selection, micro-actuators: hydraulic, pneumatic, electrostatic/ magnetic etc. for medical to general purpose applications. Micro-sensors based on Thermal, mechanical, electrical properties; micro-sensors for measurement of pressure, flow, temperature, inertia, force, acceleration, torque, vibration, and monitoring of manufacturing systems.

UNIT II FABRICATION PROCESSES FOR MICRO-SYSTEMS 9

Additive, subtractive, forming process, micro systems-Micro-pumps, micro- turbines, micro engines, micro-robot, and miniature biomedical devices

UNIT III INTRODUCTION TO PRECISION ENGINEERING 9

Machine tools, holding and handling devices, positioning fixtures for fabrication/ assembly of micro systems. Precision drives: inch worm motors, ultrasonic motors, stick- slip mechanism and other piezo-based devices.

UNIT IV PRECISION MACHINING PROCESSES 9

Precision machining processes for macro components - Diamond turning, fixed and free abrasive processes, finishing processes.

UNIT V METROLOGY FOR MICRO SYSTEMS 9

Metrology for micro systems - Surface integrity and its characterization.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- **CO1 :** Select suitable precision machine tools and operate
- **CO2 :** Apply the macro and micro components for fabrication of micro systems.
- **CO3:** Apply suitable machining process
- **CO4:** Able to work with miniature models of existing machine tools/robots and other instruments.
- **CO5:** Apply metrology for micro system
- **CO6:** Select suitable precision machine tools and operate

TEXT BOOKS:

1. Davim, J. Paulo, ed. Microfabrication and Precision Engineering: Research and Development. Woodhead Publishing, 2017
2. Gupta K, editor. Micro and Precision Manufacturing. Springer; 2017

REFERENCE BOOKS:

1. Dornfeld, D., and Lee, D. E., Precision Manufacturing, 2008, Springer.
2. H. Nakazawa, Principles of Precision Engineering, 1994, Oxford University Press.
3. Whitehouse, D. J., Handbook of Surface Metrology, Institute of Physics Publishing, Philadelphia PA, 1994.
4. Murthy.R.L, ―Precision Engineering in Manufacturing‖, New Age International, New Delhi, 2005

U23MEO23	ENERGY CONSERVATION AND MANAGEMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main objectives of this course are to:

1. understand and analyse the energy data of industries
2. carryout energy accounting and balancing
3. conduct energy audit and suggest methodologies for energy savings and
4. utilise the available resources in optimal ways

UNIT I INTRODUCTION 9

Energy - Power – Past & Present scenario of World; National Energy consumption Data – Environmental aspects associated with energy utilization – Energy Auditing: Need, Types, Methodology and Barriers. Role of Energy Managers. Instruments for energy auditing.

UNIT II ELECTRICAL SYSTEMS 9

Components of EB billing – HT and LT supply, Transformers, Cable Sizing, Concept of Capacitors, Power Factor Improvement, 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 III THERMAL SYSTEMS 9

Stoichiometry, Boilers, Furnaces and Thermic Fluid Heaters – Efficiency computation and encon measures. Steam: Distribution &U sage: Steam Traps, Condensate Recovery, Flash Steam Utilization, Insulators & Refractories

UNIT IV ENERGY CONSERVATION IN MAJOR UTILITIES 9

Pumps, Fans, Blowers, Compressed Air Systems, Refrigeration and Air Conditioning Systems – Cooling Towers – D.G. sets

UNITV ECONOMICS 9

Energy Economics – Discount Rate, Payback Period, Internal Rate of Return, Net Present Value, Life Cycle Costing –ESCO concept

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- **CO1 :** Remember the knowledge for Basic combustion and furnace design and selection of thermal and mechanical energy equipment.
- **CO2 :** Study the Importance of Stoichiometry relations, Theoretical air required for combustion.
- **CO3:** Skills on combustion thermodynamics and kinetics.
- **CO4:** Apply calculation and design tube still heaters.
- **CO5:** Studied different heat treatment furnace.
- **CO6:** Practical and theoretical knowledge burner design.

TEXT BOOKS:

1. Nelson, W. L., "Petroleum Refinery Engineering", 4th Edition. McGraw Hill, New York,1985.
2. Wiseman. P., "Petrochemicals", UMIST Series in Science and Technology, John Wiley & Sons,1986.

REFERENCE BOOKS:

1. Bhaskara Rao, B. K., "Modern Petroleum Refining Processes", 2nd Edition, Oxford and IBH Publishing Company, New Delhi, 1990.
2. Bhaskara Rao, B. K. "A Text on Petrochemicals", 1st Edition, Khanna Publishers

U23MEO24	NANOMATERIALS AND APPLICATIONS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

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

1. Understanding the evolution of nanomaterials in the scientific era and make them to understand different types of nanomaterials for the future engineering applications
2. Gaining knowledge on dimensionality effects on different properties of nanomaterials
3. Getting acquainted with the different processing techniques employed for fabricating nanomaterials
4. Having knowledge on the different characterisation techniques employed to characterise the nanomaterials
5. Acquiring knowledge on different applications of nanomaterials in different disciplines of engineering.

UNIT I NANOMATERIALS 9

Introduction, Classification: 0D, 1D, 2D, 3D nanomaterials and nano-composites, their mechanical, electrical, optical, magnetic properties; Nanomaterials versus bulk materials.

UNIT II THERMODYNAMICS & KINETICS OF NANOSTRUCTURED MATERIALS 9

Size and interface/interphase effects, interfacial thermodynamics, phase diagrams, diffusivity, grain growth, and thermal stability of nanomaterials.

UNIT III PROCESSING 9

Bottom -up and top-down approaches for the synthesis of nanomaterials, mechanical alloying, chemical routes, severe plastic deformation, and electrical wire explosion technique.

UNIT IV STRUCTURAL CHARACTERISTICS 9

Principles of emerging nanoscale X ray techniques such as small angle X-ray scattering and X-ray absorption fine structure (XAFS), electron and neutron diffraction techniques and their application to nanomaterials; SPM, Nanoindentation, Grain size, phase formation, texture, stress analysis

UNITV APPLICATIONS 9

Applications of nanoparticles, quantum dots, nanotubes, nanowires, nanocoatings; applications in electronic, electrical and medical industries

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 : Evaluate nanomaterials and understand the different types of nanomaterials .

CO2 : Recognise the effects of dimensionality of materials on the properties

CO3: Process different nanomaterials and use them in engineering applications

CO4: Use appropriate techniques for characterising nanomaterials

CO5: Identify applications of nanomaterials

CO6: Use different nanomaterials in various engineering fields.

TEXT BOOKS:

1. Bhusan, Bharat (Ed), "Springer Handbook of Nanotechnology", 2nd edition, 2007.
2. Carl C. Koch (ed.), NANOSTRUCTURED MATERIALS, Processing, Properties and Potential Applications, NOYES PUBLICATIONS, Norwich, New York, U.S.A.

REFERENCE BOOKS:

1. Poole C.P, and Owens F.J., Introduction to Nanotechnology, John Wiley 2003
2. Nalwa H.S., Encyclopedia of Nanoscience and Nanotechnology, American Scientific Publishers 2004
3. Zehetbauer M.J. and Zhu Y.T., Bulk Nanostructured Materials, Wiley 2008
4. Wang Z.L., Characterization of Nanophase Materials, Wiley 2000
5. Gutkin Y., Ovid'ko I.A. and Gutkin M., Plastic Deformation in Nanocrystalline Materials, Springer 2004

U23MEO25	INDUSTRIAL DESIGN & RAPID PROTOTYPING TECHNIQUES	L	T	P	C
		3	0	0	3

OBJECTIVES:

1. Outline Fundamental concepts in UI & UX
2. Introduce the principles of Design and Building an mobile app
3. Illustrate the use of CAD in product design
4. Outline the choice and use of prototyping tools
5. Understanding design of electronic circuits and fabrication of electronic devices

UNIT I UI/UX **9**

Fundamental concepts in UI & UX - Tools - Fundamentals of design principles - Psychology and Human Factors for User Interface Design - Layout and composition for Web, Mobile and Devices - Typography - Information architecture - Color theory - Design process flow, wireframes, best practices in the industry -User engagement ethics - Design alternatives

UNIT II APP DEVELOPMENT **9**

SDLC - Introduction to App Development - Types of Apps - web Development - understanding Stack - Frontend - backend - Working with Databases - Introduction to API - Introduction to Cloud services - Cloud environment Setup- Reading and writing data to cloud - Embedding ML models to Apps - Deploying application.

UNIT III INDUSTRIAL DESIGN **9**

Introduction to Industrial Design - Points, lines, and planes - Sketching and concept generation - Sketch to CAD - Introduction to CAD tools - Types of 3D modeling - Basic 3D Modeling Tools - Part creation – Assembly - Product design and rendering basics - Dimensioning & Tolerancing.

UNIT IV MECHANICAL RAPID PROTOTYPING **9**

Need for prototyping - Domains in prototyping - Difference between actual manufacturing and prototyping - Rapid prototyping methods - Tools used in different domains - Mechanical Prototyping; 3D Printing and classification - Laser Cutting and engraving - RD Works - Additive manufacturing

UNIT V ELECTRONIC RAPID PROTOTYPING **9**

Basics of electronic circuit design - lumped circuits - Electronic Prototyping - Working with simulation tool - simple PCB design with EDA

TOTAL : 45 PERIODS

COURSE OUTCOMES

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

CO1: Create quick UI/UX prototypes for customer needs

CO2: Develop web application to test product traction / product feature

CO3: Develop 3D models for prototyping various product ideas

CO4: Built prototypes using Tools and Techniques in a quick iterative methodology

CO5: Demonstrate the ability to build and assemble basic electronic circuits on a breadboard or a prototyping board.

CO6: Explain the purpose and benefits of using simulation tools in electronic circuit design and analysis.

TEXT BOOKS

1. Peter Fiell, Charlotte Fiell, Industrial Design A-Z, TASCHEN America Llc(2003)
2. Samar Malik, Autodesk Fusion 360 - The Master Guide.
3. Steve Krug, Don't Make Me Think, Revisited: A Common Sense Approach to Web Usability, Pearson,3rd edition(2014)

REFERENCES:

1. https://www.adobe.com/products/xd/learn/get-star ted.html
2. https://developer.android.com/guide
3. https://help.autodesk.com/view/fusion360/ENU/courses/
4. https://help.prusa3d.com/en/categor y/prusaslicer_204