RAJALAKSHMI
ENGINEERING COLLEGE
An AUTONOMOUS Institution
Affiliated to ANNA UNIVERSITY, Chennai

25 years OF ACADEMIC EXCELLENCE

DEPARTMENT OF MECHANICAL ENGINEERING

Regulation 2023

Choice Based Credit System (CBCS)

Curriculum and Syllabus

(I sem to VI sem)

Rajalakshmi Engineering College, Thandalam

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

Department of Mechanical Engineering

B.E. – Mechanical Engineering

Curriculum & Syllabus

Regulation 2023

RAJALAKSHMI ENGINEERING COLLEGE

(An Autonomous Institution Affiliated to Anna University Chennai)

DEPARTMENT OF MEHANICAL ENGINEERING

REGULATIONS 2023

CHOICE BASED CREDIT SYSTEM

CURRICULUM AND SYLLABUS

DEPARTMENT VISION

To provide a world class Mechanical Engineering education through innovation and excellence in Teaching and Research.

DEPARTMENT MISSION

- To impart high quality technical education and prepare Mechanical Engineers with all round knowledge of multi-disciplinary branches of Engineering and Technology.
- To foster skill sets required to be a global professional for industry, research and technology management.
- To provide consultancy to the neighborhood industries.
- To cultivate the spirit of entrepreneurship.

PEO I

To provide students with sound foundation in the mathematical, scientific and engineering

fundamentals necessary to formulate, analyze and solve engineering problems and to prepare them for graduate studies and for successful careers in industry.

PEO II

To impart students with skills for design, improvement and installation of Mechanical and allied integrated systems of men and material.

PEO III

To educate the students on designing the modern mechanical systems and expose them to industrial practices for better employability and adaptability.

PEO IV

To instill the values, skills, leadership and team spirit for comprehensive and wholesome personality, to promote entrepreneurial interest among students and to create a fervor for use of Engineering in addressing societal concerns.

Programme Outcomes (POs)

Engineering Graduates will be able to:

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. **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.
4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **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.
6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **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.
11. **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 mME1ultidisciplinary environments.
12. **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 technological change.

PROGRAM SPECIFIC OUTCOMES (PSOs)

1. To innovate a Mechanical System which meets the desired specifications and requirements using CAE tools.
2. To explore alternate materials for automobile, manufacturing and process industries
3. To lead professional career in industries or an entrepreneur by applying Engineering and Management principles and practices.

B.E. MECHANICAL ENGINEERING

REGULATION 2023

CURRICULUM AND SYLLABUS

CHOICE BASED CREDIT SYSTEM (CBCS)

SEMESTER I

S.No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
THEORY								
1	HS23111	Technical Communication I	HS	2	2	0	0	**2**
2	MA23112	Algebra and Calculus	BS	4	3	1	0	**4**
3	GE23111	Engineering Graphics	ES	6	2	0	4	**4**
4	EC23111	Basic Electronics Engineering	ES	3	3	0	0	**3**
5	GE23117	தமிழர் மரபு / Heritage of Tamils	HS	1	1	0	0	**1**
LAB ORIENTED THEORY								
6	PH23131	Physics of Materials	BS	5	3	0	2	**4**
PRACTICAL								
7	GE23121	Engineering Practices - Civil and Mechanical	ES	**2**	0	0	2	**1**
NON-CREDIT - MANDATORY COURSE								
8	MC23112	Environmental Science and Engineering	MC	**3**	3	0	0	**0**
			TOTAL	**26**	**17**	**1**	**8**	**19**

SEMESTER II

S.No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
THEORY								
1	HS23221/ HS23222	Technical Communication II / English for Professional Competence	HS	2	0	0	2	**1**
2	MA23212	Differential Equations and Complex variables	BS	4	3	1	0	**4**
3	GE23211	Engineering Mechanics	ES	3	2	1	0	**3**
4	GE23217	தமிழரும் தொழில்நுட்பமும் / Tamils and Technology	HS	1	1	0	0	**1**
LAB ORIENTED THEORY								
5	CY23233	Engineering Chemistry	BS	5	3	0	2	**4**
6	EE23132	Basic Electrical Engineering	ES	5	3	0	2	**4**
7	GE23233	Problem solving and Python Programming	ES	6	2	0	4	**4**
PRACTICAL								
8	GE23122	Engineering Practices- Electrical and Electronics	ES	2	0	0	2	**1**
NON-CREDIT - MANDATORY COURSE								
9	MC23111	Indian Constitution and Freedom Movement	MC	**3**	**3**	**0**	**0**	**0**
			TOTAL	**30**	**18**	**2**	**10**	**22**

SEMESTER-III

S.No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
THEORY								
1	ME23311	Engineering Thermodynamics	PC	4	3	1	0	**4**
2	ME23312	Manufacturing Technology I	PC	3	3	0	0	**3**
3	ME23313	Kinematics of Machinery	PC	3	3	0	0	**3**
LAB ORIENTED THEORY								
4	MA23331	Transforms and Statistics	BS	5	3	0	2	**4**
5	ME23331	Strength of Materials	PC	5	3	0	2	**4**
PRACTICAL								
6	ME23321	Manufacturing Technology Laboratory I	PC	2	0	0	2	**1**
7	CS23422	Python Programming for Machine learning	ES	4	0	0	4	**2**
			TOTAL	**26**	**15**	**1**	**10**	**21**

SEMESTER-IV

S.No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
THEORY								
1	ME23411	Engineering Materials and Metallurgy	PC	3	3	0	0	**3**
2	ME23412	Manufacturing Technology II	PC	3	3	0	0	**3**
LAB ORIENTED THEORY								
3	ME23431	Dynamics of Machines	PC	5	3	0	2	**4**
4	ME23432	Fluid Mechanics and Machinery	PC	5	3	0	2	**4**
5	ME23433	Thermal Engineering	PC	5	3	0	2	**4**
PRACTICAL								
6	GE23421	Soft Skills - I	EEC	2	0	0	2	**1**
7	ME23421	Machine Drawing Laboratory	PC	4	0	0	4	**2**
8	ME23422	Manufacturing Technology Laboratory II	PC	4	0	0	4	**2**
			TOTAL	**31**	**15**	**0**	**16**	**23**

SEMESTER-V

S.No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
THEORY								
1	GE23511	Economics for Engineers	HS	3	3	0	0	**3**
2	ME23511	Machine Design	PC	3	3	0	0	**3**
3		Professional Elective-I / Verticals	PE	3	3	0	0	**3**
4		**Open Elective - I**	OE	3	3	0	0	**3**
LAB ORIENTED THEORY								
5	ME23531	Heat and Mass Transfer	PC	5	3	0	2	**4**
6	ME23532	Metrology and Measurements	PC	5	3	0	2	**4**
PRACTICAL								
7	GE23521	Soft Skills - II	EEC	2	0	0	2	**1**
8	ME23521	Component Modeling Laboratory	PC	4	0	0	4	**2**
9	ME23522	Internship	EEC	2	0	0	2	**1**
			TOTAL	**30**	**18**	**0**	**12**	**24**

SEMESTER-VI

S.No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
THEORY								
1	ME23611	Additive Manufacturing Technologies	PC	3	3	0	0	**3**
2	ME23612	Design of Transmission systems	PC	3	3	0	0	**3**
3	ME23613	Finite Element Analysis	PC	3	3	0	0	**3**
5		Professional Elective II / Verticals	PE	3	3	0	0	**3**
6		**Open Elective – II**	OE	3	3	0	0	**3**
LAB ORIENTED THEORY								
7	ME23631	Robotics and CNC Programming	PC	4	2	0	2	**3**
PRACTICAL								
8	GE23621	Problem Solving Techniques	EEC	2	0	0	2	**1**
9	ME23622	Simulation and Analysis Laboratory	PC	3	0	0	3	**2**
10	GE23627	Design Thinking and Innovation	EEC	4	0	0	4	**2**
			TOTAL	**28**	**17**	**0**	**11**	**23**

SEMESTER-VII

S.No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
THEORY								
1	ME23711	Process Planning and Cost Estimation	PC	3	3	0	0	**3**
	ME23712	Total Quality Management	PC	3	3	0	0	**3**
2		Professional Elective III / Verticals	PE	3	3	0	0	**3**
3		Professional Elective IV / Verticals	PE	3	3	0	0	**3**
LAB ORIENTED THEORY								
4	ME23731	Artificial Intelligence for Mechanical Engineers	PC	5	1	0	4	**3**
5	ME23732	Mechatronics	PC	5	3	0	2	**4**
PRACTICAL								
6	ME23721	Project Work Phase I	EEC	4	0	0	4	**2**
7	ME23722	Comprehension	EEC	2	0	0	2	**1**
			TOTAL	**28**	**13**	**0**	**12**	**22**

SEMESTER-VIII

S.No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
THEORY								
1		Professional Elective V / Verticals	PE	**3**	**3**	**0**	**0**	**3**
PRACTICAL								
2	ME23821	Project Work Phase II	EEC	**16**	**0**	**0**	**16**	**8**
			TOTAL	**19**	**3**	**0**	**16**	**11**

Total Credits : 165

Summary of Credits:

CATEGORY	I	II	III	IV	V	VI	VII	VIII	Credits	(%)
BS	**8**	**8**	**4**						**20**	12%
HS	**3**	**2**			**3**				**8**	5%
ES	**8**	**12**	**2**						**22**	13%
PC			**15**	**22**	**13**	**14**	**13**		**77**	47%
PE					**3**	**3**	**6**	**3**	**15**	9%
EEC				**1**	**2**	**3**	**3**	**8**	**17**	10%
OE					**3**	**3**			**6**	4%
Non-Credit*/ (Mandatory)	**0**	**0**							**0**	0%
TOTAL	**19**	**22**	**21**	**23**	**24**	**23**	**22**	**11**	**165**	**100%**

Open Electives offered by Mechanical Engineering Department to other Departments

OME2311 Supply Chain Management
OME2312 Reverse Engineering and Additive Manufacturing
OME2313 Industrial Safety Engineering

Category	Common Verticals / Professional Electives		Dept. Verticals / Professional Electives- MECH				Diversified / Professional Electives
	Vertical 1	Vertical 2	Vertical 3	Vertical 4	Vertical 5	Vertical 6	Vertical 7
Offered in	Computational Engineering	Logistics And Supply Chain Management	Robotics And Automation	Product Design	Digital Manufacturing	Energy Systems	Diversified Courses
V Sem	ME23A11	ME23B11	ME23C11	ME23D11	ME23E11	ME23F11	ME23G11
	Machine Learning for Intelligent Systems	Reliability and Maintenance Engineering	Drone Technologies	Product Design and Development	Digital Manufacturing and IoT	Measurement and control for energy system	Automobile Engineering
V Sem	ME23A12	ME23B12	ME23C12	ME23D12	ME23E12	ME23F12	ME23G12
	CAD and CAE	Warehousing Automation	Electrical Drives and Actuators	Computer Aided Design	Lean Manufacturing	Energy conservation and waste heat recovery	Industrial Safety
VI Sem	ME23A13	ME23B13	ME23C13	ME23D13	ME23E13	ME 23F13	ME23G13
	Numerical heat transfer	Operations Management	Automation in Manufacturing	Geometric Dimensioning and Tolerancing	Advanced Machining Processes	Renewable sources of Energy	Composite Materials and Mechanics
VI Sem	ME23A14	ME23B14	ME23C14	ME23D14	ME23E14	ME 23F14	ME23G14
	Theory on Computation and Visualization	Material Handling Equipment, Repair and Maintenance	Embedded Systems and Programming	Design of Experiments	Green Manufacturing Design and Practices	Hybrid and Electrical Vehicles	Material Characterisation Techniques
VII Sem	ME23A15	ME23B15	ME23C15	ME23D15	ME23E15	ME23F15	ME23G15
	Computational Bio-Mechanics	Container Logistics	Sensors and Instrumentation	Design with Advanced materials	Intelligent Machining	Introduction to Power Plant Engineering	Principles of Management
VII Sem	ME23A16	ME23B16	ME23C16	ME 23D16	ME23E16	ME23F16	ME23G16
	Advanced Statistics and Data Analytics	Production Planning and Control	Hydraulics and Pneumatics	Design For X	Welding Technology	Refrigeration and Air conditioning	Entrepreneurship Development
VII Sem	ME23A17	ME23B17	ME23C17	ME23D17	ME23E17	ME23F17	ME23G17
	Noise Acoustics and Vibration	Operations Research	Smart Mobility and Intelligent Vehicles	Product Life Cycle Management	Electronics Manufacturing technology	Advanced energy storage technologies	Marketing Management
VIII Sem	ME23A18	ME23B18	ME23C18	ME23D18	ME23E18	ME23F18	ME23G18
	Computational Solid Mechanics	Supply chain and Logistics Management	Haptics and Immersive Technologies	New Product Development	Digital Twin and Industry 4.0	Energy systems modelling and analysis	Research Methodology and Intellectual Property Rights
VIII Sem	ME23A19	ME23B19	ME23C19	ME23D19	ME23E19	ME23F19	ME23G19
	Computational Fluid Dynamics	Data Science	Robot dynamics Applications	Design of Jigs, Fixture and Press tools	Non-Destructive Testing and Evaluation	Energy Engineering and Management	Corrosion and Surface Engineering

SEMESTER I

Course Code	Course Title (Theory Course)	Category	L	T	P	C
HS 23111	Technical Communication I	HS	2	0	0	2
	Common to all branches of B.E/B. Tech programmes – First Semester					

Objectives:
To facilitate students develop their comprehension skills
To enable students to improve their receptive skills
To equip learners with better vocabulary and enhance their writing skills
To aid students speak effectively in all kinds of communicative contexts.
To improve the learners' basic proficiency in workplace communication

UNIT-I	DEVELOPING COMPREHENSION SKILLS	6
Listening: Introduction to Informational listening – Listening to Podcasts, News **Reading**: Intentional Reading - Short Narratives and Passages. **Speaking:** Introducing Oneself, Narrating a Story / Incident. **Writing:** Sequential Writing – connecting ideas using transitional words (Jumbled Sentences), Process Description **Grammar:** Verbs – Main & Auxiliary: Simple Tenses – Form, Function and Meaning. **Vocabulary**: Word formation – Prefix, Suffix, Compound Words.		
UNIT-II	**LISTENING AND EXTENDED READING**	6
Listening: Deep Listening – Listening to Talk Shows and Debates **Reading**: In-depth Reading - Scanning Passages **Speaking**: Describing Current Issues, Happenings, etc.., **Writing**: Note Making, Note Taking – Paragraph Writing **Grammar**: Continuous Tenses, Prepositions, Articles **Vocabulary**: One Word Substitutes, Phrasal Verbs.		
UNIT-III	**FORMAL WRITING AND VERBAL ABILITY**	6
Listening: Listening to Lectures and Taking Notes **Reading:** Interpretation of Tables, Charts and Graphs **Speaking:** SWOT Analysis on Oneself **Writing:** Formal Letter Writing and Email Writing **Grammar:** Perfect Tenses, Phrases and Clauses, Discourse Markers **Vocabulary :** Verbal Analogy / Cloze Exercise		
UNIT-IV	**ENHANCING SPEAKING ABILITY**	6
Listening: Listening to eminent voices of one's interest (Martin Luther King, APJ Abdul Kalam, etc..) **Reading:** Timed Reading, Filling KWL Chart. **Speaking:** Just a Minute, Impromptu **Writing:** Check-list, Instructions. **Grammar:** 'Wh' Questions / 'Yes' or 'No' Questions, Imperatives **Vocabulary:** Synonyms, Antonyms, Different forms of the same words.		
UNIT-V	**LANGUAGE FOR WORKPLACE**	6
Listening: Extensive Listening (Audio books, rendering of poems, etc.) **Reading**: Extensive reading (Jigsaw Reading, Short Stories, Novels) **Speaking**: Short Presentations on Technical Topics **Writing:** Recommendations, Essay Writing **Grammar:** Impersonal Passive, Reported Speech, Concord **Vocabulary :** Informal Vocabulary and Formal Substitutes		
Total Contact Hours: 30		

Course Outcomes:
On completion of the course students will be able to
apply their comprehension skills and interpret different contents effortlessly
read and comprehend various texts and audio visual contents
infer data from graphs and charts and communicate it efficiently in varied contexts
participate effectively in diverse speaking situations
to present, discuss and coordinate with their peers in workplace using their language skills

Text Book(s):
1. Effective Technical Communication by M. Ashraf Rizvi (Author) 2nd Edition Paperback 2017
2. Sylvan Barnet and Hugo Bedau, 'Critical Thinking Reading and Writing', Bedford/st. Martin's: Fifth Edition (June 28, 2004)

3. Meenakshi Upadhyay, Arun Sharma – Verbal Ability and Reading Comprehension.
4. Teaching Speaking: A Holistic Approach, Book by Anne Burns and Christine ChuenMeng Goh, Cambridge University Press

Reference Books(s) / Web links:
1. Basic Vocabulary in Use: 60 Units of Vocabulary Practice in North American English With Answers 2nd Edition by Michael McCarthy (Author), Felicity O'Dell (Author), John D. Bunting (Contributor)
2. Reading Development and Difficulties By Kate Cain
3. The 7 Habits of Highly Effective People by Stephen Covey, Simon and Schuster, UK
4. Everybody Writes: Your Go-To Guide to Creating Ridiculously Good Content Hardcover by Ann Handley (Author)

PO/PSO / CO	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO 12	PSO 1	PSO2	PS O3
HS23111. 1	-	-	-	1	-	-	-	-	-	3	-	-	-	-	-
HS23111. 2	-	-	-	1	-	-	-	-	-	3	-	-	-	-	-
HS23111. 3	-	1	-	1	-	-	-	-	-	3	-	-	-	-	-
HS23111. 4	-	-	-	2	-	-	-	-	1	3	-	-	-	-	-
HS23111. 5	-	-	-	1	-	-	-	-	1	3	-	-	-	-	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	**Course Title (Theory Course)**	**Category**	**L**	**T**	**P**	**C**
MA23112	**ALGEBRA AND CALCULUS**	**BS**	3	1	0	4
Common to I sem. B.E. - AERO, AUTO, MECH, MCT, R&A, CIVIL and B.Tech. - BT, FT & CHEM						

Objectives:
● To introduce the matrix techniques and to illustrate the nature of the matrix.
● To address data and synthesis of the information to provide valid conclusions.
● To explain techniques of calculus which are applied in the solutions of engineering problems.
● To analyse special types of integrals by analytical methods and numerical techniques.
● To practice the techniques of Integration in finding area and volumes.

UNIT-I	**MATRICES**	12
Matrices - Eigenvalues and eigenvectors - Diagonalization of matrices using orthogonal transformation - Cayley-Hamilton Theorem(without proof) -Quadratic forms- Reduction to canonical form using orthogonal transformation- Numerical computation of Eigen value using Power method		
UNIT-II	**FUNCTIONS OF SEVERAL VARIABLES**	12
Partial differentiation–Total derivative–Change of variables–Jacobians–Partial differentiation of implicit functions–Taylor's series for functions of two variables–Maxima and minima of functions of two variables–Lagrange's method of undetermined multipliers.		
UNIT-III	**INTEGRAL CALCULUS**	12
Integral Calculus: Definite Integrals as a limit of sums - Applications of integration to area, volume - Improper integrals: Beta and Gamma integrals - Numerical computation of integrals: Trapezoidal rule - Gaussian Two point quadrature		
UNIT-IV	**MULTIPLE INTEGRALS**	12
Double integrals – Change of order of integration – Area enclosed by plane curves–Triple integrals–Volume of solids–Numerical computation of double integrals: Trapezoidal rule.		
UNIT-V	**REGRESSION**	12
Scatter diagram - Karl Pearson coefficient of correlation for raw data –Spearman rank correlation coefficient - Lines of regression - Regression equation X on Y and Y on X- Curve fitting by Principle of least squares - Fitting a straight line y = ax+b and a parabola $y = ax^2 + bx + c$.		
Total Contact Hours:60		

Course Outcomes:
On completion of the course students will be able to
● Demonstrate the matrix techniques in solving the related problems in engineering and technology.
● Analyse and interpret data, and synthesize information to provide valid conclusions.
● Interpret the problems in Engineering and Technology using the principles of mathematical calculus.
● Apply the analytical methods and numerical techniques to solve the related engineering problems.
● Evaluate multiple integrals to conduct investigations of complex problems.

Text Book(s):	
1.	Grewal B.S., " Higher Engineering Mathematics ", Khanna Publishers, New Delhi, 43rd Edition, 2014.
2.	Gupta S.C. and Kapoor V.K."Fundamentals of Mathematical Statistics", Sultan and Sons 10^{th} Edition,2000.
3.	T Veerarajan, Engineering Mathematics –I , Mc Graw Hill Education, 2018.
4.	I.R. Miller, J.E. Freund and R. Johnson , "Probability and Statistics for Engineers ",4th Edition, Pearson, 2018.
5.	A. Goon, M. Gupta and B.Dasgupta , "Fundamentals of Statistics ",Vol. I & Vol. II, World Press, 2019.

Reference Books(s) / Web links:	
1.	Ramana. B.V., " Higher Engineering Mathematics ", McGraw Hill Education Pvt. Ltd, New Delhi, 2018.
2.	T Veerarajan ,Fundamentals of Mathematical Statistics , yesdee publications, 2017.
3.	Erwin Kreyszig ," Advanced Engineering Mathematics ", John Wiley and Sons, 10th Edition, New Delhi, 2016.
4.	Bali, N.P. and Manish Goyal, A Text Book of Engineering Mathematics, Lakshmi Publications Pvt. Ltd., New Delhi, 2006.
5.	N. Draper & H. Smith,"Applied Regression Analysis" III edition, Wiley, 1998.

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MA23112.1	3	2	1	-	-	-	-	-	-	-	1	-	-	-	-
MA23112.2	3	2	-	1	-	-	-	-	-	-	1	1	1	-	-
MA23112.3	2	2	-	-	-	-	-	-	-	-	1	1	-	-	-
MA23112.4	3	3	1	-	-	-	-	-	-	-	1	1	-	-	-
MA23112.5	2	2	-	-	-	-	-	-	-	-	-	-	1	-	-
Average	2.6	2.2	1	1	-	-	-	-	-	-	1	1	1	-	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Theory Course)	Category	L	T	P	C
GE23111	**ENGINEERING GRAPHICS**	**ES**	2	0	4	4

Objectives:
● To understand the importance of the drawing in engineering applications
● To develop graphic skills for communication of concepts, ideas and design of engineering products
● To expose them to existing national standards related to technical drawings.
● To improve their visualization skills so that they can apply this skill in developing new products.
● To improve their technical communication skill in the form of communicative drawings

CONCEPTS AND CONVENTIONS (Not for Examination)	**1**
Importance of graphics in engineering applications–Use of drafting instruments– BIS conventions and specifications– Size, layout and folding of drawing sheets– Lettering and dimensioning. Basic Geometrical constructions.	

UNIT-I	PLANE CURVES AND PROJECTION OF POINTS	5+12
Curves used in engineering practices: Conics–Construction of ellipse, parabola and hyperbola by eccentricity method – Cycloidal Curves–Construction of cycloid, epicycloid and hypocycloid – Construction of involutes of square and circle–Drawing of tangents and normal to the above curves. Principles of Projection and Projection of points.		
UNIT-II	**PROJECTION OF LINES AND PLANE SURFACES**	**6+12**
Projection of straight lines (First angle projection) inclined to both the principal planes – Determination of true lengths and true inclinations by rotating line method Projection of planes (polygonal and circular surfaces) inclined to both the principal planes by rotating object method.		
UNIT-III	**PROJECTION OF SOLIDS AND PROJECTION OF SECTIONED SOLIDS**	**6+12**
Projection of simple solids like prisms, pyramids, cylinder and cone when the axis is inclined to one of the principal planes by rotating object method. Sectioning of solids in simple vertical position when the cutting plane is inclined to HP and perpendicular to VP – obtaining true shape of the section. Practicing three-dimensional modeling of simple objects by CAD software (Not for examination)		
UNIT-IV	**DEVELOPMENT OF SURFACE AND ISOMETRIC PROJECTIONS**	**6+12**
Development of lateral surfaces of simple and sectioned solids – Prisms, pyramids cylinders and cones. Principles of isometric projection–isometric scale–Isometric projections of simple solids and truncated solids - Prisms, pyramids, cylinders and cones Model making of isometric projection of combination of solids as assignment (Not for End semester)		
UNIT-V	**FREE HAND SKETCHING AND PERSPECTIVE PROJECTIONS**	**6+12**
Free Hand sketching: Freehand sketching of multiple views from pictorial views of objects - Freehand sketching of pictorial views of object from multiple views Perspective projection of simple solids-Prisms, pyramids, cylinder and cone by visual ray method.		
		Total Contact Hours: 90 (L=30; P=60)

Course Outcomes:

After learning the course, the students should be able

- To construct different plane curves and to comprehend the theory of projection
- To draw the basic views related to projection of lines and planes.
- To draw the projection of simple solids and to draw the projection of development of surfaces of Sectioned solids in simple vertical position
- To draw the orthographic projection from pictorial objects and Isometric projections of simple solids
- To visualize Perspective view of simple solids

Text Book(s):

1. Bhatt N.D. and Panchal V.M., "Engineering Drawing", Charotar Publishing House, 50th Edition, 2010
2. Natarajan K.V., "A text book of Engineering Graphics", Dhanalakshmi Publishers, Chennai, 2017.

Reference Book(s) / Weblinks:

1. Varghese P I., "Engineering Graphics", McGraw Hill Education (I) Pvt.Ltd., 2013.
2. V.B Sikka "Civil Engineering Drawing", S.K Kataria & Sons, New Delhi.
3. Venugopal K. and PrabhuRaja V., "Engineering Graphics", New Age International (P)Limited, 2008.
4. Gopalakrishna K.R., "Engineering Drawing" (Vol. I&II combined), Subhas Stores, Bangalore, 2017
5. Basant Agarwal and Agarwal C.M., "Engineering Drawing", McGraw Hill Publishing Company Limited, New Delhi, 2018

CO PO PSO MAPPING

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

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Theory course)	Category	L	T	P	C
EC23111	**BASIC ELECTRONICS ENGINEERING**	ES	3	0	0	3
Common to	**Mechanical and Automobile Engineering**					

Objectives: The Student should be made
● To study the operation of semiconductor devices and their characteristics.
● To understand the concepts of operational amplifiers with its applications.
● To acquire knowledge about the operation of timing circuits and Oscillators.
● To gain knowledge about digital logic circuits.
● To introduce the basics of electronic communication systems.

UNIT-I	**SEMICONDUCTOR DEVICES AND APPLICATIONS**	**9**
Introduction to P-N junction Diode and V-I characteristics, Half wave and Full-wave rectifiers. Zener diode and its characteristics, Zener diode as voltage regulator. Introduction to BJT and its input and output characteristics, BJT as a single stage CE amplifier.		
UNIT-II	**OPERATIONAL AMPLIFIER AND APPLICATIONS**	**9**
Introduction to operational amplifiers, Op-amp input modes and parameters, Op-amp in open loop configuration, Op-amp with negative feedback, study of practical Op-amp IC 741, inverting and non-inverting amplifier applications: summing and difference amplifier, unity gain buffer, comparator, integrator and differentiator.		
UNIT-III	**TIMING CIRCUITS AND OSCILLATORS**	**9**
RC-timing circuits, IC 555 and its applications as astable and mono-stable multi-vibrators, positive feedback, Barkhausen criteria for oscillation, R-C phase shift and Wein bridge oscillator.		
UNIT-IV	**DIGITAL ELECTRONICS FUNDAMENTALS**	**9**
Boolean algebra, Basic and Universal Gates, Symbols, Truth tables, logic expressions, Logic simplification using K-map, half and full adder/subtractor, multiplexers, de-multiplexers, flipflops, shift registers, counters, Block diagram of 8086 microprocessor and 8051 microcontroller and their applications.		
UNIT-V	**MODERN WIRELESS COMMUNICATION SYSTEMS**	**9**
The elements of communication system, Transmission media: wired and wireless, need of modulation, AM and FM modulation schemes, Mobile communication systems: cellular concept and block diagram of GSM system.		
Total Contact Hours: 45		

Course Outcomes: On completion of course, students will be able to
● Demonstrate the characteristics of the diode and transistors.
● Design suitable amplifiers for simple applications.
● Analyze the timing circuits and design oscillators.
● Construct simple digital logic circuits.
● Develop a high degree of familiarity with the Electronic Communication Systems.

Text Book(s):
● Floyd, “Electronic Devices” Pearson Education, 9th edition, 2012.
● R.P. Jain, “Modern Digital Electronics”, Tata Mc Graw Hill, 3rd Edition, 2007.
● Frenzel, “Communication Electronics: Principles and Applications”, Tata Mc Graw Hill, 3rd Edition,2001
Reference Books(s) / Web links:
1. Donald .A. Neamen, Electronic Circuit Analysis and Design – 2nd Edition, Tata McGraw Hill, 2009
2. David A., “Bell Electronic Devices and Circuits”, Oxford Higher Education Press, 5th Edition, 2010
3. M. Morris Mano, “Digital Design”, 4th Edition, Prentice Hall of India Pvt. Ltd., 2008 / Pearson Education (Singapore) Pvt. Ltd., New Delhi, 2003.
4. Simon Haykin, Communication Systems, John Wiley & sons, NY, 4th Edition, 2001.
5. Salivahanan. S, Suresh Kumar. N, Vallavaraj.A, “Electronic Devices and circuits”, Third Edition, Tata McGraw- Hill, 2008

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EC23315.1	3	3	3	3	3	2	1	2	2	2	1	2	2	2	2
EC23315.2	3	3	3	3	3	2	1	2	2	2	1	2	3	3	3
EC23315.3	3	3	3	3	3	2	1	2	2	2	1	2	3	3	3
EC23315.4	3	3	3	3	3	2	1	2	2	2	1	2	3	3	3
EC23315.5	3	3	3	3	3	2	1	2	2	2	1	2	3	3	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Theory course)		L	T	P	C
GE23117	**தமிழர் மரபு / HERITAGE OF TAMILS**		1	0	0	1

அலகு I	**மொழி மற்றும் இலக்கியம்**	**3**

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

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

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

அலகு III	**நாட்டுப்புறக் கலைகள் மற்றும் வீர விளையாட்டுகள்**	**3**

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

அலகு IV	**தமிழர்களின் திணைக் கோட்பாடுகள்**	**3**

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

அலகு V	**இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்பாட்டிற்குத் தமிழர்களின் பங்களிப்பு**	**9**

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

Total Contact Hours: 15

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.

Course Code	Course Title (Lab Oriented Theory Course)	Category	L	T	P	C
PH23131	PHYSICS OF MATERIALS Common to I sem. B.E. - Aero, Auto, Civil, Mech, MCT and R&A	BS	3	0	2	4

Objectives:

- To enhance the fundamental knowledge of elasticity and its applications relevant to engineering streams.
- To become proficient in crystal growth and crystal systems.
- To introduce the essential of phase transformation in materials.
- To impart knowledge on the structure, properties, treatment, testing and applications of metals and alloys.
- To familiarize students with thermal properties and applications.

UNIT-I **PROPERTIES OF MATTER** 9

Elasticity–Hooke's law-stress–strain-modulus of elasticity-stress-strain diagram-Poisson's ratio-rigidity modulus-twisting couple on a cylinder-moment of inertia - torsional pendulum method. Bending of beams -bending moment-cantilever depression-theory and experiment - Young's modulus determination–uniform and non-uniform bending-I-shape girders. Viscosity-flow of motion-Reynolds number.

UNIT-II **THERMAL PHYSICS** 9

Transfer of heat energy – thermal expansion of solids and liquids – expansion joints - bimetallic strips - thermal conduction, convection and radiation –rectilinear heat flow – thermal conductivity - Forbe's and Lee's disc method: theory and experiment - conduction through compound media (series and parallel) – thermal insulation – applications: heat exchangers, refrigerators, ovens and solar water heaters.

UNIT-III **PHASE DIAGRAMS** 9

Solid solutions - Hume-Rothery's rules –Gibb's phase rule – unary phase diagram- binary phase diagrams - isomorphous systems - tie-line and lever rule - eutectic, eutectoid, peritectic, peritectoid, monotectic and syntectic systems - formation of microstructures-homogeneous and non-homogenous cooling – nucleation (Qualitative)– iron-carbon phase diagram - eutectoid steel – hypo-eutectoid and hyper-eutectoid steel – diffusion - Fick's laws – T-T-T diagrams.

UNIT-IV **CRYSTAL PHYSICS** 9

Basis – lattices – unit cell-crystal systems – Bravais lattices –number of atoms, atomic radius, co-ordination number and packing fraction - SC, BCC, FCC, HCP lattices and diamond structure - polymorphism and allotropy-graphite structure - Miller indices – determination of d-space-crystal growth techniques-solution growth –melt growth-Bridgmann and Czochralski - crystal defects.

UNIT-V **ADVANCED MATERIALS & TESTING** 9

Metallic glasses – preparation, properties and applications - Composites – types and properties - Shape memory alloys – properties and applications - Nano-materials – top down and bottom up approaches –sol-gel method-pulsed laser deposition-ball milling- properties-applications - Tensile strength – Hardness – Fatigue - Impact strength – Creep - Fracture – types of fracture.

Contact Hours : 45

List of Experiments

1	Determination of Young's modulus of given material by non-uniform bending method.
2	Determination of moment of inertia of a disc and rigidity modulus of a given wire using Torsional pendulum.
3	Determination of Young's modulus of given beam by cantilever method.
4	Determination of viscosity of the given liquid using Poiseuille's method.
5	Determination of Thermal conductivity of a bad conductor – Lee's Disc method.
6	Determination of Velocity of ultrasound and compressibility of given liquid – Ultrasonic interferometer.
7	Determination of the wavelength of Laser and particle size of given powder.
8	Determination of the Hysteresis loss of ferromagnetic material by B-H curve experiment.
9	Find the thickness of a given thin wire – Air wedge method.
10	Study the characteristics of solar cell parameters.

Contact Hours : 30

Total Contact Hours : 75

Course Outcomes:

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

- apply the elastic nature of materials and determine the elastic moduli of different materials.
- apply the basic knowledge of crystal structure in solids.
- analyse and measure the properties of alloys.
- analyse various material testing methods and use them in suitable applications.
- understand the concepts of heat transfer in various applications.

Text Book(s):	
1	Bhattacharya, D.K. &Poonam, T. *"Engineering Physics"*.Oxford University Press, 2018.
2	Gaur, R.K. & Gupta, S.L. *"Engineering Physics"*.DhanpatRai Publishers, 2018.
3	Raghavan, V. *"Physical Metallurgy: Principles and Practice"*. PHI Learning, 2019.
Reference Books(s) / Web links:	
1	Balasubramaniam, R. *"Callister's Materials Science and Engineering"*.Wiley India Pvt. Ltd., 2017
2	Resnick, R., Halliday, D., & Walker, J. *"Principles of Physics*", Wiley India Pvt., 2018.
3	Raghavan, V. *"Materials Science and Engineering: A First course"*. PHI Learning, 2019.
4	https://nptel.ac.in/courses/113104068
5	https://archive.nptel.ac.in/courses/115/105/115105099/

List of Equipment Available
(Common to B.E. Aero, Auto, Civil, Mechanical, Mechatronics Engineering and R&A)

S. No	Name of the equipment	Quantity Required	Quantity Available	Deficiency
1	Young's modulus by Non - Uniform bending method Travelling Microscopes, Meter scale etc.,	6	13	-
2	Rigidity Modulus - Torsional Pendulum Setup	6	19	-
3	Velocity of sound and compressibility of liquid – Ultrasonic Interferometer	6	14	-
4	Wavelength of Laser and Characteristics -Laser source And grating plate	6	15	-
5	B-H curve Setup and CRO	6	7	-
6	Thermal conductivity of bad conductor- Lee's Disc setup	6	16	-
7	LCR circuit kit	6	7	-
8	Thickness of a thin wire-Air wedge method – Travelling microscope	6	13	-
9	Solar cell parameters setup	6	8	-
10	Poiseuille's method set up	6	10	-

CO - PO – PSO matrices of course

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	3	3	2	-	-	-	-	-	-	-	-	-	1	1	1
CO 2	3	2	1	-	-	-	-	-	-	-	-	-	-	1	-
CO 3	3	3	2	-	-	-	-	-	-	-	-	1	1	1	-
CO 4	3	2	2	-	-	-	-	-	-	-	-	1	1	1	1
CO 5	3	3	2	-	-	-	-	-	-	-	-	1	1	-	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Laboratory Course)	Category	L	T	P	C
GE23121	ENGINEERING PRACTICES – Civil and Mechanical	ES	0	0	2	1

Objectives:

To provide exposure to the students with hands on experience on various basic engineering practices in Civil and Mechanical Engineering.

List of Experiments					
CIVIL ENGINEERING PRACTICE					
1.	Study of pipeline joints, its location and functions: valves, taps, couplings, unions, reducers, and elbows in household fittings.				
2.	Preparation of basic plumbing line sketches for wash basins, water heaters, etc.				
3.	Hands-on-exercise: Basic pipe connections – Pipe connections with different joining components.				
Carpentry Works:					
4.	Study of joints in roofs, doors, windows and furniture.				
5.	Hands-on-exercise: Woodwork, joints by sawing, planning and chiselling.				
MECHANICAL ENGINEERING PRACTICE					
6.	Preparation of butt joints, lap joints and T- joints by Shielded metal arc welding.				
7	Gas welding practice.				
Basic Machining:					
8	Simple Turning and Taper turning				
9	Drilling Practice				
Sheet Metal Work:					
10	Forming & Bending:				
11	Model making – Trays and funnels				
12	Different type of joints.				
Machine Assembly Practice:					
13	Study of centrifugal pump				
14	Study of air conditioner				
		Total Contact Hours	**:**	**30**	

Course Outcomes:	
●	Able to perform plumbing activities for residential and industrial buildings considering safety aspects while gaining clear understanding on pipeline location and functions of joints like valves, taps, couplings, unions, reducers, elbows, etc.
●	Able to perform wood working carpentry activities like sawing, planning, cutting, etc. while having clear understanding of the joints in roofs, doors, windows and furniture.
●	Able to produce joints like L joint, T joint, Lap joint, Butt joint, etc. through arc welding process while acquiring in depth knowledge in the principle of operation of welding and other accessories
●	Able to perform operations like Turning, Step turning, Taper turning, etc. in lathe and Drilling operation in drilling machine
●	Able to perform sheet metal operations like Forming, Bending, etc. and fabricating models like Trays, funnels, etc.

TOTAL: 30 PERIODS

List of equipment and components

(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 - 15 Sets.
2. Plumbing vice (fitted to work bench) – 15 Nos.
3. Carpentry vice (fitted to work bench) - 15 Nos.
4. Standard woodworking tools - 15 Sets.
5. Models of industrial trusses, door joints, furniture joints - 5 each
6. Power Tools: (a) Rotary Hammer - 1 No. (b) Circular Saw - 1 No. (c) Electric Planer - 1 No.

(d) Hand Drilling Machine - 1 No. (e) Jigsaw - 1 No. (f) Cutoff Machine – 1 No.

MECHANICAL

1. Arc welding transformer with cables and holders - 5 Nos.
2. Welding booth with exhaust facility - 5 Nos.
3. Welding accessories like welding shield, chipping hammer, wire brush, etc. - 5 Sets.
4. Oxygen and acetylene gas cylinders, blow pipe and other welding outfit - 1 No.
5. Centre lathe - 5 Nos.
6. Standard Sheet metal working tools – 2 sets
7. Study-purpose items: centrifugal pump, air-conditioner – 1 each.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	1	1	1	-	-	2	1	-	2	-	-	2	-	2	1
CO 2	1	1	1	-	-	2	1	-	2	-	-	2	-	2	1
CO 3	1	1	1	-	-	2	1	-	2	-	-	2	-	2	1
CO 4	1	1	1	-	-	2	1	-	2	-	-	2	-	2	1
CO 5	1	1	1	-	-	2	1	-	2	-	-	2	-	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Theory course)	Category	L	T	P	C
MC23112	**ENVIRONMENTAL SCIENCE AND ENGINEERING**	**MC**	**3**	**0**	**0**	**0**
Common to B.E. /B.Tech all branches except CSBS						

Objectives:
● To develop the understanding of environmental and associated issues
● To develop an attitude of concern for the environment
● To promote enthusiasm in participating environmental protection initiatives
● To nurture skills to solve environmental degradation issues
● To develop the knowledge about the environmental laws

UNIT-I	**AIR AND NOISE POLLUTION**	9
Definition –sources of air pollution –chemical and photochemical reactions in the atmosphere - formation of smog, PAN, acid rain, ozone depletion, particulate pollutants-Air quality standards-Air quality indices - control of particulate air pollutants-gravitational settling chambers, cyclone separators, wet collectors, fabric filters (Bag-house filter), electrostatic precipitators (ESP)-catalytic converters. Noise pollution –sources - health effects - standards- measurement and control methods.		
UNIT-II	**WATER POLLUTION AND ITS MANAGEMENT**	9
Definition-causes-effects of water pollution-point and nonpoint sources of wastewater-marine pollution - thermal pollution - Control of water pollution by physical, chemical and biological methods – wastewater treatment-primary, secondary and tertiary treatment-sources and characteristics of industrial effluents- zero liquid discharge.		
UNIT-III	**SOLID WASTE AND HAZARDOUS WASTE MANAGEMENT**	9
Solid waste – types- municipal solid waste management: sources, characteristics, collection, and transportation-sanitary landfill, recycling, composting, incineration, energy recovery options from waste - Hazardous waste – types, characteristics, and health impact - hazardous waste management: neutralization, oxidation reduction, precipitation, solidification, stabilization, incineration and final disposal. E-waste-definition-sources-effects on human health and environment- E-waste management- steps involved - Role of E-waste management within the initiatives of the Govt. of India- Swachh Bharat Mission.		
UNIT-IV	**SUSTAINABLE DEVELOPMENT**	9
Sustainable development- concept-dimensions-sustainable development goals - value education- gender equality – food security - poverty – hunger - famine - Twelve principles of green chemistry - Green technology - definition, importance - Cleaner development mechanism - carbon credits, carbon trading, carbon sequestration, eco labeling-International conventions and protocols-Disaster management.		

UNIT-V	ENVIRONMENTAL MANAGEMENT AND LEGISLATION	9
Environmental Management systems - ISO 14000 series- Environmental audit-Environmental Impact Assessment- life cycle assessment- human health risk assessment - Environmental Laws and Policy- Objectives - Polluter pays principle, Precautionary principle - The Environment (Protection) Act 1986 - Role of Information technology in environment and human health.		
Total Contact Hours:45		

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

- Associate air and noise quality standards with environment and human health.
- Illustrate the significance of water and devise control measures for water pollution.
- Analyze solid wastes and hazardous wastes.
- Outline the goals of sustainable development in an integrated perspective.
- Comprehend the significance of environmental laws.

Text Book(s):

1. Benny Joseph, 'Environmental Science and Engineering', Tata McGraw-Hill, New Delhi, 2016
2. Anubha Kaushik and C. P. Kaushik's "Perspectives in Environmental Studies", 6th Edition, New Age International Publisher, 2018.
3. Johri R., E-waste: implications, regulations, and management in India and current global best practices, TERI Press, New Delhi

Reference Books(s) / Web links:

- R.K. Trivedi, 'Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards', Vol. I and II, Enviro Media. 38. Edition 2010.
- Cunningham, W.P. Cooper, T.H. Gorhani, 'Environmental Encyclopedia', Jaico Publ., House, Mumbai, 2001.
- Fowler B, Electronic Waste – 1 st Edition (Toxicology and Public Health Issues), 2017 Elsevier
- NPTEL course url https://onlinecourses.nptel.ac.in/noc19_ge22/NPTEL
  https://news.mit.edu/2013/ewaste-mit

1. For downloading text/reference books the weblink is given below can be used **http://libgen.rs/**

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PSO2	PSO3
MC23112.1	1	2	3	1	-	2	2	2	1	1	1	2	-	1	-
MC23112.2	1	2	3	1	-	2	2	2	1	1	1	2	-	-	-
MC23112.3	-	-	3	1	-	2	3	2	1	-	1	2	-	-	-
MC23112.4	-	1	2	1	1	3	3	2	1	1	1	2	-	-	-
MC23112.5	-	1	2	-	-	2	2	2	1	2	2	2	-	-	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

SEMESTER II

Course Code	Course Title (Laboratory Course)	Category	L	T	P	C
HS23221	TECHNICAL COMMUNICATION II	HS	0	0	2	1
	Common to all branches of B.E/B. Tech programmes –Second Semester					

Objectives:
● To facilitate students to improve their vocabulary for a better communication
● To enable learners to understand and reproduce language
● To aid students to write technical reports in a convincing manner
● To expose students to different sentence structures
● To equip learners to present their ideas in an efficient manner

UNIT-I	VOCABULARY FOR BETTER COMMUNICATION	6
Listening: Telephonic Conversations and TV News **Reading:** Newspapers and Magazines **Speaking**: Conversational Practice: Speaking in a given situation, Asking permission and requesting etc.., **Writing:** Job Application Letter and Resume **Grammar:** Reference words: pronouns and determiners **Vocabulary:** Guessing meanings of words in different contexts.		
UNIT-II	**FUNCTIONAL LANGUAGE ASPECTS**	6
Listening: Motivational listening – listening to real life challenges **Reading:** Articles and Technical reports **Speaking:** Using Polite Expressions, Indirect Questions **Writing:** Paraphrasing a Text, Poem **Grammar:** Purpose Statements, Cause and Effect Expressions **Vocabulary:** Neologisms.		
UNIT-III	**TECHNICAL REPORTWRITING**	6
Listening: Empathetic Listening – Giving Solutions to Problems **Reading:** Inferential Reading **Speaking:** Dialogues – Interviewing Celebrities / Leaders / Sportspersons, etc.., **Writing:** Report Writing **Grammar:** Functional Usage of Expressions – used to, gone / been, etc.., **Vocabulary:** Words Often Confused		
UNIT-IV	**STRUCTURAL GRAMMAR**	6
Listening: Comprehension (IELTS practice tests) **Reading:** Intensive Reading for specific information **Speaking:** Pick and Talk **Writing:** Proposals **Grammar:** Sentence Structures – Simple, Compound, Complex Sentences **Vocabulary:** Replacing dull words with vivid ones		
UNIT-V	**PRESENTATION SKILLS**	6
Listening: Discriminative listening – sarcasm, irony, pun, etc.., **Reading:** Practice of chunking – breaking up reading materials **Speaking:** Mini presentation on some topic **Writing:** Minutes of the meeting **Grammar:** Correction of Errors **Vocabulary:** Advanced vocabulary – fixing appropriate words in the given context.		
		Total Contact Hours: 30

Course Outcomes:
On completion of the course students will be able to
● communicate effectively using appropriate vocabulary
● use the acquired language skills to comprehend various types of language contents
● evaluate different texts and write effective technical content
● use appropriate sentence structures to convey their thoughts in varied contexts
● present their concepts and ideas in an effective manner

Text Book(s):
1. Raymond Murphy, "Intermediate English Grammar," Second Edition , Cambridge University Press, 2018
2. Meenakshi Raman & Sangeeta Sharma, "Technical Communication" Third Edition, Oxford University Press, 2015

3. Teaching Speaking: A Holistic Approach, Book by Anne Burns and Christine ChuenMeng Goh, Cambridge University Press
Reference Books(s) / Web links:
1. Michael McCarthy (Author), Felicity O'Dell (Author), John D. Bunting (Contributor), "Basic Vocabulary in Use: 60 Units of Vocabulary Practice in North American English With Answers" 2nd Edition
2. Dale Carnegie, "The Art of Public Speaking," Insight Press
3. Jack C. Richards & Theodore S. Rodgers, " Approaches and Methods in Language Teaching, Second Edition, Cambridge University Press

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
HS23221. 1	-	-	-	1	-	-	-	-	-	2	-	-	-	-	-
HS23221. 2	-	-	-	1	-	-	-	-	-	3	-	-	-	-	-
HS23221. 3	-	2	-	1	-	-	-	-	-	3	-	-	-	-	-
HS23221. 4	-	-	-	1	-	-	-	-	2	3	-	-	-	-	-
HS23221. 5	-	-	-	1	-	-	-	-	2	2	-	-	-	-	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Laboratory Course)	Category	L	T	P	C
HS23222	**ENGLISH FOR PROFESSIONAL COMPETENCE** Common to all branches of B.E/B. Tech programmes –Second Semester	HS	0	0	2	1

Objectives:

- To facilitate the learners in acquiring listening and reading competence
- To enable the learners to communicate effectively through written and oral medium
- To assist the learners in preparing for competitive examinations
- To train the students in acquiring corporate skills
- To inculcate professional standards among the students and make them realize their responsibility in addressing the challenges

UNIT-I	**RECEPTIVE SKILLS**	6

Listening – Comprehensive Listening – Watching the news – Listening to a peer giving presentation, etc. – Critical Listening – Watching a televised debate, Listening to poems – **Reading** – Extensive Reading – Short stories and One-act Plays – Intensive Reading – Articles or Editorials in Magazines, Blog posts on topics like science and technology, arts, etc.

UNIT-II	**PRODUCTIVE SKILLS**	**6**

Speaking – Demonstrative Speaking – Process description through visual aids – Persuasive Speaking – Convincing the listener with the speaker's view – **Writing** – Descriptive Writing - Describing a place, person, process – Subjective Writing – Autobiography, Writing based on personal opinions and interpretations

UNIT-III	**ENGLISH FOR COMPETITIVE EXAMS**	6

An introduction to International English Language Testing System (IELTS) – Test of English as a Foreign Language (TOEFL) – Graduate Record Examination (GRE) – Civil Service, Indian Economic Service Examination, Indian Statistical Service Examination, Combined Defence Services Examination, Staff Selection- (Language Related) – Aptitude tests.

UNIT-IV	**CORPORATE SKILLS**	**6**

Critical Thinking and Problem Solving – Case Study, Brainstorming, Q & A Discussion – **Team work and Collaboration** – Activities like Office Debates, Perfect Square, Blind Retriever, etc. – **Professionalism and Strong Work Ethics** – Integrity, Resilience, Accountability, Adaptability, Growth Mind set

UNIT-V	**PROJECT WORK**	6

Case Study based on the challenges faced by the employers and the employees – Devise Plan, Provide Solution

Total Contact Hours	30

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

● interpret and respond appropriately in the listening and reading contexts.
● express themselves effectively in spoken and written communication
● apply their acquired language skills in writing the competitive examinations
● exhibit their professional skills in their work place
● identify the challenges in the work place and suggest strategies solutions

Reference Books	
1	How to Read Better & Faster, Norman Lewis, Goyal Publishers
2	Teaching Speaking: A Holistic Approach, Book by Anne Burns and Christine Chuen Meng Goh, Cambridge University Press
3	The Official Cambridge Guide To IELTS by Pauline Cullen, Cambridge University Press
4	The 7 Habits of Highly Effective People by Stephen Covey, Simon and Schuster, UK

Reference Books(s) / Web links:
1. Board of Editors. Sure Outcomes. A Communication Skills Course for Undergraduate Engineers and Technologists. Orient Black Swan Limited, Hyderabad, 2013.
2. Hartley, Mary. "The Power of Listening," JaicoPublishing House; First Edition (2015).
3. Chambers, Harry. "Effective Communication Skills for Scientific and Technical Professionals," Persues Publishing, Cambridge, Massachusetts, 2000.

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
HS23222. 1	-	1	-	-	-	-	-	-	-	3	-	-	-	-	-
HS23222. 2	-	1	-	-	-	-	-	-	-	3	-	-	-	-	-
HS23222. 3	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-
HS23222. 4	-	-	-	-	-	-	2	2	-	3	-	-	-	-	-
HS23222. 5	-	-	1	-	-	-	2	-	-	3	-	-	-	-	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	**Course Title (Theory course)**	**Category**	**L**	**T**	**P**	**C**
MA23212	**DIFFERENTIAL EQUATIONS AND COMPLEX VARIABLES**	**BS**	**3**	**1**	**0**	**4**

Common to II Sem. B.E. –AERO, AUTO, BME, CIVIL, EEE, ECE, MECH, MCT, R&A and B. Tech. - BT, FT & CHEM

Objectives:

- To provide students with an introduction to the theory of ordinary differential equations through applications, methods of solution, and numerical approximations.
- To introduce students to how to solve linear Partial Differential with different methods.
- To enable the students to study the Laplace Transforms, properties of Laplace Transform, inverse Laplace Transform and some applications to solve the differential equations and integral equations.
- To explain the concept of a vector integration in a plane and in space.
- To describe basic properties of complex variables and to have the ability to compute complex integrals.

UNIT-I	**ORDINARY DIFFERENTIAL EQUATIONS**	**12**

Second and higher order Linear differential equations with constant coefficients - Method of variation of parameters – Legendre's linear equations – Numerical solution of ODE - Single Step methods: Taylor's series method, Euler's method.

UNIT-II	PARTIAL DIFFERENTIAL EQUATIONS	12
Formation of partial differential equations - Classification of PDE – Solutions of standard types of first order partial differential equations - Lagrange's linear equation –Linear homogeneous partial differential equations of second and higher order with constant coefficients.		
UNIT-III	**LAPLACE TRANSFORM**	**12**
Laplace transform –Basic properties – Transforms of derivatives and integrals of functions - Transforms of unit step function and impulse functions, periodic functions. Inverse Laplace transform – Problems using Convolution theorem – Solution of linear ODE of second order with constant coefficients using Laplace transformation techniques		
UNIT-IV	**VECTOR CALCULUS**	**12**
Gradient, divergence and curl – Directional derivative – Irrotational and Solenoidal vector fields – Vector integration – Green's theorem in a plane, Gauss divergence theorem and Stokes' theorem (excluding proofs) – Simple applications involving cubes and rectangular parallelopipeds.		
UNIT-V	**COMPLEX VARIABLES**	**12**
Analytic functions — Construction of analytic function - Bilinear transformation –Singularities – Cauchy's integral theorem (without proof) - Residues – Residue theorem (without proof) - Simple problems - Contour integral over $\|z\|=1$.		
Total Contact Hours: 60		

Course Outcomes:
On completion of the course students will be able to
● Apply the methods as a potent tool in the solution of a variety of problems in the natural sciences and technology.
● Develop specific methodologies, techniques and resources in Partial differential equations to conduct research and produce innovative results in the area of specialisation.
● Use Laplace transform and inverse transform techniques to solve the complex problems in engineering and technology.
● Apply the concepts in multivariable analysis, including space curves; directional derivative; gradient; multiple integrals; line and surface integrals; vector fields; divergence, curl ; the theorems of Green and Stokes, and the divergence theorem in different fields of engineering.
● Demonstrate the concept of Analytic functions, conformal mapping and complex integration in solving Engineering problems.

Text Book(s):	
1.	Grewal B.S., " Higher Engineering Mathematics ", Khanna Publishers, New Delhi, 43rd Edition, 2014.
2.	Veerarajan. T, Engineering Mathematics –II, Mc Graw Hill Education, 2018.
3.	Erwin Kreyszig," Advanced Engineering Mathematics ", John Wiley and Sons, 10th Edition, New Delhi, 2016.
4.	Glyn James, "Advanced Modern Engineering Mathematics", Pearson Education, 4th Edition, New Delhi, 2011.
5.	Jain R.K. and Iyengar S.R.K., "Advanced Engineering Mathematics", Narosa Publications, 5 th Edition, New Delhi, 2017.

Reference Books(s) / Web links:	
1.	Ramana. B.V., "Higher Engineering Mathematics ", McGraw Hill Education Pvt. Ltd, New Delhi, 2016.
2.	T Veerarajan, Transforms and Partial Differential Equations, Third Edition, 2018.
3.	Bali, N.P. and Manish Goyal, A Text Book of Engineering Mathematics, Lakshmi Publications Pvt. Ltd., New Delhi, 4th Edition 2006.
4.	Peter V.O'Neil, "Advanced Engineering Mathematics", Cengage Learning India Pvt., Ltd, 7th Edition, New Delhi, 2012.

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MA23212.1	3	2	1	-	-	-	-	-	-	-	-	1	1	-	-
MA23212.2	3	2	1	-	-	-	-	-	-	-	-	1	1	-	-
MA23212.3	3	2	1	-	-	-	-	-	-	-	-	-	-	-	-
MA23212.4	2	2	1	-	-	-	-	-	-	-	-	-	-	-	-
MA23212.5	3	2	1	-	-	-	-	-	-	-	-	1	-	-	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Theory course)	Category	L	T	P	C
GE23211	ENGINEERING MECHANICS (Common to Mech, Aero, Auto, Civil and MCT)	ES	2	1	0	3

Objectives: The students can be able to

- To understand the basics of mechanics and apply the concept of equilibrium of system of forces.
- To understand the concept of equilibrium and to solve problems of rigid bodies.
- To learn about the centroid and centre of gravity of objects and moment of inertia
- To learn the basic concepts of friction.
- To learn the concepts in kinematics and kinetics of rigid bodies in plane motion.

UNIT-I	STATICS OF PARTICLES	9

Introduction – Units and Dimensions – Laws of Mechanics – Lami's theorem, Parallelogram and triangular Law of forces – Resolution of forces – Vector operations of forces - Coplanar Forces – rectangular components – Equilibrium of a particle – Forces in space – Equilibrium of a particle in space – Equivalent systems of forces – Principle of transmissibility.

UNIT-II	EQUILIBRIUM OF RIGID BODIES	9

Free body diagram – Types of supports –Action and reaction forces –stable equilibrium – Moments and Couples – Moment of a force about a point and about an axis – Vectorial representation of moments and couples – Scalar components of a moment – Varignon's theorem – Single equivalent force -Equilibrium of Rigid bodies in two dimensions – Equilibrium of Rigid bodies in and three dimensions (class room lecture only) – (Descriptive treatment only)

UNIT-III	PROPERTIES OF SURFACES AND SOLIDS	12

Centroids - First moment of area – Second moment of area and centre of mass – Centroids of lines and areas - Rectangular, circular, triangular areas by integration – T section, I section, Angle section, Hollow section by using standard formula –Theorems of Pappus - Area moments of inertia of plane areas – Rectangular, circular, triangular areas by integration – T section, I section, Angle section, Hollow section by using standard formula – Parallel axis theorem and perpendicular axis theorem – Principal moments of inertia of plane areas – Principal axes of inertia-Mass moment of inertia –mass moment of inertia for prismatic, cylindrical and spherical solids from first principle – Relation to area moments of inertia.

UNIT-IV	DYNAMICS OF PARTICLES	7

Displacements, Velocity and acceleration, their relationship – Relative motion – Curvilinear motion - Newton's laws of motion – Work Energy Equation– Impulse and Momentum – Impact of elastic bodies.

UNIT-V	FRICTION AND RIGID BODY DYNAMICS	8

Friction force – Laws of sliding friction - Characteristics of dry friction – equilibrium analysis of simple systems with sliding friction –wedge friction, Ladder friction, Rolling resistance -Translation and Rotation of Rigid Bodies – Velocity and acceleration – General Plane motion of simple rigid bodies such as cylinder, disc/wheel and sphere.

Total Contact Hours	:	45

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

CO1	Analyze the forces in the system and to understand vectorial and scalar representation of forces and moments
CO2	Study about the rigid body in equilibrium and to analyze the problems in engineering systems using the concept of static equilibrium
CO3	Determine the properties of surfaces and solids by means of finding centroid , centre of gravity and moment of inertia.
CO4	Solve problems involving kinematics and kinetics of rigid bodies in plane motion.
CO5	Solve problems involving frictional phenomena in machines by understanding the concept of friction and the effects by the laws of friction

Text Books:

1	Beer, F.P and Johnston Jr. E.R, Cornwell and Sanghi ., "Vector Mechanics for Engineers (In SI Units): Statics and Dynamics", 12th Edition, McGraw-Hill Publishing company, New Delhi (2018).
2	Rajasekaran S and Sankarasubramanian G., "Engineering Mechanics Statics and Dynamics", 3rd Edition, Vikas Publishing House Pvt. Ltd., 2005.

Reference Books(s) / Web links:

1	Meriam J.L. and Kraige L.G., "Engineering Mechanics- Statics - Volume 1, Dynamics- Volume 2", 7th Edition, Wiley India, 2018.
2	Hibbeller, R.C and Ashok Gupta, "Engineering Mechanics: Statics and Dynamics", 14th Edition, Pearson Education 2017.

3	Irving H. Shames and Krishna Mohana Rao. G., "Engineering Mechanics – Statics and Dynamics" 4th Edition, Pearson Education 2006.
4	Bhavikatti S S, Engineering Mechanics, New Age International Publishers, 2016
5	Vela Murali, "Engineering Mechanics", Oxford University Press 2010
6	Palanichamy M S, Nagan S, Elango P, Engineering Mechanics: Dynamics, Tata McGraw-Hill Publishing Company Limited, 2004

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	3	3	1	1	-	-	-	-	2	1	3	1	3	-	3
CO 2	3	3	1	1	-	-	-	-	2	1	3	1	3	-	3
CO 3	3	3	1	1	-	-	-	-	1	1	3	1	3	-	3
CO 4	3	3	1	1	-	-	-	-	3	1	3	1	3	-	3
CO 5	3	3	1	1	-	-	-	-	3	1	3	1	3	-	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Theory course)	Category	L	T	P	C
GE23217	**தமிழரும் தொழில்நுட்பமும் / TAMILS AND TECHNOLOGY**	**HS**	1	0	0	1

அலகு I	**நெசவு மற்றும் பானைத் தொழில்நுட்பம்**	**3**

சங்க காலத்தில் நெசவுத் தொழில் - பானைத் தொழில்நுட்பம் - கருப்பு சிவப்பு பாண்டங்கள் - பண்டங்களில் கீறல் குறியீடுகள்.

அலகு II	**வடிவமைப்பு மற்றும் கட்டிடத் தொழில்நுட்பம்**	**3**

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

அலகு III	**உற்பத்தித் தொழில் நுட்பம்**	**3**

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

அலகு IV	**வேளாண்மை மற்றும் நீர்ப்பாசனத் தொழில் நுட்பம்**	**3**

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

அலகு V	**அறிவியல் தமிழ் மற்றும் கணித்தமிழ்**	**9**

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

Total Contact Hours: 15

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

Course Code	Course Title (Lab Oriented Theory Course)	Category	L	T	P	C
CY23233	ENGINEERING CHEMISTRY	BS	3	0	2	4
Common to B.E. – AERONAUTICAL, AUTOMOBILE, MECHANICAL and CIVIL						

Objectives:

- To understand the types of corrosion and its prevention
- To develop an understanding of the basic concepts of phase rule and its applications
- To provide a brief outline of polymers and composites in mechanical sciences
- To interpret the different types of batteries and fuel cells
- To provide an insight on nanomaterials and lubricants

UNIT-I	CORROSION SCIENCE AND CONTROL	9

Corrosion: Introduction- chemical and electrochemical theory of corrosion- types of corrosion-galvanic, differential aeration (waterline and pitting) and stress corrosion (caustic embrittlement)- corrosion penetration rate (CPR).
Corrosion control: Cathodic protection- Metallic coatings- Electroplating- electroplating of chromium (hard and decorative)- Electroless plating-electroless plating of nickel- Chemical conversion coatings-Organic coatings-paints-constituents-functions - special paints.

UNIT-II	PHASE RULE AND THERMAL ANALYSIS	9

Phase rule - Introduction, definition of terms - phase, components and degree of freedom - phase diagram- one component system -water system - reduced phase rule - thermal analysis and cooling curves - two component systems - lead-silver system. Alloys - significance of alloying - heat treatment of steel.
Thermal analysis - Thermogravimetric analysis- Differential thermal analysis- Differential scanning calorimetry-instrumentation (block diagram) and applications.

UNIT-III	POLYMERS AND COMPOSITES	9

Plastics - Types-preparation, properties and uses of Teflon, polycarbonate and PMMA
Rubbers - Types-vulcanization-synthetic rubber-Buna N rubber, Butyl rubber.
Composite Materials - Introduction-Types– MMC, CMC and PMC-Fiber-Reinforced composites-preparation, properties, and applications.

UNIT-IV	FUELS AND ENERGY STORAGE DEVICES	9

Fuels - Introduction, calorific value- numerical problems GCV and NCV-Green fuels-Introduction, synthesis and applications of power alcohol and biodiesel-High energy fuels-Production of hydrogen by electrolysis of water and its advantages.
Energy devices - Electrode potential-electrochemical series - construction, working and applications of lead acid battery, Lithium-ion battery-Fuel Cell-Hydrogen-Oxygen (H_2-O_2) fuel cell, proton exchange membrane and solid oxide fuel cells.

UNIT-V	NANOMATERIALS AND LUBRICANTS	9

Nanomaterials - Introduction, size-dependent properties - Synthesis of Nanomaterials-sol-gel, precipitation, hydrothermal and solvothermal methods - Carbon based nano materials - Introduction to CNT, Graphene and Fullerenes- synthesis, properties and applications of CNT.
Lubricants: Classification- properties of lubricants- mechanism of lubrication- additives to lubricants- solid lubricants (graphite and MoS_2).

Total Contact Hours:45

Description of the Experiments		Total Contact Hours:30
1.	Estimation of the acid by pH metry	
2.	Determination of corrosion rate on mild steel by weight loss method	
3.	Estimation of mixture of acids by conductometry	
4.	Estimation of extent of corrosion of Iron pieces by potentiometry	
5.	Determination of flash and fire points of lubricating oil	
6.	Determination of cloud and pour points of lubricating oil	
7.	Determination of molecular weight of a polymer by viscometry method	
8.	Synthesis of nanomaterials by simple precipitation method	
9.	Determination of phase change temperature of a solid	
10.	Determination of strength of an acid in Pb acid battery	
11.	Synthesis of biodiesel	
12.	Determination of acid value of biofuel	

Course Outcomes:

At the end of the course the student will be able to:

- Explain and the fundamental concepts of corrosion, its control and surface modification methods such as electroplating and electroless plating
- Apply the concept of phase rule in alloying and predict its thermal properties
- Identify the different types of plastics and composite materials of industrial importance
- Categorize the types of fuels and the energy storage devices
- Synthesize nanomaterials for modern engineering and technology

Text Book(s):

1. P. C. Jain and Monika Jain, "Engineering Chemistry", 17th Edition, Dhanpat Rai Publishing Company (P) Ltd, New Delhi, 2018.
2. O.G.Palanna, "Engineering Chemistry", McGraw Hill Education (India) Pvt, Ltd, New Delhi, 2nd Edition, 2017.
3. Shikha Agarwal "Engineering Chemistry-Fundamentals and applications", Cambridge University Press, New Delhi, 2019

Reference Books(s)

- Polymer Science, V R Gowariker, N V Viswanathan, Jayadev, Sreedhar, Newage Int. Publishers, 4th Edition, 2021
- A Text Book Engineering Chemistry, Sunita Rattan, S.K. Kataria & Sons, 1st 2018
- A Text Book of Engg. Chemistry, Shashi Chawla, Dhanpat Rai & Co. (P) Ltd.2011
- PradeepT, "A Text Book of Nanoscience and Nanotechnology", Tata McGraw Hill, New Delhi, 2012
- Laboratory Manual Engg. Chemistry, Anupma Rajput, Dhanpat Rai & Co

Lab equipment required:

S. No	Name of the Equipment	Quantity Required
1.	Conductivity meter	10
2.	Potentiometer	10
3	pH meter	10
4	Magnetic stirrer with hot plate	1
5	Flash and Fire point apparatus	2
6	Cloud and pour point apparatus	2

Weblinks

- **http://libgen.rs/**
- https://nptel.ac.in/courses/104/103/104103019/
- https://ndl.iitkgp.ac.in/
- https://www.youtube.com/watch?v=j5Hml6KN4TI
- https://www.youtube.com/watch?v=1xWBPZnEJk8

Web links for virtual lab (if any)

https://drive.google.com/drive/folders/1k8g7fGRJ0Dl8FPbjQYg4l5jS1U9qIXnJ

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CY23233. 1	2	1	1	-	-	1	2	-	-	-	-	1	-	2	-
CY23233.2	3	1	1	-	-	-	-	-	-	-	-	1	-	1	-
CY23233.3	2	1	2	-	-	-	-	-	-	-	-	1	-	2	-
CY23233.4	2	1	1	-	-	-	-	-	-	-	-	1	-	1	-
CY23233.5	3	1	2	-	-	1	1	-	-	-	-	1	-	2	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	**Course Title (Lab Oriented Theory Course)**	**Category**	**L**	**T**	**P**	**C**
EE23132	**BASIC ELECTRICAL ENGINEERING**	**ES**	**3**	**0**	**2**	**4**

Objectives:

- To provide knowledge on the analysis of DC circuits.
- To teach methods of analysis of AC circuits.
- To impart knowledge on principles of operation of electrical machines.
- To teach the basics of electrical safety measures.
- To provide hands on experience on electric circuits and machines

UNIT-I	**DC CIRCUITS**	9

Electrical circuit elements (R, L and C), voltage and current sources, Kirchhoff's laws, Mesh and Nodal Analysis, Superposition, Thevenin's, Norton's Theorems and Maximum Power Transfer Theorem

UNIT-II	**AC CIRCUITS**	9

Representation of sinusoidal waveforms, Power and Power factor. Analysis of single-phase ac circuits consisting of R, L, C, RL, RC, RLC combinations. Three phase balanced circuits.

UNIT-III	**DC MOTORS AND TRANSFORMERS**	9

Construction, working and characteristics of DC motors. Construction, principle of operation of single-phase Transformer, EMF Equation.

UNIT-IV	**AC ROTATING MACHINES**	9

Construction and basic working of three phase Alternators and Induction motors, Construction and Types of single-phase induction motors- Construction and basic working of Stepper motor, Permanent magnet Brushless Motor (PMBLDC) (Qualitative Treatment Only).

UNIT-V	**ELECTRICAL SAFETY MEASURES**	9

Primary and secondary hazards- arc, blast, shocks-causes and effects-safety equipment- flash and thermal protection - Safety in the use of portable tools - Preventive maintenance- Types of earthing and its importance-Safety precautions for electrical appliances- National electrical Safety code - Indian electricity acts and rules

Total Contact Hours	**:**	**45**

List of Experiments

1	Kirchhoff's laws.
2	Network theorems (Thevenin's , Norton's and Maximum Power Transfer Theorems)
3	Determination of Impedance and Current in RL, RC and RLC series circuits
4	Measurement of voltage and current in three phase balanced star & delta connected loads.
5	Load test on DC shunt motor (Virtual Lab)
6	Load test on single-phase transformer (Virtual Lab)
7	Load test on three phase induction motor (Virtual Lab)
8	Load test on Single phase induction motor.

Contact Hours	**:**	**30**
Total Contact Hours	**:**	**75**

Course Outcomes:

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

- analyse DC circuits and apply circuit theorems.
- calculate the power and power factor in AC circuits
- comprehend the principles of electrical machines.

•	realise the electrical safety precautions.
•	experimentally analyze the electric circuits and machines.
Suggested Activities	
•	Problem solving sessions
Suggested Evaluation methods	
•	Quizzes
•	Class Presentation / Discussion
Text Book(s):	
1	E. Hughes, "Electrical and Electronics Technology", Pearson, 2010.
2	J.B.Gupta, "Fundamentals of Electrical Engineering and Electronics" S.K.Kataria& Sons Publications, 2010.
3	K.Venkataratnam, ―Special Electrical Machines‖, Universities Press (India) Private Limited, 2008.
4	John Cadick, P.E. Mary Capelli-Schellpfeffer, M.D., M.P.A. Dennis K. Neitzel, C.P.E. "Al Winfield Electrical Safety Hand Book, fifth edition, The McGraw-Hill 2012
Reference Books(s) / Web links:	
1	Joseph A. Edminister, Mahmood, Nahri, "Electric Circuits" – Shaum Series and Systems", Schaum"s Outlines, Tata McGrawHill, Indian. 5th Edison , 2017
2	D. C. Kulshreshtha, "Basic Electrical Engineering", McGraw Hill, 2009.
3	D. Toro, "Electrical Engineering Fundamentals", Prentice Hall India, 1989.
4	L. S. Bobrow, "Fundamentals of Electrical Engineering", Oxford University Press, 2011.
5	https://nptel.ac.in/courses/108108076
6	E G Janardanan, ―Special Electrical Machines‖, Prentice Hall India Limited, 2013.
7	Maxwell Adams.J, "Electrical safety- a guide to the causes and prevention of electric hazards",The Institution of Electric Engineers, 1994.

Lab Equipment Required

Sl. No.	Name of the equipment	Quantity Required (for batch of 30 students
1.	**Verification of Kirchhoff's Laws** 1. DC Regulated Power supply (0 - 30 V variable) 2. Bread Board 3. Resistors 4. Ammeter (0-50)mA 5. Voltmeter (0-30)V 6. Multimeter 7. Connecting wires	1 1 As per Circuit diagram 3 3 1 As Required
2.	**Verification of Network Theorems (Thevenins and Nortons)** 1. DC Regulated Power supply (0 - 30 V variable) 2. Bread Board 3. Resistors 4. Ammeter (0-50)mA 5. Voltmeter (0-30)V 6. Multimeter **7.** Connecting wires	1 1 As per Circuit diagram 1 1 1 As Required
3.	**Determination of current and Impedance in RL, RC and RLC series circuit** 1. DC Regulated Power supply (0 - 30 V variable) 2. Resistors, Inductors and capacitors 3. Ammeter (0-50)mA 4. Voltmeter (0-30)V 5. Connecting wires	1 As per Circuit diagram 1 1 As Required

4.	**Measurement of Voltage and Current in Three Phase Balanced Star and Delta Connected Loads** **1.** Three phase star& delta connected load / Single phase load bank of suitable rating 2. Ammeter and Voltmeter 3. Connecting wires	**3** As per Circuit diagram As Required
5.	**Load test on DC Shunt Motor.** 1. Ammeter MC (0-20A) 2. Voltmeter MC (0-300)V 3. Tachometer 4. Field Rheostat 500 Ω, 1.5 A 5. Connecting wires	1 1 1 1 As Required
6.	**Load test on Single phase Transformer** 1. Ammeter (0-30) A, (0-5) A 2. Voltmeter (0-150)V, (0-300)V 3. Wattmeter – 300V, 5A, UPF 4. Autotransformer 5. Single phase Transformer 6. Connecting Wires	**1** **1** **1** **1** **1** As Required
7.	**Load Test on Three phase Induction Motor** 1. Ammeter MI (0-20A) 2. Voltmeter MI (0-300)V 3. Wattmeter – 300V, 30 A 4. Tachometer – Digital 5. Three phase Induction motor 6. Connecting Wires	1 1 1 1 1 As Required

COs/POs&PSOs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO 1	3	3	3	3	-	3	1	1	2	1	1	1	-	-	1
CO 2	3	3	3	3	-	3	1	1	2	1	1	1	-	-	1
CO 3	3	3	3	3	-	3	1	1	2	1	1	1	-	-	1
CO 4	3	3	3	3	-	3	1	1	2	1	1	1	-	-	1
CO 5	3	3	3	3	-	3	3	1	2	1	1	1	-	-	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	**Course Title (Lab Oriented Theory Course)**	**Category**	**L**	**T**	**P**	**C**
GE23233	**PROBLEM SOLVING AND PYTHON PROGRAMMING**	**ES**	**2**	**0**	**4**	**4**

Objectives:	
	To know the basics of algorithmic problems solving
	To develop Python programs with conditionals and loops
	To define Python functions and call them
	To use Python data structures–-lists, tuples, dictionaries
	To do input/output with files in Python

UNIT-I	**ALGORITHMIC PROBLEM SOLVING**	**6**
Introduction to computers-characteristics-basic organization of a computer– algorithms-building blocks of algorithms (instructions / statements, state, control flow, functions)-notation (pseudo code, flow chart, programming language) - algorithmic problem solving - simple strategies for developing algorithms (iteration,recursion).		

UNIT-II	DATA, EXPRESSIONS, STATEMENTS AND CONTROL FLOW	6
Python interpreter and interactive mode - values and types - data types – variables – keywords – expressions and statements- python I/O - operators- precedenceof operators– comments. Conditionals:conditional(if)-alternative(if-else)-chained conditional (if- elif- else)–nested conditional.		
UNIT-III	**CONTROL FLOW – II AND FUNCTIONS**	**7**
Iteration: while – for - break – continue – pass. Illustrative programs: exchange the values of two variables- circulate the values of n variables-test for leap year. Function calls – type conversion– math function– composition- definition and use - flow of execution - parameters and arguments. Fruitful functions: return values – parameters - scope: local and global - recursion.		
UNIT-IV	**STRINGS**	**5**
Strings: string slices – immutability - string functions and methods – string comparison. Illustrative programs: square root– GCD– exponentiation-sum the array of numbers linear search- binary search.		
UNIT-V	**LISTS, TUPLES AND DICTIONARIES**	**6**
Lists - list operations - list slices - list methods - list loop – mutability – aliasing - cloning lists - listparameters. Tuples – immutable - tuple assignment - tuple as return value. Dictionaries: operations and methods– dictionaries and tuples– dictionaries and lists. Advanced list processing- list comprehension. Illustrative programs: Sorting.		
	Contact Hours : 30	

List of Experiments				
1	Introduction to Python Programming and Python IDLE/Anaconda distribution.			
2	Experiments based on Variables, Data types and Operators in Python.			
3	Coding Standards and Formatting Output.			
4	Algorithmic Approach: Selection control structures.			
5	Algorithmic Approach: Iteration control structures.			
6	Experiments based on Strings and its operations.			
7	Experiments based on Lists and its operations.			
8	Experiments based on Tuples and its operations.			
9	Experiments based on Sets and its operations.			
10	Experiments based on Dictionary and its operations.			
11	Functions: Built-in functions.			
12	Searching techniques: Linear and Binary.			
13	Sorting techniques: Bubble and Merge Sort.			
	Contact Hours	**:**	**60**	
	Total Contact Hours	**:**	**90**	

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

□	Understand the working principle of a computer and identify the purpose of a computer programming language and ability to identify an appropriate approach to solve the problem.
□	Write, test, and debug simple Python programs with conditionals and loops.
□	Develop Python programs step - wise by defining functions and calling them.
□	Use Python lists, tuples, dictionaries for representing compound data.
□	Apply searching, sorting on data and efficiently handle data using flat files.

TextBooks:

1.	Allen B. Downey, Think Python:How to Think Like a Computer Scientist, Second edition,UpdatedforPython3, Shroff/ O'Reilly Publishers, 2016 (http://greenteapress.com/wp/think-python/)
2.	Guido Van Rossum and Fred L. Drake Jr, An Introduction to Python-Revised and updated for Python3.2, Network Theory Ltd., 2011.

ReferenceBooks:

1.	JohnVGuttag, 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.	Timothy A.Budd, Exploring Python, Mc-Graw Hill Education(India)PrivateLtd.,2015.

4.	Kenneth A. Lambert, Fundamentals of Python: First Programs, CengageLearning,2012.
5.	Charles Dierbach, Introduction to Computer Science using Python: A Computational Problem Solving Focus, Wiley India Edition,2013.
6.	Paul Gries, Jennifer Campbell and Jason Montojo, Practical Programming: An Introduction to Computer Science using Python3, Second edition, Pragmatic Programmers, LLC, 2013.

Plat form Needed:

Python3 interpreter for Windows/Linux

CO -PO–PSO matrices of course

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CS23232.1	2	2	2	2	1	-	-	-	1	1	1	1	3	3	-
CS23232.2	2	1	1	1	1	-	-	-	-	-	1	1	3	2	-
CS23232.3	1	1	2	1	2	-	-	-	-	-	1	1	2	3	2
CS23232.4	2	2	3	2	2	-	-	-	-	-	2	1	2	2	2
CS23232.5	2	2	3	2	3	-	-	-	-	-	2	1	2	2	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Laboratory Course)	Category	L	T	P	C
GE23122	ENGINEERING PRACTICES - ELECTRICAL AND ELECTRONICS	ES	0	0	2	1

Objectives:

- To provide hands-on experience on various basic engineering practices in Electrical Engineering.
- To provide hands-on experience on various basic engineering practices in Electronics Engineering.

List of Experiments

A. ELECTRICAL ENGINEERING PRACTICE

1	Residential house wiring using switches, fuses, indicators, lamp and energy meter.
2	Fluorescent lamp wiring.
3	Stair case wiring.
4	Measurement of electrical quantities – voltage, current, power & power factor in RL circuit.
5	Measurement of earth resistance using Megger.
6	Study of Ceiling Fan and Iron Box

B. ELECTRONICS ENGINEERING PRACTICE

1	Study of electronic components and equipment – Resistor, colour coding, measurement of AC signal parameters (peak-peak, rms period, frequency) using CRO/DSO.
2	(a) Measurement of electrical quantities using Multimeter (b) Testing of electronic components.
3	Study of logic gates : AND, OR, EXOR and NOT.
4	Generation of Clock Signals.
5	Soldering practice – Components Devices and Circuits – Using general purpose PCB.
6	Measurement of ripple factor of Half-wave and Full-wave Rectifiers.

Total Contact Hours : 30

Course Outcomes:

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

- fabricate the basic electrical circuits
- implement the house wiring circuits
- fabricate the electronic circuits

•	verify the truth table of logic gates
•	design the Half-wave and Full-wave Rectifiers using diodes and passive components
SUGGESTED EVALUATION METHODS ● Experiment based Viva	
REFERENCE	
1	Bawa H.S., "Workshop Practice", Tata McGraw – Hill Publishing Company Limited, 2007.
2	Jeyachandran K., Natarajan S. & Balasubramanian S., "A Primer on Engineering Practices Laboratory", Anuradha Publications, 2007.
3	Jeyapoovan T., Saravanapandian M. &Pranitha S., "Engineering Practices Lab Manual",Vikas Publishing House Pvt.Ltd, 2006.
4	Rajendra Prasad A. &Sarma P.M.M.S., "Workshop Practice", SreeSai Publication, 2002.

Lab Equipment Required:

S. No.	**Name of the Equipment**	**Quantity Required**
1	Residential house wiring using switches, fuse, indicator, lamp and energy meter.	3 Nos
2	Fluorescent lamp wiring.	3 Nos
3	Stair case wiring	3 Nos
4	Measurement of electrical quantities – voltage, current, power & power factor in RL circuit.	2 Nos
5	Study purpose items: Iron box, Ceiling fan.	2 each
6	Megger (250V/500V)	2 Nos.
7	Soldering guns	10 Nos.
8	Assorted electronic components for making circuits	50 Nos.
9	Small PCBs	10 Nos.
10	Multimeters	10 Nos.
11	Digital trainer kit	5 Nos.
12	CRO	8 Nos.
13	Transformer	8 Nos.
14	Function Generator	8 Nos.

COs/POs&PSOs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO 1	3	3	3	2	-	-	2	-	3	2	-	3	-	-	1
CO 2	3	3	2	2	-	-	2	-	3	2	-	3	-	-	1
CO 3	3	3	3	2	-	-	2	-	3	2	-	3	-	-	1
CO 4	3	3	3	2	-	-		-	3	2	-	3	-	-	1
CO 5	3	3	3	2	-	-		-	3	2	-	3	-	-	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Theory course)	Category	L	T	P	C
MC23111	INDIAN CONSTITUTION AND FREEDOM MOVEMENT	MC	3	0	0	0
Common to all branches of B.E/B. Tech Programmes – First / Second/third Semester						

Objectives:
● To apprehend the sacrifices made by the freedom fighters.
● To inculcate the values enshrined in the Indian constitution.
● To instil a sense of responsibility as the citizens of India.
● To familiarise about the functions of the various levels of Government.
● To be informed about Constitutional and Non- Constitutional bodies.

UNIT-I	INDIAN FREEDOM MOVEMENT	9
British Colonialism in India-Colonial administration till 1857- Revolt of 1857- Early Resistance to British Rule-Rise of Nationalism in India-I**ndian Freedom Struggle under Mahatma Gandhi**-Non- Cooperation Movement-Civil Disobedience Movement- Quit India Movement-British Official response to National movement- Independence of India Act 1947-Freedom and Partition.		
UNIT-II	**CONSTITUTION OF INDIA**	9
Historical Background – Indian Constitution: Constitution' meaning of the term, Sources and constitutional history, Constituent Assembly of India – Philosophical foundations of the Indian Constitution – Preamble – Fundamental Rights – Directive Principles of State Policy – Fundamental Duties – Citizenship – Constitutional Remedies for citizens.		
UNIT-III	**STRUCTURE AND FUNCTIONS OF CENTRAL GOVERNMENT**	9
Union Government – Structure of the Union Government and Functions – President – Vice President – Prime Minister – Cabinet – Parliament – Supreme Court of India – Judicial Review.		
UNIT-IV	**STRUCTURE AND FUNCTION OF STATE GOVERNMENT AND LOCAL BODY**	9
State Government – Structure and Functions – Governor – Chief Minister – Cabinet – State Legislature – Judicial System in States – High Courts and other Subordinate Courts- Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation, Pachayati Raj: Introduction, Elected officials and their roles, Village level: Role of Elected and Appointed officials.		
UNIT-V	**CONSTITUTIONAL FUNCTIONS AND BODIES**	9
Indian Federal System – Centre – State Relations – President's Rule – Constitutional Functionaries – Assessment of working of the Parliamentary System in India- CAG, Election Commission, UPSC, GST Council and other Constitutional bodies-. NITI Aayog, Lokpal, National Development Council and other Non –Constitutional bodies.		
Total Contact Hours: 45		

Course Outcomes: Upon completion of the course, students will be able to:
● appreciate the sacrifices made by freedom fighters during freedom movement.
● be responsible citizens and abide by the rules of the Indian constitution.
● be aware of the functions of the Indian government.
● be knowledgeable about the functions of the state Government and the Local bodies.
● apply the knowledge on constitutional functions and role of constitutional bodies and non-constitutional bodies.

Text Book(s):
1. M. Laxmikanth , "Indian Polity:, McGraw-Hill, New Delhi.
2. Durga Das Basu, "Introduction to the Constitution of India ", Lexis Nexis, New Delhi. 21st ed 2013.
3. P K Agarwal and K N Chaturvedi ,PrabhatPrakashan, New Delhi, 1st ed , 2017.

Reference Books(s) / Web links:
1. Sharma, Brij Kishore, "Introduction to the Constitution of India:, Prentice Hall of India, New Delhi.
2. U.R.Gahai, "Indian Political System ", New Academic Publishing House, Jalaendhar
3. Bipan Chandra, India's Struggle for Independence, Penguin Books, 2016.
4. Maciver and Page, "Society: An Introduction Analysis ", Mac Milan India Ltd., New Delhi.2nd ed, 2014.
5. Bipan Chandra, History of Modern India, Orient Black Swan, 2009.

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MC23111.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MC23111.2	-	-	-	-	-	-	-	-		-	-	-	-	-	-
MC23111.3	-	-	-	-	-	1	-	1	-	-	-	-	-	-	-
MC23111.4	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
MC23111.5	-	-	-	-	-	1	-	1	1	-	-	-	-	-	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

SEMESTER III

Course Code	Course Title (Theory course)	Category	L	T	P	C
ME23311	ENGINEERING THERMODYNAMICS	PC	3	1	0	4

Objectives:
● To attain knowledge on the basics and application of zeroth and first law of thermodynamics.
● To acquire knowledge on the second law of thermodynamics, availability and applications of it.
● To gain knowledge about properties of pure substances and steam power cycles.
● To attain knowledge on the macroscopic properties of ideal and real gases.
● To gain knowledge about Gas mixtures and Psychrometric processes

UNIT-I	**BASICS AND FIRST LAW OF THERMODYNAMICS**	**12**
Basic concepts of Thermodynamics - systems, properties and processes - Thermodynamic Equilibrium - Displacement work - P-V diagram. Thermal equilibrium – Temperature and Zeroth law –. First law – application to closed and open systems – steady flow processes. Limitations of the first law of Thermodynamics		
UNIT-II	**SECOND LAW OF THERMODYNAMICS**	**12**
Heat Engine, Refrigerator, Heat pump. Statements of second law and their equivalence & corollaries. Carnot cycle - Reversed Carnot cycle - Performance - Clausius inequality. Concept of entropy – simple problems T-s diagram - Tds Equations - Entropy change for a pure substance. Ideal gases undergoing different processes - principle of increase in entropy. Applications of II Law. High- and low-grade energy. Availability and Irreversibility for open and closed system processes		
UNIT-III	**PROPERTIES OF PURE SUBSTANCES AND VAPOUR POWER CYCLES**	**12**
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. Ideal and actual Rankine cycles, Cycle Improvement Methods – Reheat and Regenerative cycles, Binary and Combined cycles.		
UNIT-IV	**IDEAL AND REAL GASES, THERMODYNAMIC RELATIONS**	**12**
Properties of Ideal gas- Ideal and real gas comparison- Equations of state for ideal and real gases- Reduced properties-. Compressibility factor-. Principle of Corresponding states. Generalised Compressibility Chart and its use-. Maxwell relations, Tds Equations, Difference and ratio of heat capacities, Energy equation, Joule-Thomson Coefficient, Clausius Clapeyron equation, Phase Change Processes. Simple Calculations.		
UNIT-V	**GAS MIXTURES AND PSYCHROMETRY**	**12**
Mole and Mass fraction, Dalton's and Amagat's Law. Properties of gas mixture – Molar mass, gas constant, density, change in internal energy, enthalpy, entropy and Gibb's function. Psychrometric properties, Psychrometric charts. Property calculations of air vapour mixtures by using chart and expressions. Psychrometric process – adiabatic saturation, sensible heating and cooling, humidification, dehumidification, evaporative cooling and adiabatic mixing. Simple Applications		
Total Contact Hours:60		

Course Outcomes: At the end of this course the students will have the
1. Ability to apply the first law of thermodynamics and can apply it to closed and open systems to calculate specified parameters such as work, heat transfer, internal energy, mass flow rate and enthalpy.
2. Ability to Implement the second law of thermodynamics and can apply it to closed and open systems to calculate specified parameters such as work, heat transfer, or entropy.
3. Ability to adopt knowledge on the construction and principles governing the one-component pressure-volume-temperature diagrams. Also have thorough understanding of the basic concepts of vapour power cycles and the use of steam tables in the analysis of engineering devices and systems.
4. Ability to appreciate the behavior of Ideal gas and the interrelationship between thermodynamic functions and solve practical problems.
5. Ability to calculate the properties of gas mixtures and capable to calculate the psychrometric properties for various psychrometric processes.

Text Book(s):
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, Lakshmi Publications, New Delhi, 2016.

Reference Books(s) / Web links:
1. Cengel, Y and M. Boles, Thermodynamics - An Engineering Approach, Tata McGraw Hill,8th Edition, 2015.
2. Chattopadhyay, P, "Engineering Thermodynamics", 2nd Edition Oxford University Press, 2016.
3. Gordon Rogers, Yon Mayhew**, "**Engineering Thermodynamics: Work and Heat Transfer, 4th Edition, Pearson, 2002.
4. Claus Borgnakke and Richard E. Sonntag, "Fundamentals of Thermodynamics", 7th Edition, Wiley Eastern, 2009.
5. Venkatesh. A, "Basic Engineering Thermodynamics", Universities Press (India) Limited, 2007.
6. https://nptel.ac.in/courses/101104063/
7. https://nptel.ac.in/courses/112/102/112102255/
8. https://www.thermal-engineering.org
9. https://www.grc.nasa.gov › www › airplane › thermo

PO-PSO / CO	POs												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	2	-	-	1	2	-	-	1	-	3	-	1	2
CO2	3	2	2	-	-	1	2	-	-	1	-	3	-	1	2
CO3	3	2	2	-	-	1	2	-	-	1	-	3	-	1	2
CO4	3	2	2	-	-	1	2	-	-	1	-	3	-	1	2
CO5	3	2	2	-	-	1	2	-	-	1	-	3	-	1	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	**Course Title (Theory Course)**	**Category**	**L**	**T**	**P**	**C**
ME23312	**MANUFACTURING TECHNOLOGY – I**	**PC**	**3**	**0**	**0**	**3**

Objectives:
● To understand the basic concepts of sand casting technique and special casting technique.
● To understand the principles and equipment used for different welding techniques
● To know various operations and equipment requirements of hot and cold metal forming processes.
● To understand the working principle and applications of different types of sheet metal processes.
● To understand the working principles of different types of thermo plastic manufacturing methods.

UNIT-I	**METAL CASTING**	**9**
Sand Casting : Sand Mould – Type of patterns - Pattern Materials – Pattern allowances –Moulding sand Properties and testing – Moulding machines– Types and applications; Melting furnaces : Blast and Cupola Furnaces; Principle of special casting processes : Shell - investment – Ceramic mould – Pressure die casting - Centrifugal Casting- Continuous casting - Vacuum casting- CO2 process – Stir casting; Defects in Sand casting.		
UNIT-II	**METAL JOINING PROCESSES**	**9**
Equipment, operating principle, merits and applications of: Fusion welding processes: Gas Tungsten arc welding - Gas metal arc welding - Submerged arc welding - Electro slag welding; Operating principle and applications of Resistance welding - Plasma arc welding – Thermit welding – Electron beam welding –Laser welding- Friction welding and Friction Stir Welding; Brazing and soldering; Weld defects: types, causes and cure.		
UNIT-III	**METAL FORMING PROCESSES**	**9**
Hot working and cold working of metals – Forging processes – Open, impression and closed die forging – forging operations. Rolling of metals – Types of Rolling – Flat strip rolling – shape rolling operations - Thread rolling, Ring rolling – Defects in rolled parts. Principle of rod and wire drawing – Tube drawing – Principles of Extrusion – Types – Hot and cold extrusion.		
UNIT-IV	**SHEET METAL PROCESSES**	**9**
Sheet metal characteristics – shearing, bending and drawing operations – Hemming and seaming – Stretch forming operations – Formability of sheet metal – special forming processes-Working principle and applications – Hydro forming – Rubber pad forming – Metal spinning.		

UNIT-V	MANUFACTURE OF PLASTIC COMPONENTS	9
Types and characteristics of plastics – Moulding of thermoplastics – working principles and typical applications – injection moulding – Plunger and screw machines – Compression moulding, Transfer Moulding – Typical industrial applications – introduction to blow moulding –Rotational moulding – Film blowing – Extrusion – Thermoforming – Bonding of Thermoplastics.		
	Total Contact Hours:	**45**

Course Outcomes: After completion of the course, the students can able to
1. Illustrate the requirements, processes, applications and defects of sand casting and special casting processes.
2. Apply the working principles and applications of different arc welding processes, special welding processes and identify the defects associated with them.
3. Determine the suitable process for manufacturing of components among forging, rolling, drawing, extrusion and its types.
4. Implement the principles and working of shearing, bending, drawing and forming in sheet metalfabrication.
5. Differentiate the various manufacturing methods for thermo and thermo setting plastic based components.

Text Book(s):
1. Hajra Choudhary. S.K and Hajra Choudhary. A.K., "Elements of Workshop Technology", Volume I and II, Media Promoters and Publishers Private Limited, Mumbai, 2010.
2. Kalpakjian. S, “Manufacturing Engineering and Technology”, 7th Edition, Pearson Education India Edition, 2018.

Reference Books(s) / Web links:
1. Roy A. Lindberg, "Processes and Materials of Manufacture", PHI / Pearson education, 2006
2. Black J.T and Ronald A. Kosher, "Degarmos Materials and Processes, in Manufacturing" 12th Edition, Wiley Publishers, 2017.
3. Sharma, P.C., "A Text book of production Technology", S.Chand and Co. Ltd., 2006
4. https://nptel.ac.in/courses/112107144/

PO-PSO / CO	POs												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	0	2	0	-	-	-	-	0	0	0	3	0	-	2
CO2	3	0	2	0	-	-	-	-	0	0	0	3	0	-	2
CO3	3	0	2	0	-	-	-	-	0	0	0	3	0	-	2
CO4	3	0	2	0	-	-	-	-	0	0	0	3	0	-	2
CO5	3	0	2	0	-	-	-	-	0	0	0	3	0	-	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Theory Course)	Category	L	T	P	C
ME23313	**KINEMATICS OF MACHINERY**	**PC**	**2**	**1**	**0**	**3**

Objectives:
● To impart knowledge on various types of Mechanisms and its generalization
● To impart skills to analyze velocity and acceleration of linkages in mechanisms
● To understand kinematic diagram of mechanism and perform synthesis
● To facilitate students to understand the functions of cams, gears
● To create the basic concepts of toothed gearing and kinematics of gear trains

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**
Velocity analysis: definition of velocity - graphical velocity analysis - instant centers of velocity - mechanical advantage. Acceleration analysis: definition of acceleration-graphical acceleration analysis - Coriolis acceleration. Construction of Velocity and acceleration Analysis using Simulation software.		
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		
UNIT – V	**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 Contact hours: 45		

Course Outcomes: On completion of the course, the students will be able to
1. Investigate common mechanisms and assess the suitability of different mechanisms for specific tasks.
2. Recall and construct the velocity and acceleration plot for a given mechanism
3. Remember, understanding cams and followers motion.
4. Recall gear terminology, Investigate gear train speed ratios and Assess the suitability of different gear types for specific applications
5. Investigate friction-related issues in machine elements and assess the effectiveness of different braking mechanisms.

Text Book(s):

1. Uicker, J.J., Pennock G.R and Shigley, J.E., "Theory of Machines and Mechanisms", Oxford University Press, 4th Edition, Reprint: 2017
2. Rattan, S.S, "Theory of Machines", McGraw-Hill Education Pvt. Ltd., 5th Edition, 2019.

Reference Books(s) / Web links:

1. Rao.J.S. and Dukkipati.R.V. "Mechanism and Machine Theory", New Age International Pvt. Ltd., 2nd Edition, 2020
2. Amitabha Ghosh and Asok Kumar Mallik, "Theory of Mechanisms and Machines", Affiliated East-West Pvt. Ltd.,2008.
3. Robert L. Norton, Kinematics and Dynamics of Machinery, McGraw-Hill Education, Special Indian Edition, Reprint-2017
4. https://nptel.ac.in/courses/112/104/112104121/
5. https://nptel.ac.in/courses/112105268/
6. https://nptel.ac.in/courses/112101096/

PO-PSO / CO	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	1	1	-	1	-	-	1	-	-	-	2	-	-	2
CO2	2	1	1	-	1	-	-	1	-	-	-	2	-	-	2
CO3	2	1	1	-	1	-	-	1	-	-	-	2	-	-	2
CO4	2	1	1	-	1	-	-	1	-	-	-	2	-	-	2
CO5	2	1	1	-	1	-	-	1	-	-	-	2	-	-	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Lab Oriented Theory Course)	Category	L	T	P	C
MA23331	TRANSFORMS AND STATISTICS	BS	3	0	2	4
Common to III sem. B.E. – Civil Engineering, Mechanical Engineering and Automobile Engineering						

Objectives:

- To express Fourier series to study the behaviour of periodic functions and their applications in system communications, digital signal processing and field theory.
- To represent continuous function arising in wave and heat propagation, signals and systems using Fourier Transforms.
- To provide numerical techniques in solving the boundary value problems.
- To formulate and test a hypothesis, using critical values to draw conclusions and determining probability of making errors in hypothesis tests.
- To provide the necessary basic concepts of a few statistical methods in designing and solving problems.

UNIT-I	**FOURIER SERIES**	**9**
Dirichlet's conditions – General Fourier series – Odd and even functions – Half range sine series – Half range cosine series –Parseval's identity – Harmonic analysis.		
UNIT-II	**FOURIER TRANSFORMS**	**9**
Statement of Fourier integral theorem – Fourier transform pair – Fourier sine and cosine transforms – Properties – Transforms of simple functions – Convolution theorem – Parseval's identity - Application to boundary value problems.		
UNIT-III	**BOUNDARY VALUE PROBLEMS**	**9**
Solution of one dimensional wave equation with one non zero boundary conditions- Finite difference techniques for the solution for PDE - One Dimensional Wave Equation by Explicit method - One dimensional equation of heat conduction - Numerical computation :Heat flow equation by implicit and explicit methods		
UNIT-IV	**STATISTICAL TESTING**	**9**
Maximal Likelihood estimation – Parameters of Binomial and Poisson distribution - Tests of significance – Z test: Single mean, difference of means- Chi square - F test.		
UNIT-V	**ANOVA**	**9**
Design of Experiments - Completely randomized design – Randomized block design –Latin square design.		
Total Contact Hours: 45		

S.No	List of Experiment (using MATLAB Software)	Total Contact Hours: 30
1	Basic functions in MATLAB	
2	Mathematical functions in MATLAB	
3	Plotting data sets using MATLAB	
4	Control flow -Loops	
5	Reading and writing data sets – importing data sets	

6	Testing of Hypothesis – Z, t, F and chi-square testing
7	ANOVA – one way and two way
8	Fourier Series using MATLAB
9	Fourier Transform using MATLAB
10	BVP solving using MATLAB – using bvp4c and bvp5c solvers.

Course Outcomes:

On completion of course students will be able to

●	Demonstrate Fourier series to study the behaviour of periodic functions and their applications in engineering problems such as system communications, digital signal processing and field theory.
●	Apply the shifting theorems, Fourier integral theorems, Inverse Fourier sine and cosine transforms appropriate problems in engineering and technology.
●	Solve differential equations numerically that arise in course of solving complex engineering problems.
●	Formulate, test and interpret various nonparametric tests for problems in engineering and technology. That is, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
●	Design of experiments using suitable ANOVA techniques and draw conclusions.

Text Books:

1	Erwin Kreyszig, "Advanced Engineering Mathematics", 8th Edition, Wiley India, 2007.
2	Veerarajan. T., "Transforms and Partial Differential Equations", Tata McGraw Hill Education Pvt.Ltd.,New Delhi, Second reprint, 2012.
3	Veerarajan T., 'Probability, Statistics and Random Processes (with Queueing Theory and Queueing Networks)', Mc Graw Hill, 2016.
4	Grewal B.S., "Higher Engineering Mathematics", 43rd Edition, Khanna Publishers, Delhi, 2014.
5	Ramana B.V., "Higher Engineering Mathematics", Tata McGraw Hill Publishing Company Limited, New Delhi, 2008.

Reference Books / Web links:

1	Kandasamy P., Thilagavathi and K. Gunavathi., "Statistics and Numerical Methods", S. Chand & Company Ltd. (2010).
2	Glyn James, "Advanced Modern Engineering Mathematics", 3rd Edition, Pearson Education, 2007.
3	Ray Wylie C and Barrett.L.C, "Advanced Engineering Mathematics" Tata McGraw Hill Education Pvt Ltd, Sixth Edition, New Delhi, 2012.
4	Johnson R.A., and Gupta. C.B., "Miller and Freund's Probability and Statistics for Engineers",11thEdition, Pearson Education, , Asia, 2011.
5	Walpole R.E., Myers. R.H., Myers. S.L., and Ye. K., "Probability and Statistics for Engineers and Scientists", 8th Edition, Pearson Education, Asia, 2007.
6	Spiegel M.R., Schiller. J., and Srinivasan. R.A., "Schaum's Outlines on Probability and Statistics", Tata McGraw Hill Edition, 2004.

Course Code	Course Title (Lab Oriented Theory Course)	Category	L	T	P	C
ME23331	**STRENGTH OF MATERIALS**	**PC**	**3**	**0**	**2**	**4**

Objectives: The students can able

- To understand the fundamental concepts of stress, strain and elastic constants of solids under external loading
- To learn about the transverse loading and bending loads acting on structural components
- To learn about the deformation of shafts and springs subjected to torsion
- To know about the various methods for calculating deflection of beams
- To learn about the various stresses acting in shell structures like thin cylinders and spheres

UNIT – I	**STRESS, STRAIN AND DEFORMATION OF SOLIDS**	**10**

Rigid bodies and deformable solids – Tension, Compression and Shear Stresses – Deformation of simple and compound bars – Thermal stresses – Elastic constants – Strain energy and unit strain energy – Strain energy in uniaxial loads – Volumetric strains –Stresses on inclined planes – principal stresses and principal planes – Mohr's circle of stress.

UNIT – II	TRANSVERSE LOADING ON BEAMS AND STRESSES IN BEAM	10
Beams – types transverse loading on beams – Shear force and bending moment in beams – Cantilevers – Simply supported beams and over hanging beams. Theory of simple bending– bending stresses – symmetrical and unsymmetrical sections. Proportioning of sections – Flitched beams – Shear stresses in beams – Shear stress distribution. Analysis of beams using software		
UNIT– III	**TORSION ON SHAFTS AND SPRINGS**	**8**
Torsion formulation stresses and deformation in circular and hollows shafts – Stepped shafts– Deflection in shafts fixed at the both ends – Stresses in helical springs – Maximum shear stress in spring section including Wahl Factor - Deflection of helical springs, carriage springs.		
UNIT – IV	**DEFLECTION OF BEAMS AND COLUMNS**	**9**
Double Integration method – Macaulay's method – Area moment method for computation of slopes and deflections in beams – Columns – End conditions – Equivalent length of a column – Euler equation – Slenderness ratio – Rankine formula for columns. Buckling analysis using software.		
UNIT – V	**THIN CYLINDERS, SPHERES AND THICK CYLINDERS**	**8**
Stresses in thin cylindrical shell due to internal pressure circumferential and longitudinal stresses and deformation in thin and thick cylinders – spherical shells subjected to internal pressure –Deformation in spherical shells – Lame's theorem.		
Total Contact hours: 45		

List of Experiments
1. Tension test on a mild steel rod
2. Double shear test on Mild steel and Aluminium rods
3. Torsion test on mild steel rod
4. Impact test on metal specimen – Charpy and Izod test
5. Hardness test on metals – Brinell and Rockwell Hardness Number
6. Deflection test on beams
7. Compression test on helical springs
8. Compression test on wood and bricks
Total Contact Hours:30

Course Outcomes: On completion of the course, the student is expected to be able to
1. Analyse stresses and strains under extremal loading and principal stresses
2. Illustrate the relation among shear force and bending moment of beams for beams subjected to different loading conditions.
3. Apply and solve torsion equation for shafts and springs.
4. Evaluate the slope and deflection of various beams
5. Determine stresses acting on thin cylinders and spheres

Text Book(s):
1. Bansal, R.K., "Strength of Materials", 6th edition, Laxmi Publications (P) Ltd., 2022
2. Jindal U.C., "Strength of Materials", Pearson Pvt. Ltd., New Delhi, 2012
Reference Books(s) / Web links:
1. Egor. P.Popov "Engineering Mechanics of Solids" Pearson Publication, 2015.
2. Ramamurtham S and R Narayanan., "Strength of Materials", Dhanpat Rai publishing company, 2020.
3. Hibbeler, R.C., "Mechanics of Materials", Pearson Education, 2022.
4. https://archive.nptel.ac.in/courses/112/107/112107147/
5. https://nptel.ac.in/courses/112107146
6. https://sm-nitk.vlabs.ac.in/ - VIRTUAL LAB

Lab equipment required for a batch of 30 students

S. No	Name of the Equipment	Quantity Required
1	Universal Testing machine	1
2.	Torsion Testing machine	1
3.	Impact testing machine	1
4.	Brinell Hardness Tester	1
5.	Rockwell Hardness Tester	1
6.	Deflection Test equipment	1
7.	Compression Testing machine	1

PO-PSO / CO	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	2	-	-	-	-	-	-	-	-	3	-	-	2
CO2	3	3	2	-	-	-	-	-	-	-	-	3	-	-	2
CO3	3	3	2	-	-	-	-	-	-	-	-	3	-	-	2
CO4	3	3	2	-	-	-	-	-	-	-	-	3	-	-	2
CO5	3	3	2	-	-	-	-	-	-	-	-	3	-	-	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Laboratory Course)	Category	L	T	P	C
ME23321	MANUFACTURING TECHNOLOGY LAB I	PC	0	0	2	1

Objectives: Enable the students
● To learn and practise different operations on work piece using lathe.
● To learn drilling and tapping operations on drilling machines and tap tools.
● To fabricate various sheet metal products using fabrication tools and measuring instruments.
● To prepare sand moulds using single solid pattern, sand moulding boxes and tools.
● To prepare sand moulds using split pattern, sand moulding boxes and tools.

List of Experiments	**Total Contact Hours: 30**
1. Perform Taper Turning operation in the given work piece to the dimensions using lathe.	
2. Perform External Thread cutting operation in the given work piece to the dimensions using lathe.	
3. Perform Internal Thread cutting operation in the given work piece to the dimensions using lathe.	
4. Perform Eccentric Turning in the given work piece to the dimensions as shown in the figure using lathe.	
5. Perform Knurling operation in the given work piece to the dimensions as shown in the figure using lathe.	
6. Perform drilling and tapping operation in the given work piece to the dimensions as shown in the figure using drilling machine and tap set.	
7. Fabricate a sheet metal Tray from the given sheet metal to the required dimensions.	
8. Fabricate a Funnel from the given sheet metal to the required dimensions.	
9. Prepare a sand mould of the given solid Gear pattern.	
10. Prepare a sand mould of the given split Dumbbell pattern.	
Exercises beyond Syllabus :	
1. Cutting of raw materials using Band saw machine.	

Course Outcomes: Upon completion of the exercises, students will have the
1. Ability to perform various machining operations on Lathe machines.
2. Ability to produce internal and external threaded components.
3. Ability to fabricate sheet metal products with correct dimensions.
4. Ability to prepare sand mould using single solid pattern.
5. Ability to prepare sand mould using split pattern.

Web links for virtual lab
1. https://archive.nptel.ac.in/courses/112/104/112104195/
2. https://www.slideshare.net/krishnachaitanyagali/manufacturing-technology-lab1

Lab equipment required:

S. No	Name of the Equipment	Quantity Required in (No.)	Remarks
1	Central Lathe	5	
2	Drilling Machine	1	
3	Tapping tool set	1	
4	Sheet metal fabrication tools and accessories	2 sets	
4	Sand moulding box (cope & drag) with tools & accessories	2 sets	
5	Measuring and marking tools set	5 sets	

PO-PSO / CO	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	-	-	-	-	1	1	-	2	-	-	3	-	1	2
CO2	1	-	-	-	-	1	1	-	2	-	-	3	-	1	2
CO3	1	-	-	-	-	1	1	-	2	-	-	3	-	1	2
CO4	1	-	-	-	-	1	1	-	2	-	-	3	-	1	2
CO5	1	-	-	-	-	1	1	-	2	-	-	3	-	1	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Laboratory Course)	Category	L	T	P	C
CS23422	PYTHON PROGRAMMING FOR MACHINE LEARNING	ES	0	0	4	2

Objectives:
● To understand the relationship of the data collected for decision making.
● To know the concept of principal components, factor analysis and cluster analysis for profiling and interpreting the data collected.
● Lay the foundation of machine learning and its practical applications and prepare students for real-time problem-solving in data science.
● Develop self-learning algorithms using training data to classify or predict the outcome of future datasets.
● Distinguish overtraining and techniques to avoid it such as cross-validation.

List of Experiments:
1. NumPy Basics: Arrays and Vectorized Computation
2. Getting Started with pandas
3. Data Loading, Storage, and File Formats
4. Data Cleaning and Preparation
5. Data Wrangling: Join, Combine, and Reshape
6. Plotting and Visualization
7. Data Aggregation and Group Operations
8. Time Series
9. Supervised Learning
10. Unsupervised Learning and Pre-processing
11. Representing Data and Engineering Features
12. Model Evaluation and Improvement
Contact Hours: 60

Course Outcomes: On completion of the course, the students will be able to
● Develop a sound understanding of current, modern computational statistical approaches and their application to a variety of datasets.
● Analyze and perform an evaluation of learning algorithms and model selection.
● Compare the strengths and weaknesses of many popular machine learning approaches.
● Appreciate the underlying mathematical relationships within and across machine learning algorithms and the paradigms of supervised and unsupervised learning.
● Design and implement various machine learning algorithms in a range of real-world applications.

Text Book(s):
1. Wes McKinney, Python for Data Analysis - Data wrangling with pandas, Numpy, and ipython, Second Edition, O‟Reilly Media Inc, 2017.
2. Andreas C. Müller and Sarah Guido, Introduction to Machine Learning with Python - A Guide for Data Scientists, First Edition, O‟Reilly Media Inc, 2016.

Reference Books(s) / Web links:
1. Aurélien Géron, Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, 2nd Edition, O‟Reilly Media Inc, 2019.

PO/PSO / CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CS23422.1	2	2	2	2	1	-	-	-	1	1	1	1	3	3	-
CS23422.2	2	1	1	1	1	-	-	-	-	-	1	1	3	2	-
CS23422.3	1	1	2	1	2	-	-	-	-	-	1	1	2	3	2
CS23422.4	2	2	3	2	2	-	-	-	-	-	2	1	2	2	2
CS23422.5	2	2	3	2	3	-	-	-	-	-	2	1	2	2	2

SEMESTER IV

Course Code	Course Title (Theory Course)	Category	L	T	P	C
ME23411	ENGINEERING MATERIALS AND METALLURGY	PC	3	0	0	3

Objectives:
● To understand the constituents of various alloy system and their properties.
● To learn about various heat treatment processes for hardening the solidified product.
● To study about the various phases and compositions of ferrous and non-ferrous materials.
● To understand about various polymer materials, properties and their applications.
● To understand about various testing tools & procedures for evaluating the strength of materials.

UNIT-I	**ALLOYS AND PHASE DIAGRAMS**	**9**
Constitution of alloys – Solid solutions, substitutional and interstitial – phase diagrams, Isomorphous, eutectic, eutectoid, peritectic, and peritectoid reactions, Iron – Carbon equilibrium diagram. Classification of Steel and Cast Iron microstructulre, properties and application.		
UNIT-II	**HEAT TREATMENT**	**9**
Definition – Full annealing, stress relief, recrystallisation and spheroidising – normalising, hardening and Tempering of steel. Isothermal transformation diagrams – cooling curves superimposed on I.T. diagram CCR – Hardenability, Jominy end quench test – Austempering, martempering – case hardening, carburizing, Nitriding, cyaniding, carbonitriding – Flame and Induction hardening – Vacuum and Plasma hardening.		
UNIT-III	**FERROUS AND NON-FERROUS METALS**	**9**
Effect of alloying additions on steel- α and β stabilizers – stainless and tool steels – HSLA, Maraging steels – Cast Iron – Grey, white, malleable, spheroidal – alloy cast irons, Copper and copper alloys – Brass, Bronze and Cupronickel – Aluminium and Al-Cu – Precipitation strengthening treatment – Bearing alloys, Mg-alloys, Ni-based super alloys and Titanium alloys, Shape memory alloys - Properties and Applications.		
UNIT-IV	**NON-METALLIC MATERIALS**	**9**
Polymers – types of polymer, commodity and engineering polymers – Properties and applications of various thermosetting and thermoplastic polymers (PP, PS, PVC, PMMA, PET, PC, PA, ABS, PI, PAI, PPO, PPS, PEEK, PTFE, Polymers – Urea and Phenol formaldehydes) - Engineering Ceramics – Properties and applications of Al2O3, SiC, Si3N4, PSZ and SIALON – Composites. Classifications - Metal Matrix and FRP – Applications of Composites. Nano structured materials.		
UNIT-V	**MECHANICAL PROPERTIES AND DEFORMATION MECHANISMS**	**9**
Mechanisms of plastic deformation, slip and twinning – Types of fracture–Testing of materials under tension, Compression and shear loads – Hardness tests (Brinell, Vickers Rockwell and Shore), Nano Indentation test, Impact test - lzod and Charpy, fatigue and creep failure mechanisms.		
	Total Contact Hours:	**45**

Course Outcomes: After completion of the course, the students can able to
1. Analyze the phase diagram for microstructure formation.
2. Select and apply various heat treatment processes for different materials surface.
3. Apply different types of ferrous, non-ferrous alloys and shape memory alloys and their uses in engineering fields.
4. Apply different polymer, ceramics and composites and their uses in engineering fields.
5. Apply various testing procedures and failure mechanism in engineering fields.
Text Book(s):
1. Kenneth G. Budinski and Michael K. Budinski, “Engineering Materials”, Pearson 2009.
2. V Ragavan, “Physical Metallurgy – Principles and Practice”, PHI, 2015.

Reference Books(s) / Web links:
1. Williams D Callister, “Material Science and Engineering” Wiley India Pvt. Ltd., Revised Indian edition 2007.
2. A. Alavudeen, N. Venkateshwaran and J.T. Winowlin Jappes, A Text book of Engineering Materials and Metallurgy, Laxmi Publications, 2006.
3. Sydney H. Avner, “Introduction to Physical Metallurgy”, McGraw Hill Book Company, 1994.
4. R. Balasubramaniam, Callister's Materials Science and Engineering, Wiley Publication, 2014.

PO-PSO / CO	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	2	1	-	-	-	-	2	1	2	-	3	3	2
CO2	3	2	3	-	-	-	-	-	2	1	-	-	3	2	3
CO3	3	-	3	-	-	-	3	-	2	1	2	-	3	-	3
CO4	3	-	3	-	-	-	3	-	-	-	-	-	3	-	3
CO5	3	-	3	2	-	-	3	-	-	-	-	-	3	-	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Theory Course)	Category	L	T	P	C
ME23412	MANUFACTURING TECHNOLOGY II	PC	3	0	0	3

Objectives:

- To understand the fundamental principles in material removal processes and importance of metal cutting parameters.
- To understand the working principles of turning machines, Semi-automatic and automatic machine tools.
- To study the working principles of reciprocating machines, milling processes and gear manufacturing methods.
- To impart basic knowledge on grinding and broaching processes.
- To understand the basics of CNC machine tools and programming for different manufacturing processes

UNIT-I	THEORY OF METAL CUTTING	9

Mechanics of chip formation, forces in machining, Merchant's Force diagram, 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, machining time and power estimation. Semi-automatic lathes – Capstan and turret lathes – -tool layout – automatic lathes – single spindle: Swiss type, automatic screw type – multi spindle machines.

UNIT-III	RECIPROCATING, MILLING AND GEAR CUTTING MACHINES	9

Reciprocating machine tool: Construction of shaper and Slotter – operation; Hole making; Types of Drilling machines – Construction – operations; Milling - type and various milling operations – attachments - types of milling cutter – Cutter Nomenclature – Indexing and machining time calculations; Gear Manufacturing – Gear cutting, Gear generation- gear hobbing and gear shaping – gear finishing methods.

UNIT-IV	ABRASIVE PROCESSES AND BROACHING	9

Abrasive processes: grinding wheel – specifications and selection, types of grinding process – cylindrical grinding, surface grinding, centreless grinding, internal grinding - micro finishing methods – Honing – lapping - Magnetorheological finishing machines – Maintenance of grinding wheels - Typical applications – concepts of surface integrity, broaching machines: broach construction – push, pull, surface and continuous broaching machines.

UNIT-V	COMPUTER NUMERICAL CONTROL (CNC) MACHINE TOOLS	9

Computer Numerical Control (CNC) machine tools – types, constructional details, Coordinates, Motion control special features – Drives: Reciprocating ball screws, Automatic Tool changers (ATC), Machining Centre and part programming fundamentals – Manual part programming and computer assisted part programming. Pert programming for lathe and milling operations.

Total Contact Hours: 45

Course Outcomes: After completion of the course, the students can able to

- Apply the mechanism of metal removal process and identify the factors involved in improving the machinability.
- Describe the constructional and operational features of centre lathe and other special purpose lathes.
- Demonstrate the constructional and operational features of reciprocating, milling and gear cutting machine tools.
- Describe the constructional and operational features of grinding and broaching machine tools.
- Demonstrate the construction & control systems of CNC machine tools and write part programs for simple lathe and milling operations.

Text Book(s):
1. Kalpakjian.S, "Manufacturing Engineering and Technology", Pearson Education India, Third Edition, 2009.
2. Hajra Choudhury. "Elements of Workshop Technology – Vol. II" Media Publishers & Promoters, India, 2010.

Reference Books(s) / Web links:
1. Geofrey Boothroyd, Winston A. Knight "Fundamentals of Machining and Machine Tools", Taylor & Francis, CRC press, 2006.
2. P.N. Rao. "Manufacturing Technology: Metal Cutting and Machine Tools, McGraw Hill Education (India) Private Limited, 2019.
3. HMT – "Production Technology", Tata McGraw Hill, 1998.
4. Richerd R Kibbe, John E .Neely, Roland O. Merges and Warren J. White "Machine Tool Practices", Prentice Hall of India, 1998.
5. Roy. A. Lindberg, Processes and materials of manufacture, PHI / Pearson education, 2006.
6. B.L.Juneja, G.S.Sekhon, Nitin Seth, Fundamentals of Metal cutting and Machine tools, Second Edition, New Age International (P) Ltd., 2005.
7. https://nptel.ac.in/courses/112105233/

PO-PSO / CO	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	-	-	-	1	2	-	-	-	-	3	-	-	2
CO2	3	2	-	-	-	1	1	-	-	-	-	3	-	-	2
CO3	3	2	-	-	-	1	1	-	-	-	-	3	-	-	2
CO4	3	2	-	-	-	1	1	-	-	-	-	3	-	-	2
CO5	3	2	-	-	3	1	1	-	-	-	-	3	-	-	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Lab Oriented Theory Course)	Category	L	T	P	C
ME23431	DYNAMICS OF MACHINES	PC	3	0	2	4

Objectives: The objective of this course is to prepare the students
• To derive the force-motion relationship in components subjected to external forces and analysis of standard mechanisms.
• To outline the undesirable effects of unbalances resulting from prescribed motions in mechanism. To conversant with balancing problems of machines.
• To interpret the effect of free vibrations and forced vibration.
• To develop analytical competency in solving vibration problems.
• To justify the principles in mechanisms used for speed control and stability control.

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.		
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 – Study on Balancing Machines -Field balancing of discs and rotors. Self-study: Balancing of wheel / rotor on computerized balancing machine OR Demonstration of wheel balancing during a visit to industry / workshop.		
UNIT-III	**BASICS OF FREE VIBRATION**	**9**
Basic concepts of S.H.M, Causes and effects of vibration - 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- Classification, vibrometer, velocity pickup, accelerometer ,vibration pickups, vibration frequency measurement,		
UNIT-V	**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 Contact Hours	**:**	**45**

List of Experiments	**Total Contact Hours:30**
1. Determination of Mass Moment of Inertia using bifilar suspension and compound pendulum.	
2. Undamped free vibration of Equivalent Spring mass system.	
3. Torsional Vibration (Undamped) of single rotor shaft system.	
4. Dynamic analysis of cam mechanism.	
5. Balancing of rotating masses.	
6. Experiment on various governors	
7. Experiment of motorized gyroscope.	
8. Determination of critical speed of shaft.	
9. Study the machine fault diagnostic system based on vibration analysis.	
10. Study of gear parameters	

Text Book(s):
1. Uicker, J.J., Pennock G.R and Shigley, J.E., “Theory of Machines and Mechanisms”,V Edition, Oxford University Press, 2016.
2. S Rao and R V Dukkipat, Mechanism and Machine Theory, 2nd Ed., New Age Intl., 2020
Reference Books(s) / Web links:
1. Rattan, S.S, “Theory of Machines”, IV Edition, McGraw-Hill, 2019.
2. Thomas Bevan, "Theory of Machines", 3rd Edition, CBS Publishers and Distributors, 2010.
3. Robert L. Norton, "Kinematics and Dynamics of Machinery", Tata McGraw-Hill, 2009.
4. https://archive.nptel.ac.in/courses/112/104/112104114/
5. https://nptel.ac.in./courses/112/101/112101096
6. https://dom-nitk.vlabs.ac.in/

Course Outcomes: On successful completion of the course, the student will be able to
1. Understand dynamic force analysis and able to construct the turning moment diagram for flywheel design
2. Apply the techniques for static and dynamic balancing, including single and multi-cylinder engine balancing, using balancing machines, and field balancing procedures.
3. Comprehend free vibrations of single-degree freedom systems.
4. Evaluate system vibration responses under forced conditions and demonstrate comprehension of vibration measuring device functionalities.
5. Evaluate the characteristics of governors, distinguish between types, and comprehend gyroscopic principles in various applications.

Lab equipment required for a batch of 30 students

S. No	Name of the Equipment	Quantity Required	Remarks
1	Models of various gears	1	
2.	Epicyclic gear setup	1	
3.	Differential Gear train setup	1	
4.	Compound Pendulum	1	
5.	Bifilar Suspension Set up	1	
6.	Undamped free vibration set up	1	
7.	Damped free vibration set up	1	
8.	Torsional vibration set up	1	

9.	Cam Analysis apparatus	1	
10.	Forced vibration set up	1	
11.	Motorised Universal Gyroscope	1	
12.	Static and Dynamic Balancing Apparatus	1	
13.	Universal Governor Setup	1	
14.	Whirling of Shaft apparatus	1	
15.	Journal Bearing Apparatus	1	
16	Tachometer	1	
17	Vernier Calliper	1	
18	Tool box	1	
19	Stop Watch	2	
20.	Vibrometer	1	
21.	Vibration Exciter	1	
22.	Motor – 1 HP	1	
23.	Digital Sound level meter	1	

PO-PSO / CO	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	2	-	-	-	-	-	-	-	-	3	-	-	2
CO2	3	3	2	-	-	-	-	-	-	-	-	3	-	-	2
CO3	3	3	2	-	-	-	-	-	-	-	-	3	-	-	2
CO4	3	3	2	-	-	-	-	-	-	-	-	3	-	-	2
CO5	3	3	2	-	-	-	-	-	-	-	-	3	-	-	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Lab Oriented Theory Course)	Category	L	T	P	C
ME23432	FLUID MECHANICS AND MACHINERY	PC	3	0	2	4

Objectives: The main learning objective of this course is to
● Introduce about properties of the fluids and the behaviour of fluids under static and dynamic conditions applied to their applications.
● Understand the difference between laminar and turbulent flow through circular conduits and losses in pipe flow.
● Gain knowledge of dimensional and model analysis.
● Understand the performance calculations of turbines with their velocity triangle.
● Understand the performance calculations of pumps and their application.

UNIT – 1	**FLUID PROPERTIES AND FLOW CHARACTERISTICS**	**10**
Properties of fluids- Pressure Measurements-Buoyancy and floatation-Flow characteristics- Eulerian and Lagrangian Principle of fluid flow – the concept of control volume and system - continuity equation, energy equation, and momentum equation-Applications.		
UNIT – II	**FLOW THROUGH PIPES AND BOUNDARY LAYER**	**10**
Laminar flow through circular conduits- Darcy Weisbach equation – friction factor- Moody diagram- minor losses- Hydraulic and energy gradient (theory) – Pipes in series and parallel Boundary layer concepts – types of boundary layer thickness.		
UNIT– III	**DIMENSIONAL ANALYSIS AND MODEL STUDIES**	**8**
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**
Introduction about Impact of jets - Theory of roto-dynamic machines - Classification of turbines – Pelton wheel, Francis turbine (inward and outward), and Kaplan turbine- Working principles - Work done by water on the runner - Efficiencies – Draft tube - Specific speed - Performance curves for turbines – Governing of turbines		
UNIT – V	**PUMPS**	**8**
Classification of pumps- Centrifugal pumps– working principle - Heads and efficiencies– Velocity triangles- Work done by the impeller - performance curves - Reciprocating pump – indicator diagram and its variations (theory) – air vessels (concept basis).		
Total Contact Hours		**45**

List of Experiments	Total Contact Hours: 30
1. Determination of the Coefficient of discharge of the given Orifice meter.	
2. Determination of the Coefficient of discharge of the given Venturi meter.	
3. Calculation the rate of flow using the Rota meter.	
4. Determination of friction factor for a given set of pipes.	
5. Conducting experiments and drawing the characteristic curves of the centrifugal pump.	
6. Conducting experiments and drawing the characteristic curves of the reciprocating/Gear pump.	
7. Conducting experiments and drawing the characteristic curves of the Gear pump.	
8. Conducting experiments and drawing the characteristic curves of the Pelton wheel.	
9. Conducting experiments and drawing the characteristics curves of the Francis/Kaplan turbine.	

Course Outcomes: On completion of the course, the student is expected to be able to
1. Distinguish the difference between solid and fluid and its properties and behaviour in static & dynamic conditions.
2. Estimate losses in pipelines for both laminar and turbulent conditions and analysis of pipes connected in series and parallel.
3. Formulate the relationship among the parameters involved in the given fluid phenomenon and predict the performances of prototypes by model studies.
4. Analyse the performance of turbines and their characteristics.
5. Analyse the performance of pumps and their characteristics.

Text Book(s):
1. Modi P.N. and Seth, S.M. Hydraulics and Fluid Mechanics, Standard Book House, New Delhi, (2017).
2. Yunus A. Cengel; John M. Cimbala, Fluid Mechanics, McGraw Hill Education Pvt. Ltd.,2014.

Reference Books(s) / Web links:
1. R K Bansal, Fluid mechanics and Hydraulic machines, Laxmi Publications Pvt Ltd, Ninth Edition 2012.
2. S K Som; Gautam Biswas and S Chakraborty, Introduction to Fluid Mechanics and Fluid Machines, Tata McGraw Hill Education Pvt. Ltd., 2012.
3. Subramanya, K. Fluid Mechanics and Hydraulic Machines, Tata McGraw- Hill Pub. Co., New Delhi, 2011.
4. Jain A. K. Fluid Mechanics including Hydraulic Machines, Khanna Publishers, New Delhi, 2014.
5. Streeter, V. L. and Wylie E. B., Fluid Mechanics, McGraw Hill Publishing Co. (2010).
6. https://nptel.ac.in/courses/112/104/112104117/
7. https://nptel.ac.in/courses/112/105/112105182/
8. https://nptel.ac.in/courses/105101082/
9. http://www2.eng.cam.ac.uk/~mpj1001/learnfluidmechanics.org/LFM_L0.html

Lab equipment required:

S. No	Name of the Equipment	Quantity Required	Remarks
1	Orifice meter.	1	
2	Venturi meter.	1	
3	Rota meter.	1	
4	Set of pipes.	1	
5	Centrifugal pump.	1	
6	Reciprocating pump.	1	
7	Gear pump.	1	
8	Pelton wheel.	1	
9	Francis turbine.	1	
10	Kaplan turbine.	1	

PO-PSO / CO	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	2	2	-	-	-	-	-	-	-	1	-	-	-
CO2	3	3	3	2	-	-	-	-	-	-	-	1	-	-	-
CO3	3	3	3	3	-	-	-	-	-	-	-	1	-	-	-
CO4	3	3	3	3	-	-	1	-	1	-	-	2	-	2	1
CO5	3	3	3	3	-	-	1	-	1	-	-	2	-	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Lab Oriented Theory Course)	Category	L	T	P	C
ME23433	THERMAL ENGINEERING	PC	3	0	2	4

Objectives: The main learning objective of this course is to prepare the students
● To integrate the laws and concepts of thermodynamics into the analysis of gas power cycles
● To analyse the working of internal combustion engines and its auxiliary systems
● To understand the working and performance of the steam nozzles and steam turbines
● To understand the working of air compressors and to evaluate their performance
● To analyse various refrigeration cycles and air conditioning systems

(Use of standard refrigerant property data book, Steam Tables, Mollier diagram and Psychrometric chart are permitted)

UNIT-I	GAS POWER CYCLES	9
Otto, Diesel, Dual, Brayton cycles, Calculation of mean effective pressure, and air standard efficiency - Comparison of cycles.		
UNIT-II	**INTERNAL COMBUSTION ENGINES**	**9**
Classification - Components and their function. Valve timing diagram and port timing diagram - actual and theoretical p-V diagram of four stroke and two stroke engines. Carburettor. MPFI, Diesel pump and injector system. Battery and Magneto Ignition System - Principles of Combustion and knocking in SI and CI Engines. Lubrication and Cooling systems. Performance of IC Engines (Description only).		
UNIT-III	**STEAM NOZZLES AND TURBINES**	**9**
Flow of steam through nozzles, shapes of nozzles, effect of friction, critical pressure ratio, supersaturated flow. Impulse and Reaction principles, compounding, velocity diagram for simple and multi-stage turbines, speed regulations –Governors.		
UNIT-IV	**AIR COMPRESSOR**	**9**
Classification and working principle of various types of compressors, work of compression with and without clearance, Volumetric efficiency, Isothermal efficiency and Isentropic efficiency of reciprocating compressors, Working of multistage air compressor (Description only).		
UNIT-V	**REFRIGERATION AND AIR CONDITIONING**	**9**
Refrigerants - Vapour compression refrigeration cycle- super heat, sub cooling – Performance calculations - working principle of vapour absorption system, Ammonia –Water, Lithium bromide – water systems (Description only). Air conditioning system - Processes, Types and Working Principles.		
Total Contact Hours		**45**

List of Experiments	Total Contact Hours: 30
1. Valve Timing and Port Timing diagrams	
2. Determination of Flash Point and Fire Point of various fuels / lubricants	
3. Determination of Viscosity – Red Wood Viscometer	
4. Performance and Heat Balance Test on 4 – stroke slow/ high speed single cylinder Diesel Engine	
5. Performance and Heat Balance Test on 4 – stroke twin cylinder Diesel Engine	
6. Performance test for 2-stroke / 4-stroke SI engine.	
7. Measurement of Exhaust Emissions of IC engine.	
8. Demonstration of p-v plots using a computerized IC engine test rig.	
9. Retardation Test on a Diesel Engine	
10. Study on Steam Generators and Turbines	

Course Outcomes: At the end the course, the students will be able to
1. integrate the laws and concepts of thermodynamics into the analysis of gas power cycles
2. analyse the working of internal combustion engines and its auxiliary systems
3. understand the working and performance of the steam nozzles and steam turbines
4. understand the working of air compressors and to evaluate their performance
5. analyse various refrigeration cycles and air conditioning systems

Text Book(s):
4. Rajput. R. K., "Thermal Engineering", 10th Edition, Laxmi Publications, 2018
5. Ballaney. P. L., "Thermal Engineering", 25th Edition, Khanna Publishers, 2017.

Reference Books(s) / Web links:
1. Mahesh. M. Rathore, "Thermal Engineering", 1st Edition, Tata McGraw Hill, 2010.
2. Kothandaraman.C.P., Domkundwar. S,Domkundwar. A.V., "A course in thermal Engineering", Fifth Edition, Dhanpat Rai & sons , 2004
3. Ganesan V.." Internal Combustion Engines" , Third Edition, Tata Mcgraw-Hill 2007
4. Rudramoorthy, R, "Thermal Engineering ",Tata McGraw-Hill, New Delhi,2003
5. https://nptel.ac.in/courses/112103262/
6. https://nptel.ac.in/content/storage2/courses/112105129/pdf/R&AC%20Lecture%2018.pdf
7. https://nptel.ac.in/courses/112/103/112103275/

Lab equipment required:

S. No	**Name of the Equipment**	**Quantity Required**
1	I.C Engine – 2 stroke and 4 stroke model.	1
2	Red Wood Viscometer.	1
3	Apparatus for Flash and Fire Point	1
4	4-stroke Diesel Engine with mechanical loading.	1
5	4-stroke Diesel Engine with electrical loading	1
6	4 – stroke twin cylinder Diesel Engine	1
7	Steam Boiler with turbine setup.	1

PO-PSO / CO	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	3	2	1	-	1	2	-	-	1	-	2	2	2	2
CO2	3	3	2	1	-	2	2	-	-	1	-	2	2	2	2
CO3	3	3	2	1	-	1	-	-	-	1	-	2	2	2	2
CO4	3	3	1	1	-	1	1	-	-	1	-	2	2	2	2
CO5	3	3	3	2	-	2	2	-	-	1	-	2	2	2	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Laboratory Course)	Category	L	T	P	C
GE23421	SOFT SKILLS I	EEC	0	0	2	1

Programming Learning Goal
This program will help our students to build confidence and improve their English communication in order to face the corporate world as well as providing them with opportunities to grow within an organization
Course Objectives
● To help students break out of shyness. ● To build confidence ● To enhance English communication skills. ● To encourage students' creative thinking to help them frame their own opinions

Week	Activity Name	Description	Objective
1	Introduction	The trainer and the college facilitator talk to the students about the course and in turn the students introduce themselves.	To set expectations about the course and the students are made aware of the rules and regulations involved in this program
2	If I ruled the world	This is a quick and useful game by getting students to form a circle and provide their point of view. Each student then repeats what the other has said and comes up with their own opinion.	The aim of this activity is to for students to get to know each other and also develop their listening skills as well as learning how to agree and disagree politely.
3	Picture Narrating	This activity is based on several sequential pictures. Students are asked to tell the story taking place in the sequential pictures by paying attention to the criteria provided by the teacher as a rubric. Rubrics can include the vocabulary or structures they need to use while narrating.	The aim of this activity is to make the students develop creative way of thinking.
4	Brainstorming	On a given topic, students can produce ideas in a limited time. Depending on the context, either individual or group brainstorming is effective and learners generate ideas quickly and freely. The good characteristics of brainstorming are that the students are not criticized for their ideas so students will be open to sharing new ideas.	The activity aims at making the students speak freely without the fear of being criticized. It also encourages students to come up with their own opinions.
5	Debate	Is competition necessary in regards to the learning process?	The aim of this activity is to develop the students ability to debate and think out of the box
6	Short Talks	Here the students are given topics for which they take one minute to prepare and two minutes to speak. They can write down points but can't read them out they can only use it as a reference.	The activity aims at breaking the students' shyness and encouraging them to standup in front of the class and speaks. It also aims at creating awareness that they are restricted for time so they only speak points that are relevant and important.
7	Debate	Will posting students' grades on bulletin boards publicly motivate them to perform better or is it humiliating?	This activity aims at enhancing the students unbiased thought process when it comes to exams and grades as well as develop their skills to debate
8	The Art of diplomacy	The facilitator proceeds to share multiple concepts of conversation and helps the participants to identify the various methods of being diplomatic and how do deal with misinformation.	The aim of the lesson is to provide an opportunity for the participants to learn about body language and choosing the appropriate words for conversation.
9	Debate	Are humans too dependent on computers?	The aim of this activity is to test the students debating skills and thought process with a topic that affects everybody in daily life.
10	Story Completion	The teacher starts to tell a story but after 2 sentences he/she asks students to work in groups to create the rest of the story which includes the plot and the ending.	This activity aims at building their narrating skills as well as their creativity and ability to work in a

			team.
11	Role play debate	Students scrutinize different points of view or perspectives related to an issue. For example, a debate about the question "Should students be required to wear uniforms at school?" might yield a range of opinions. Those might include views expressed by a student (or perhaps two students – one representing each side of the issue), a parent, a school principal, a police officer, a teacher, the owner of a clothing store, and others.	The aim of this activity is to get students to speak based on other people's perspective instead of their own. The students take the role of various characters and debate accordingly.
12	I Couldn't Disagree More	This is a game where students practice rebuttal techniques where one student provides a thought or an idea and the other students starts with the phrase I couldn't disagree more and continues with his opinion	The aim of this activity is to improve general communication skills and confidence.
	Feedback	At the end of the session in the final week (12) the trainer would provide feedback to the students on best practices for future benefits	The aim is to do both give feedback to students as well as obtain feedback on the course from them.

Course Outcomes: On successful completion of the course, students should be able to:	
1	Be more confident
2	Speak in front of a large audience
3	Be better creative thinkers
4	Be spontaneous
5	Know the importance of communicating in English

PO-PSO / CO	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	-	-	-	-		-	-	-	-	1	-	-	-	-	-
CO2	-	-	-	-		-	-	-	-	1	-	-	-	-	-
CO3	-	-	-	-		-	-	-	-	1	-	-	-	-	-
CO4	-	-	-	-		-	-	-	-	1	-	-	-	-	-
CO5	-	-	-	-		-	-	-	-	1	-	-	-	-	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	**Course Title (Laboratory Course)**	**Category**	**L**	**T**	**P**	**C**
ME23421	**MACHINE DRAWING LABORATORY**	**PC**	**0**	**0**	**4**	**2**

Objectives: The students can be able to	
●	To familiarize the students with Indian Standards on drawing practices and standard components
●	To make the students to draw various thread forms, Welding symbols, Riveted joints, Keys and fasteners. Fits, tolerances and understand the principle of GD&T (Geometric Dimensioning & Tolerance)
●	To understand the fundamentals of 2D drafting using AutoCAD.
●	To develop the skills to create, modify, and annotate 2D drawings.
●	To learn best practices for professional drafting and documentation.

LIST OF EXERCISES

DRAWING STANDARDS & FITS AND TOLERANCES **20**
Code of practice for Engineering Drawing, BIS specifications – Thread forms, Welding symbols, riveted joints, keys, and fasteners - Reference to hand book for the selection of standard components like bolts, nuts, screws, keys etc. Limits, Fits, Tolerance of individual dimensions- Specification of Fits- Basic principles of GD&T (Geometric Dimensioning & Tolerance).
2D DRAFTING **40**

1. Introduction of 2D CAD packages 2. Create a simple 2D layout with basic shapes and dimension. 3. Drawing Tools - Modify commands (Move, Copy, Rotate, Scale, Trim, Extend, Offset, Mirror, Fillet, and Chamfer.) 4. Managing object properties: Layers, Colors, Line Types, and Line Weights. 5. Prepare a 2D assembly model of machine components like Flange Coupling, Plummer Block, Screw Jack, Universal Joint, Stuffing box, Lathe Tailstock, Safety Valves, Connecting rod, Piston etc. 6. **Project- Student has to select a component and complete its part and assembly model.**	
Total Contact Hours	**: 60**

Course Outcomes: On successful completion of the course, the student will be able to	
1	Read the engineering drawings based on the standards of machine drawing practiced by Bureau of Indian standards (B.I.S)
2	Draw the different types of thread forms, welding symbols, types of Keys, Riveted joints and fasteners.
3	Draft any 2D machine component.
4	Analyse and Assemble the machine component in 2D
5	Generate the different views of the machine component.

Reference Books(s) / Web links:	
1	Bhatt.N.D. and Panchal.V.M., "Machine Drawing", Charotar Publishing House, 2016
2	Gopalakrishna.K.R., "Machine Drawing", SubhasStores,2013
3	P.S.G. Design Data Book, Kalaikathir Achchagam, 2012
4	SolidWorks 2019 for Engineers and Designers by Prof. Sham Tickoo- BPB Publications (2019)
5	https://www.solidworks.com/partner-product/solidworks-online-training-and-books

CO - PO – PSO matrices of course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	3	3	2	-	-	-	-	-	-	-	-	3	-	-	2
CO2	3	3	2	-	-	-	-	-	-	-	-	3	-	-	2
CO3	3	3	2	-	-	-	-	-	-	-	-	3	-	-	2
CO4	3	3	2	-	-	-	-	-	-	-	-	3	-	-	2
CO5	3	3	2	-	-	-	-	-	-	-	-	3	-	-	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Lab equipment required for a batch of 30 students

S. No	Name of the Equipment	Quantity Required	Remarks
1.	Computer System	30	**Processor:** 3.3 GHz or faster, Intel® Core i5, i7 or equivalent AMD®, **Operating System:** Windows® 11 or 10 **Memory:** 32GB or more as required **Hard Drive:** Solid State Drive (SSD) > 250GB, **Graphics Cards:** NVIDIA® RTX A5000, RTX A6000, RTX 8000
2.	Drafting Software	30	CAD drafting software
3.	Laser Printer	1	To take students drawing as printout.

Course Code	Course Title (Laboratory Course)	Category	L	T	P	C
ME23422	MANUFACTURING TECHNOLOGY LAB II	PC	0	0	4	2

Objectives: Enable the students
● To machine components using vertical and horizontal milling machines.
● To machine components using cylindrical & surface grinding machines and grind a tool for various tool angles.
● To manufacture gears using gear hobbing machine.
● To machine key ways, slots and grooves on the work piece using slotter & shaper machines and to machine components using capstan lathe.
● To produce components using Fused Deposition Modelling process.

List of Exercises	Total Contact Hours: 45
1. Machine a hexagon to the given dimensions using vertical milling machine.	
2. Milling of spur gear to the given module and number of teeth using horizontal milling machine.	
3. Grind the work piece to the given dimensions using Cylindrical grinding Machine.	
4. Grind the work piece to the given dimensions using Surface grinder.	
5. Machine a spur gear using gear hobbing machine.	
6. Machine the work piece to the given dimensions using Capstan lathe.	
7. Grind the tool to the given tool angles using tool and Cutter Grinder.	
8. Machine a Square Block as shown in the figure using shaping machine.	
9. Machine an internal keyway using slotting machine.	
10. Fabrication of a simple model using FDM Printer.	
Exercises beyond Syllabus :	
1. Moulding of a cap using semi-automatic injection moulding machine.	

Course Outcomes: Upon completion of the exercises, students will have the
1. Ability to machine various components on vertical and horizontal milling machines.
2. Ability to use different grinding machines for finishing operations.
3. Ability to generate different gear teeth profiles on gear blanks.
4. Ability to machine keyways, slots and grooves on the work piece using slotter and shaper machines.
5. Ability to produce 3D printed components.

Web links for virtual lab
● https://msvs-dei.vlabs.ac.in/
● http://www.digimat.in/nptel/courses/video/112104290/L15.html

Lab equipment required:

S. No	Name of the Equipment	Quantity Required in (No.)	Remarks
1	Vertical milling machine.	1	
2	Horizontal milling centre.	1	
3	Cylindrical Grinding Machine.	1	
4	Surface Grinding Machine.	1	
5	Gear Hobbing Machine.	1	
6	Capstan lathe.	1	
7	Tool and Cutter Grinder machine.	1	
8	Shaping machine.	1	
9	Slotting machine.	1	
10	3D Printer	1	

PO-PSO / CO	POs												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	3	1	-	3	1	-	2	-	-	3	3	2	1
CO2	3	2	3	1	-	3	1	-	2	-	-	3	3	2	1
CO3	3	2	3	1	-	3	1	-	2	-	-	3	3	2	1
CO4	3	2	3	1	-	3	1	-	2	-	-	3	3	2	1
CO5	3	2	3	1	-	3	1	-	2	-	-	3	3	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

SEMESTER V

Course Code	Course Title (Theory course)	Category	L	T	P	C
GE23511	ECONOMICS FOR ENGINEERS	HS	3	0	0	3

Objectives:	
●	To enable students to understand the micro economics principles applicable to engineering
●	To enable the students to understand the behaviour of price and consumer, inflation and depreciation
●	To learn the theory of production of production and cost of firms for economic decision making
●	To familiarize the students with basic fundamentals of Engineering economy and stock market
●	To learn the Indian economy models

UNIT-I	MICRO ECONOMICS	9
Principles of Demand and Supply — Supply Curves of Firms — Elasticity of Supply; Demand Curves of Households — Elasticity of Demand; Market Equilibrium and Comparative Statics (Shift of a Curve and Movement along the Curve); Welfare Analysis — Consumers' and Producers' Surplus.		
UNIT-II	**PRICE AND CONSUMER BEHAVIOUR**	9
Price Ceilings and Price Floors; Consumer Behaviour — Axioms of Choice – Inflation – Depreciation – Methods- Straight-Line Depreciation Declining Balance Depreciation — Budget Constraints and Indifference Curves; Consumer's Equilibrium — Effects of a Price Change, Income and Substitution Effects —Derivation of a Demand Curve; Applications — Tax and Subsidies — Intertemporal Consumption — Suppliers' Income Effect		
UNIT-III	**THEORY OF PRODUCTION, COST AND FIRMS**	9
Production Function and Iso-quants — Costs - Fixed, Variable, Marginal & Average Costs, Sunk Costs, Opportunity Costs, Recurring And Nonrecurring Costs, Incremental Costs, Cash Costs vs Book Costs, Break Even analysis, Life-Cycle Costs; Types Of Estimate, Estimating Models - Per- Unit Model, Segmenting Model, Cost Indexes, Power-Sizing Model, Improvement & Learning Curve, Benefits; Cost Minimization; Total, Average and Marginal Costs — Long Run and Short Run Costs; Equilibrium of a Firm Under Perfect Competition; Monopoly and Monopolistic Competition		
UNIT-IV	**ENGINEERING ECONOMY & STOCK MARKET**	9
National Income and its Components — GNP, NNP, GDP, NDP; Consumption Function; Investment; Simple Keynesian Model of Income Determination and the Keynesian Multiplier; Government Sector — Taxes and Subsidies; External Sector — Exports and Imports; Money — Definitions; Demand for Money — Transactionary and Speculative Demand; Supply of Money. Stock Market – Capital market, Stock exchanges in India, Investing Fundamentals, Risk, Analysis of the Company-Ratio Analysis, K-shape recovery, game theory, Financial & Non-Financial Data Analysis		
UNIT-V	**INDIAN ECONOMY**	9
Nature and characteristics of Indian economy, Banking - functions of Commercial banks, Functions of RBI. Globalization, Privatization, Elementary concepts like WTO, GATT, TRIPS, Monetary Policy and Fiscal Policy, IS, LM Model; Business Cycles and Stabilization; Classical Paradigm — Price and Wage Rigidities — Voluntary and Involuntary Unemployment- Introduction to individual Income Tax-and Corporate Income Tax- GST, GST Council		
	Total Contact Hours : 45	

Course Outcomes: At the end of the course the students would be able to	
●	Understand the concepts and principles of micro economics in the engineering discipline
●	Explain the behaviour of price and consumer in engineering economy
●	Describe the theory of production of production and cost of firms for economic decision making.
●	Explain the basic fundamentals of Engineering economy and stock market
●	Learn and Evaluate the Indian economy models

Text Books:	
1	Robert S. Pindyk and D.L. Rubinfeld, Microeconomics, 7th edition, Pearson Education India, 2015
2	Hal R. Varian, Intermediate Microeconomics: A Modern Approach, W W Norton & Co Inc, 8th edition, 2009
3	Paul A. Samuelson, William D. Nordhaus, Sudip Chaudhuri and Anindya Sen, Economics, 19th edition, Tata McGraw Hill, New Delhi, 2010

Reference Books(s) / Web links:	
1	Sullivan and Wicks, Engineering Economy, 14th edition, Pearson Publisher, 2011
2	R.Paneer Selvan, Engineering Economics, PHI Learning Private Limited, 2012
3	Michael R Lindeburg, Engineering Economics Analysis – An Introduction, Professional Pubns Inc, 1993
4	https://archive.nptel.ac.in/courses/110/105/110105121
5	Handbook of Statistics On Indian Economy, RBI, 1999

PO-PSO / CO	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
GE23511.1	1	1	-	-	-	2	1	-	-	-	2	2	-	-	-
GE23511.2	1	1	-	-	-	2	1	-	-	-	2	2	-	-	-
GE23511.3	1	1	-	-	-	2	1	-	-	-	2	2	-	-	-
GE23511.4	1	1	-	-	-	2	1	-	-	-	2	2	-	-	-
GE23511.5	1	1	-	-	-	2	1	-	-	-	2	2	-	-	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Theory course)	Category	L	T	P	C
ME23511	MACHINE DESIGN (Approved Design Data Book is Permitted)	PC	3	0	0	3

Objectives:	
•	To demonstrate the methods of determining steady and variable stresses in machine members.
•	To illustrate the principle involved in the design of shaft and couplings.
•	To build knowledge on the design of temporary and permanent joints.
•	To explain the design procedure of springs.
•	To outline the design steps and selection procedure involved in bearings.

UNIT-I	STEADY STRESSES AND VARIABLE STRESSES IN MACHINE MEMBERS	9
Introduction to the design process - Factors influencing machine design, Design consideration, Standards and codes. Modern design process: Digital design workflow, use of computer-aided design (CAD) - Selection of materials based on mechanical properties. Advanced materials: Focus on modern materials such as composites, high-strength alloys, and lightweight materials. - Preferred numbers, fits and tolerances –Direct, bending and torsional stress equations — Calculation of principal stresses for various load combinations, eccentric loading – Curved beams – crane hook and C frame - Factor of safety - Theories of failure – Design based on strength and stiffness – stress concentration – Design for variable loading.		
UNIT-II	**SHAFTS AND COUPLINGS**	**9**
Design of solid and hollow Shaft – for static and varying loads, for strength and rigidity - Design of coupling-Types-flange, muff and flexible rubber bushed coupling– Keys, keyways and splines - Rigid and flexible couplings.		
UNIT-III	**TEMPORARY AND PERMANENT JOINT**	**9**
Threaded fasteners - Design of bolts under static load, Design of bolts subjected to fatigue load – Design of knuckle joints, cotter joints – Design of riveted joints and welded Joints for structures - Theory of bonded joints and its applications in high strength and light weight joints.		
UNIT-IV	**SPRINGS**	**9**
Helical springs: Stresses and deflection in round wire helical springs accounting for static and variable loading, concentric springs; Design of leaf springs - stress and deflection equation, nipping; Overview of the design of helical and leaf springs in automobile suspension system.		
UNIT-V	**BEARING**	**9**
Selection of Sliding contact and rolling contact bearings – Antifriction Bearing - Reliability consideration - McKee's equation - Sommerfield Number - Raimondi & Boyd graphs - Design of hydrodynamic journal bearings – Design of sliding Contact and rolling contact bearings. Bearing damage and failure analysis.		
	Total Contact Hours : 45	

Course Outcomes: At the end of the course the students would be able to	
•	Utilize the codes in general practice and design the machine members under various loading conditions.
•	Design the Shaft and Couplings under various loading conditions.
•	Make use of the design procedure of temporary and permanent joints.
•	Interpret the design of springs.
•	Design and select the standard bearing from the catalogue.

Text Books:	
1	Bhandari V, Design of Machine Elements, 4th Edition, McGraw-Hill Book Co, 2020.
2	Joseph Shigley, Richard G. Budynas and J. Keith Nisbett, "Mechanical Engineering Design", 10th Edition, Tata McGraw-Hill, 2015.

Reference Books(s) / Web links:	
1	R.B. Patel, Design of Machine Elements, MacMillan Publishers India P Ltd., Tech-Max Educational resources, 2011.
2	Sundarajamoorthy T. V. Shanmugam. N, Machine Design, Anuradha Publications, Chennai, 2015.
3	P.C. Gope, Machine Design – Fundamental and Application, PHI Learning Private Ltd, New Delhi, 2012.
4	Alfred Hall, Halowenko, A and Laughlin, H., Machine Design, McGraw-Hill Book Co.(Schaum's Outline), 2010.
5	Robert C.Juvinall and Kurt M. Marshek, Fundamentals of Machine components Design,4th Edition, John Wileyand Sons,2011.
6	PSG Design Data Handbook, Data Book of Engineers, by PSG College of Technology, Coimbatore, 2023.
7	https:// nptel.ac.in/courses/112/105/112105125/

PO-PSO / CO	POs												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
ME23511.1	2	2	3	-	-	1	-	-	2	-	-	1	-	2	2
ME23511.2	2	2	3	-	-	1	-	-	2	-	-	1	-	2	2
ME23511.3	2	2	3	-	-	1	-	-	2	-	-	1	-	2	2
ME23511.4	2	2	3	-	-	1	-	-	2	-	-	1	-	2	2
ME23511.5	2	2	3	-	-	1	-	-	2	-	-	1	-	2	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course code	Course Title (Lab Oriented Theory Course)	Category	L	T	P	C
ME23531	**HEAT AND MASS TRANSFER**	**PC**	**3**	**0**	**2**	**4**

Objectives: The main learning objective of this course is to prepare the students	
•	To understand the mechanisms of heat transfer under steady conditions in composite systems an fins
•	To understand the concepts of natural and forced convection in internal and external flows
•	To provide knowledge about the phase change heat transfer and heat exchangers
•	To know the radiation and study the various laws of radiation, shape factor
•	To study convective mass transfer and its types and applications

Unit – I	**Conduction**	**9**
General Differential equation of Heat Conduction– Cartesian and Polar 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. Composite problems using ANSYS software.		
Unit – II	**Convection**	**9**
Free and Forced Convection - Hydrodynamic and Thermal Boundary Layer. Free and Forced Convection during external flow over Plates and Cylinders and Internal flow through tubes. Fluid flow problems using ANSYS Fluent software.		
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 - Overall Heat Transfer Coefficient – Fouling Factors - Analysis – LMTD method - NTU method.		
Unit – IV	**Radiation**	**9**
Black Body Radiation – Grey body radiation - Shape Factor – Electrical Analogy – Radiation Shield Radiation through gases.		

Unit – V	Mass Transfer		9
Basic Concepts – Diffusion Mass Transfer – Fick's Law of Diffusion – Steady state Molecular Diffusion– Convective Mass Transfer – Momentum, Heat and Mass Transfer Analogy –Convective Mass Transfer Correlations.			
	Total Contact Hours	:	**45**

Course Outcomes: Upon completion of the course students should be able to:	
•	Apply steady state heat conduction problems for composite systems and fins
•	Solve problems in natural and forced convection for internal and external flows
•	Calculate the effectiveness of heat exchanger using LMTD and NTU methods
•	Analyse radiation shape factors for various geometries
•	Demonstrate the phenomenon of diffusion and convective mass transfer.

Text Books:	
1	Yunus A. Cengel, "Heat Transfer A Practical Approach", Tata McGraw Hill, 2015.
2	Holman, J.P., "Heat and Mass Transfer", Tata McGraw Hill, 10th Edition 2017.
3	R. C. Sachdeva, "Fundamentals of Engineering Heat and Mass Transfer", New Age International Publishers, Fifth Edition 2017.
Reference Books:	
1	Frank P. Incropera and David P. Dewitt, "Fundamentals of Heat and Mass Transfer", John Wile & Sons, 2011.
2	Ghoshdastidar, P.S, "Heat Transfer", Oxford, 2012. 5. Nag, P.K., "Heat Transfer", Tata McGraw Hill, New Delhi, 2011.
3	C. P. Kothadaraman, Heat and Mass Transfer Data book, 10th Edition, 2022.
4	https://nptel.ac.in/courses/112/101/112101097/
5	https://nptel.ac.in/courses/112/108/112108149//

HEAT TRANSFER LAB EXPERIMENT

1. Thermal conductivity measurement of pipe insulation using lagged pipe apparatus
2. Determination of heat transfer coefficient under natural convection from a vertical cylinder
3. Determination of heat transfer coefficient under forced convection from a tube
4. Determination of Thermal conductivity of composite wall
5. Determination of Thermal conductivity of insulating powder
6. Determination of Stefan – Boltzmann constant
7. Determination of emissivity of a grey surface
8. Effectiveness of Parallel / counter flow heat exchanger
9. Determination of COP of a refrigeration system
10. Determination of COP of an air-conditioning system
11. Determine the thermal conductivity of lagged pipe apparatus using ANSYS Fluent software [**Beyond syllabus**]

Total Contact Hours: 30

Lab equipment required for a batch of 30 students

S. No	Name of the Equipment	Quantity Required
1	Lagged pipe apparatus setup	01
2	Natural convection from a vertical cylinder setup	01
3	Forced convection setup	01
4	Composite wall setup	01
5	Insulating powder setup	01
6	Stefan – Boltzmann setup	01
7	Emissivity setup	01
8	Parallel / counter flow heat exchanger setup	01
9	Refrigeration setup	01
10	Air-Conditioning setup	01
11	Reciprocating air compressor setup	01

PO –PSO CO	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	1	2	3
ME23531.1	3	3	2	2	1	-	2	-	1	-	-	2	-	1	2
ME23531.2	3	3	2	2	3	-	2	-	1	-	-	2	-	2	3
ME23531.3	2	3	3	1	1	1	1	-	1	-	-	1	-	2	2
ME23531.4	2	3	3	1	1	2	1	-	1	-	-	1	-	2	2
ME23531.5	2	3	3	1	1	2	2	-	1	-	-	3	-	1	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Lab Oriented Theory Course)	Category	L	T	P	C
ME23532	**METROLOGY AND MEASUREMENTS**	**PC**	**3**	**0**	**2**	**4**

Objectives:	
●	To explore the fundamentals and significance of measurement and acquire skills in using measuring instruments for precise measurements.
●	To enhance proficiency in evaluating critical parameters of assembly and transmission elements.
●	To develop proficiency in analyzing and solving problems related to limits, fits, and classifications of limit gauges.
●	To understand the principles and techniques for inspecting geometric of surfaces.
●	To learn the principles of laser technology and its advantages in precision metrology applications.

UNIT-I	**BASICS OF METROLOGY AND MEASUREMENT OF LINEAR AND ANGULAR DIMENSIONS**	**9**
Measurement – Need, Process, Role in quality control; Factors affecting measurement - SWIPE; Errors in Measurements – Types – Control. Calibration of measuring instruments, ISO standards. Linear Measuring Instruments – Vernier caliper, Micrometer, Vernier height gauge, Depth Micrometer, bore gauge, telescoping gauge; Gauge blocks – Use and precautions, Comparators – Working and advantages; Angular measuring instruments – Bevel protractor, Clinometer, Angle gauges, Precision level, Sine bar, Sine Centre, Autocollimator, Angle dekkor,		
UNIT-II	**MEASUREMENT OF ASSEMBLY &TRANSMISSION ELEMENTS**	**9**
Measurement of Screw threads – Floating carriage micrometer - Single element measurements – Pitch Diameter, Lead, Pitch. Measurement of assembly and transmission elements using tool makers microscope and profile projector. Measurement of Gears – purpose – Analytical measurement – Run out, Pitch variation, Tooth profile, Tooth Thickness- Gear tooth vernier caliper. Constant chord method and base tangent method, Lead – Functional checking – Rolling gear test. Measurement of assembly and transmission elements using tool makers microscope and profile projector.		
UNIT-III	**TOLERANCE ANALYSIS**	**9**
Tolerancing – Interchangeability, Selective assembly, Tolerance classifications and representations – Terminologies. Minimum Material Conditions and Minimum material conditions – Hole Basis and Shaft Basis systems – Problems. Limits and Fits, Problems. Classifications of limit gauges. Fundamentals of Geometric Dimensioning & Tolerancing- Conventional vs Geometric tolerance, Datum's, Design of Limit gauges, Taylor's principle, Problems. Tolerance analysis in manufacturing, Process capability, tolerance stack up, tolerance charting.		
UNIT-IV	**METROLOGY OF SURFACES**	**9**
Inspection of geometric deviations like straightness, flatness, roundness. Measurement of Surface finish – Simple problems. Functionality of surfaces, Parameters, Comparative, Stylus based and Optical Measurement techniques, Filters, Introduction to 3D surface metrology- Parameters.		
UNIT-V	**ADVANCES IN METROLOGY**	**9**
Lasers in metrology - Advantages of lasers – Laser scan micrometers; AC & DC 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 in manufacturing industries- On-line and in-process monitoring in production.		
	Total Contact Hours : 45	

List of Experiments		
1	Calibration of linear measuring instruments – Vernier caliper	
2	Calibration of linear measuring instruments – Vernier height gauge	
3	Measurement of angles using bevel protractor.	
4	Measurement of angles using sine bar.	
5	Measurement of screw thread parameters using floating carriage micrometer .	
6	Measurement of gear parameters using Gear Tooth Vernier caliper.	
7	Non-contact (Optical) measurement using Toolmaker's microscope / Profile projector.	
8	Measurement of Force.	
9	Measurement of Torque.	
10	Measurement of Surface finish using stylus-based instruments.	
	Lab Contact Hours	**30**
	Total Contact Hours	**75**

Course Outcomes: At the end of the course the students would be able to	
●	Demonstrate proficiency in calibrating measuring instruments and Analyze the functionality and advantages of measuring instruments.
●	Apply accurate measurement techniques to evaluate and optimize mechanical assemblies and transmission components.
●	Analyze and determine appropriate limits and fits for engineering components and design the limit gauges.
●	Compare and apply different surface measurement techniques and assess geometric deviations.
●	Describe the basic concepts, construction, and types of Coordinate Measuring Machines (CMMs) and machine vision systems.

Text Books:	
1	Jain R.K. "Engineering Metrology", Khanna Publishers, 25th Reprint 2020.
2	Raghavendra N.V. and Krishnamurthy. L., Engineering Metrology and Measurements, Oxford University Press, 2022.
Reference Books(s) / Web links:	
1	Gupta. I.C., "Engineering Metrology", Dhanpatrai Publications, 2021.
2	Venkateshan, S. P., "Mechanical Measurements", Second edition, John Wiley &Sons, 2020.
3	Ammar Grous, J "Applied Metrology for Manufacturing Engineering", Wiley-ISTE, 2022.
4	National Physical Laboratory Guide No. 40, No. 41, No. 42, No. 43, No. 80, No. 118, No. 130, No. 131. http://www.npl.co.uk.

PO / PSO	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
ME23532.1	2	2	1	-	-	-	-	-	3	2	-	3	-	-	2
ME23532.2	2	2	1	-	-	-	-	-	3	2	-	3	-	-	2
ME23532.3	3	3	3	-	1	-	-	-	3	2	-	3	-	-	2
ME23532.4	3	3	1	-	1	-	-	-	3	2	-	3	-	-	2
ME23532.5	2	-	-	-	2	-	-	-	3	2	-	3	-	-	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Laboratory Course)	Category	L	T	P	C
GE23521	SOFT SKILLS-II	EEC	0	0	2	1

Objectives:	
•	To help students break out of shyness.
•	To build confidence
•	To enhance English communication skills
•	To encourage students' creative thinking to help them frame their own opinions

Learning and Teaching Strategy:
The program is completely student centric where the focus is on activities led by students which include role plays, discussions, debates other games as well. These activities would be supplemented by interactive use of technology and brief trainer input.

Week	Activity Name	Description	Objective
1	The News hour	Students are made to read news articles from the English newspapers. The students also have to find words and their meaning from the article they have not come across before and share it with the group. They then use these words in sentences of their own	The aim of this activity is not only to get the students to read the newspaper but also aims at enhancing the students' vocabulary.
2	Court Case	The facilitator provides the participants the premise of a story and proceeds to convert the story into a court case. The students are required, department-wise to debate and provide their points to win the case for their clients.	The aim of the lesson is to encourage creative and out-of-the -box thinking to ensure a good debate and defense skills.
3	The ultimate weekend	The students design activities they are going to do over the weekend and they have to invite their classmates to join in the activity. The students move around the class and talk to other students and invite them.	The aim of this activity is to develop the art of conversation among students. It also aims at practicing the grammatical structures of "going to" "have to" and asking questions.
4	The Four Corners	This is a debate game that uses four corners of the classroom to get students moving. The following is written on the 4 corners of the room "Strongly Agree, Somewhat Agree, Somewhat Disagree and Strongly Disagree". The topics are then given to the class and students move to the corner that they feel best explains their opinions	This activity aims at getting students to come up with their own opinions and stand by it instead of being overshadowed by others and forcing themselves to change based on others opinions.
5	Debate	Boarding school or day school? Which is more beneficial for a student?	The aim of this activity is to encourage students to draw up feasible points on the advantages and benefits of both. And enhance their debating ability
6	Grand Master	The facilitator starts the session by keeping an individual in mind, upon which the students guess it only through "Yes or No" questions. Post few trials the students are given same opportunity to do the same with the crowd.	The aim of the lesson is designed to teach the art of questioning. It also helps to enhance the students' speaking and listening skills.
7	Debate	Does violence on the TV and Video games influence children negatively?	This activity aims at encouraging the students to debate on real life scenarios that most students spend a lot of time on.
8	Turn Tables	This is a speaking activity where the students need to speak for and against the given topics when the facilitator shouts out 'Turn Table'.	The aim of this activity is to make the participants become spontaneous and have good presence of mind.
9	Debate	Do marks define the capabilities of a student?	This debate activity aims at allowing the students to argue on this worrisome adage of marks.
10	FictionAD	The Participants are asked to create an Ad for a	The activity aims at developing

		challenging topic only using fictional characters.	their creativity and presentation skills.
11	Debate	Are social networking sites effective, or are they just a sophisticated means for stalking people?	This activity aims at refining the students debating skills on a very real life situation
12	Talent Hunt	Talent Hunt is a fun activity where the students are selected at random and supported to present any of their own skills.	The aim of this activity is designed to evoke their inner talents and break the shyness and the fear of participating in front of a crowd
	Feedback	At the end of the session in the final week (12) the trainer would provide feedback to the students on best practices for future benefits.	The aim is to do both give feedback to students as well as obtain feedback on the course from them.

Course Learning Outcome:

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

1. Be more confident
2. Speak in front of a large audience without hesitation
3. Think creatively
4. Speak impromptu
5. Communicate in English

Course Code	Course Title (Laboratory Course)	Category	L	T	P	C
ME23521	**COMPONENT MODELLING LABORATORY**	**PC**	**0**	**0**	**4**	**2**

Objectives:	
•	To apply 3D modelling techniques like extrusion and revolve to transform 2D sketches into 3D model.
•	To acquire advanced part modification techniques like cut-extrude, fillets, chamfers, to refine and enhance 3D models.
•	To apply parametric modeling techniques to create precise and functional 3D parts using sweep and loft.
•	To construct various 3D mechanical assemblies with advanced feature manipulation.
•	To evaluate and validate 3D model integrity and manufacturing feasibility.

Description of the Experiments
1. Convert 2D sketches into 3D parts by extruding them.
2. Create 3D models by revolving a 2D sketch around an axis.
3. Use cut-extrude features to create complex parts with holes and cut-outs.
4. Apply fillets and chamfers to smooth edges and corners.
5. Create complex 3D shapes by lofting between multiple profiles.
6. Sweep a profile along a path to create a 3D model.
7. 3D modelling and assembly of cotter joint.
8. 3D modelling and assembly of Flange coupling.
9. 3D modelling and assembly of Ball Bearing.
10. 3D modelling and assembly of Safety valves.
11. 3D modelling and assembly of Stuffing Box.
12. Creation of bill of materials, calculation of mass and section properties, interference check between solids.
Total Contact Hours:60
Text Book(s):
1. Faculty of Mechanical Engineering, REC Lab Manual, 2024. 2. KR Gopalakrishnan , Machine Drawing , 2017, Subhas Publications.
Reference Books(s) / Web links:
1. N D Bhatt , Machine Drawing, 2022, Charotar Publishing House.
2. https://www.udemy.com/course/fusion360-for-3d-printing/?couponCode=LEARNNOWPLANS

Course Outcomes: On successful completion of the course, students were able to	
•	Generate 3D parts from 2D sketches utilizing extrusion techniques, demonstrating advanced proficiency in 3D modeling.
•	**Construct** intricate 3D models by revolving sketches, sweeping profiles, and lofting between multiple profiles, applying complex geometric methods.
•	**Implement** precise cut-extrude features to design and refine detailed 3D parts with accurate cutouts, fillets, and chamfers.
•	**Integrate** and model standard mechanical components such as joints, couplings, and valves to showcase advanced mechanical design and assembly competency.
•	**Evaluate** and optimize 3D designs for manufacturability and functionality, applying advanced design principles to solve real-world engineering challenges

PO-PSO / CO	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
ME23521.1	3	-	-	-	3	-	-	3	2	2	-	2	3	-	2
ME23521.2	3	2	1	-	2	-	-	3	2	2	-	2	3	-	2
ME23521.3	3	-	-	-	3	-	-	3	2	2	-	2	3	-	2
ME23521.4	3	-	1	1	3	-	-	3	2	2	-	2	3	-	3
ME23521.5	3	3	1	2	3	-	-	3	2	2	-	2	3	-	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Lab equipment required for a batch of 30 students

S. No	Name of the Equipment	Quantity Required	Remarks
1	Computer Terminals/workstation	30	
2.	3D modelling software	30	
3.	A4 printer	1	
4.	Online UPS	1	
5.	Server	1	

Course Code	Course Title (Laboratory Course)	Category	L	T	P	C
ME23522	INTERNSHIP	EEC	0	0	2	1

Objectives:	
•	Will expose Technical students to the industrial environment, which cannot be simulated in the classroom and hence creating competent professionals for the industry
•	Provide possible opportunities to learn, understand and sharpen the real time technical / managerial skills required at the job.
•	Exposure to the current technological developments relevant to the subject area of training.
•	Experience gained from the 'Industrial Internship' in classroom will be used in classroom discussions.
•	Create conditions conducive to quest for knowledge and its applicability on the job.

STRATEGY:

The students individually undertake training in reputed Mechanical and Automation engineering companies for the specified duration. At the end of the training, a report on the work done will be prepared and presented. The students will be evaluated through a viva-voce examination by a team of internal staff.

Reference:

https://aicte-india.org/sites/default/files/AICTE%20Internship%20Policy.pdf

Course Outcomes: On completion of the course, the students will be able to	
ME23522.1	Construct design challenge and reframe the design challenge into design opportunity.
ME23522.2	Interview the user, and know the feelings of users to foster deep user understanding and be able to uncover the deep user insights and needs.
ME23522.3	Develop ideas and prototypes by brainstorming.
ME23522.4	Organize the user walkthrough experience to test prototype
ME23522.5	Develop smart strategies and implementation plan that will deliver/achieve the idea/solution deduced from earlier phases.

SEMESTER VI

Course Code	Course Title (Theory Course)	Category	L	T	P	C
ME23611	**ADDITIVE MANUFACTURING TECHNOLOGIES**	**PE**	**3**	**0**	**0**	**3**

Objectives:	
●	To familiarize the development of Additive Manufacturing,various business opportunities and applications.
●	To understand various software tools, techniques and file formats to create 3D models that helps in product development / prototyping requirements using AM.
●	To identify the technical aspects of liquid and solid based AM processes and their post processing requirements.
●	To interpret with the powder based process, manufacturing techniques, bio additive manufacturing processes and organ printing.
●	To relate with the basic of hybrid additive processes and rapid tooling techniques.

UNIT-I	**INTRODUCTION**	9
Need, Fundamentals of Additive and digital Manufacturing, Advantages and Applications- Comparison of Additive Manufacturing with traditional Manufacturing- Generalized Additive Manufacturing (AM) process chain-Classification of AM process and Materials used - Need for AM in product development		
UNIT-II	**REVERSE ENGINEERING AND DESIGN FOR ADDITIVE MANUFACTURING (DFAM)**	9
Introduction to Reverse Engineering: Applications, Steps in reverse Engineering and software used. Design for additive manufacturing: Digitization Techniques and Devices, Model Reconstruction, CAD model preparation, Part orientation and support generation and removal, Model slicing and software –Demo using open source software– Tool path generation - Unique Capabilities, Exploring Design Freedoms and Design Tools for AM- File formats in AM. Data Processing and Controllers.		
UNIT-III	**LIQUID AND SOLID BASED ADDITIVE MANUFACTRING PROCESSES**	9
Liquid based AM process - Stereolithography apparatus, Polyjet printing, Digital Light Processing, Solid Ground Curing (SGC); Solid Based AM process - Fused Deposition Modeling (FDM), Laminated Object Manufacturing (LOM), Wax model printing: Support Structure Removal – Surface Texture Improvement – Surface Treatments		
UNIT-IV	**POWDER BASED AND BIO ADDITIVE MANUFACTURING PROCESSES**	9
Selective Laser Sintering (SLS), Selective Laser Melting (SLM) and Electron Beam Melting (EBM), Laser Engineered Net Shaping (LENS)-Cleaning & de-powdering – Machining – Surface Coating & Infiltration: Properties of metallic and non-metallic additive manufactured surfaces, Stress induced in additive manufacturing (AM) processes-Surface roughness problem in rapid prototyping ,Technologies of metal powder production; Bio-Additive Manufacturing, Computer Aided Tissue Engineering (CATE) – Processing Steps and Case Studies. Customized Implants and Prosthesis - Materials used in bio printing- Applications and limitations		
UNIT-V	**HYBRID ADDITIVE MANUFACTURING PROCESSES AND RAPID TOOLING**	9
Hybrid Processes-Wire Arc additive Manufacturing Process, Hot Wire Deposition, Laser Metal Deposition, Multi-laser metal deposition- Sustainability in AM – Introduction to 4D and 5D printing, Smart materials used in AM Processes; Rapid Tooling- Direct tooling & Indirect Tooling methods, Applications of Rapid Tooling in Reaction Injection Molding, Vacuum Casting, RTV Silicone Rubber Molds, Spin-Casting, Cast Resin Tooling, Hydroforming and Thermoforming.		
	Total Contact Hours : 45	

Course Outcomes: At the end of the course the students would be able	
●	To familiarize the development of Additive Manufacturing, various business opportunities and applications.
●	To Understand and evaluate various software tools, techniques and file formats to create 3D models that helps in product development / prototyping requirements using AM.
●	To Interpret with Liquid and Solid based AM processes and its post processing requirements.
●	To characterize the Powder based process and stress induced in powder based processes and Bio additive Manufacturing Processes.
●	To ascertain the hybrid additive processes and rapid tooling techniques and their applications.

Text Books:	
1	Andreas Gebhardt and Jan-Steffen Hötter "Rapid Prototyping - 3d Printing And Additive Manufacturing: Principles And Applications - Fifth Edition Of Rapid Prototyping", World Scientific Publishing Co Pvt Ltd, Singapore, 2019.
2	Ian Gibson, David W. Rosen and Brent Stucker "Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing", 3rd edition, Springer., United States, 2021.

Reference Books(s) / Web links:	
1	Amit Bandyopadhyay and Susmita Bose, "Additive Manufacturing", 2nd Edition, CRC Press.,United States, 2021.
2	Andreas Gebhardt, "Understanding Additive Manufacturing: Rapid Prototyping, Rapid Manufacturing", Hanser Gardner Publication, Cincinnati., Ohio, 2011
3	Kamrani A.K. and Nasr E.A., "Engineering Design and Rapid Prototyping", Springer., United States, 2010.
4	Frank W. Liou "Rapid Prototyping and Engineering applications: A tool box for prototype development", CRC Press., United States, 2011.
5.	Milan Brandt, "Laser Additive Manufacturing: Materials, Design, Technologies, and Applications",Woodhead Publishing, United Kingdom, 2016.

CO-PO Mapping:

PO-PSO / CO	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
ME23611.1	3	-	-	-	-	1	-	-	1	1	-	2	-	1	2
ME23611.2	3	3	2	3	3	1	-	-	1	1	-	2	3	1	2
ME23611.3	3	-	-	-	-	1	-	-	1	1	-	2	-	1	2
ME23611.4	3	-	-	-	-	1	-	-	1	1	-	2	-	1	2
ME23611.5	3	-	2	2	-	1	3	-	1	1	-	2	-	1	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Theory Course)	Category	L	T	P	C
ME23612	**DESIGN OF TRANSMISSION SYSTEMS**	**PC**	**2**	**1**	**0**	**3**

Objectives: The objective of this course is to prepare the students to know the design procedure
• For flexible elements like belt, ropes and chain drives for engineering applications.
• For spur and helical gear drives for power transmission.
• For bevel and worm drives for power transmission.
• For multi speed gear box for machine tool and automotive applications.
• For clutch and brake systems for engineering applications.

UNIT-I	**DESIGN OF FLEXIBLE ELEMENTS**	**9**
Introduction to Flexible drives - Transmission of power by Belt, Rope and Chain drives – Selection of drive materials – Design of Belt drives - Flat and V Belt types - Selection of wire ropes and pulleys - Design of Chain drives and Sprockets.		
UNIT-II	**ONE DIMENSIONAL BEAM ELEMENTS**	**9**
Gear materials - Design of straight tooth spur & helical gears based on speed ratios, number of teeth, Fatigue strength, Factor of safety, strength and wear considerations. Force analysis - Tooth stresses - Dynamic effects - Design of gears using AGMA procedure involving Lewis and Buckingham equations.		
UNIT-III	**BEVEL AND WORM GEARS**	**9**
Straight bevel gear: Gear materials - Tooth terminology, tooth forces and stresses, equivalent number of teeth, estimation of dimensions of straight bevel gears. Worm Gear: Gear materials - Tooth terminology, Thermal capacity, forces and stresses, efficiency, estimation of dimensions of worm gear pair.		
UNIT-III	**GEAR BOXES**	**9**
Design of Multi speed Gear Boxes for machine tool applications - Speed selection - Geometric progression - Standard step ratio - Ray diagram, Kinematic layout - Determination of number of teeth - Types of Gear Boxes, Sliding mesh, Constant mesh, Synchro mesh gear boxes, over drive torque converters for automotive applications.		
UNIT-IV	**CLUTCHES AND BRAKES**	**9**
Friction materials – Types of clutches – Uniform pressure and uniform wear theories – Design of single and multi-		

plate clutches - Cone clutches - Centrifugal clutches – Electromagnetic clutches. Types of mechanical brakes – Design procedure – Block brakes with short and long shoe – Internal expanding shoe brakes – Band brakes – Disc brakes – Thermal considerations.			
	Total Contact Hours	**:**	**45**

Text Book(s):

1. Keith Nisbett and Richard Budynas, - Shigley's Mechanical Engineering Design:,2024 Release, Tata McGraw-Hill, ISBN10: 1265472696.
2. Bhandari V.B, Design of Machine Elements, 2020, 5th edition, Tata Mc Graw Hill.

Reference Books(s) / Web links:

3. Bernard Hamrock, Steven Schmid, Bo Jacobson, - Fundamentals of Machine Elements,3rd Edition, CRC Press Inc, 2013.
4. Sundararajamoorthy. T. V. and Shanmugam. N., - Machine Design, Anuradha Publications, Chennai, 2018.
5. Sen and Bhattacharya, - Principles of Machine Tools, New Central Book Agencies, 2nd Edition, 2009.
6. Md. Jalaludeen , Machine Design, Volume II, Design of Transmission Systems, Anuradha Publications, 2017.
7. Prabhu. T.J., "Design of Transmission Elements", Mani Offset, Chennai, 2019.
8. PSG Design Data: Data Book of Engineers, Kalaikathir Achchagam, 2020.
9. https://nptel.ac.in/courses/112/106/112106137/

Course Outcomes: On successful completion of the course, the student will be able to

- Design flexible elements like belt, ropes and chain drives for engineering applications.
- Apply to spur and helical gear drives for power transmission.
- Design bevel and worm drives for power transmission.
- Design multi speed gear box for machine tool and automotive applications.
- Design clutch and brake systems for engineering applications.

CO - PO – PSO matrices

PO-PSO / CO	POs												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
ME23611.1	3	1	1	-	-	-	-	-	1	1	-	2	2	-	1
ME23611.2	3	1	1	-	-	-	-	-	1	1	-	2	2	-	1
ME23611.3	3	1	1	-	-	-	-	-	1	1	-	2	2	-	1
ME23611.4	3	1	1	-	-	-	-	-	1	1	-	2	2	-	1
ME23611.5	3	1	1	-	-	-	-	-	1	1	-	2	2	-	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Theory Course)	Category	L	T	P	C
ME23613	FINITE ELEMENT ANALYSIS	PC	2	1	0	3

Objectives: The objective of this course is to

- Develop skills to formulate stiffness matrices and load vectors for one-dimensional spar elements.
- Equip to formulate the stiffness matrices and load vectors for one-dimensional beam elements
- Analyze heat transfer and vibration problems using one-dimensional finite element formulations.
- Perform two-dimensional finite element analysis on elasticity problems involving plane stress, plane strain and axisymmetric conditions.
- Familiarize students with isoparametric formulations and numerical integration techniques.

UNIT-I	ONE DIMENSIONAL ELEMENTS	9

Basics of Mathematical Modelling of field problems in Engineering. Basic concepts of FEM, Formulation of element stiffness matrices and load vectors: 1D linear spar and quadratic spar elements, plane truss element, treatment of boundary conditions and temperature effects; Solution of problems. Derivation of Shape functions and Stiffness matrices and force vectors for Beam element-Assembly of Matrices - Solution of problems from solid mechanics.

UNIT-II	APPLICATION OF ONE-DIMENSIONAL ELEMENT TO HEAT TRANSFER AND VIBRATION	9

Introduction to heat transfer, Derivation of matrices and vector for heat transfer. Problems on Heat transfer. Introduction of vibration analysis, Natural frequencies of longitudinal vibration and mode shapes. Transverse Natural frequencies of beams.

UNIT-III	TWO-DIMENSIONAL SCALAR ANALYSIS	9

Second Order 2D Equations involving Scalar Variable Functions - Variational formulation –Finite Element formulation — Triangular elements — Shape functions and element matrices and vectors. Application to Field Problems — Thermal problems —Quadrilateral elements — Higher Order Elements.

UNIT-IV	TWO-DIMENSIONAL VECTOR ANALYSIS	9

Equations of elasticity – Plane stress, plane strain and axisymmetric problems – Constitutive matrices and Strain displacement matrices – Stiffness matrix – Stress calculations. Introduction to plates and shell.

UNIT-V	ISOPARAMETRIC FORMULATION and NUMERICAL INTEGRATION	9

Natural co-ordinate systems – Isoparametric elements – Shape functions for isoparametric elements – One and two dimensions – Serendipity elements – Numerical integration -Introduction to non-linear FEA and coupled field analysis.

Total Contact Hours	:	45

Text Book(s):

1. Tirupathi R. Chandrupatla and Ashok D Belegunudu, Introduction to Finite Elements in Engineering, 5th Edition, 2021, Cambridge University Press.
2. Daryl L Logan, A First Course in Finite Element Method, 2016, Cengage Learning.

Reference Books(s) / Web links:

1. Bhavikatti S S , "Finite Element Analysis", 1 st Edition, New Age International, 2015
2. J N Reddy, Introduction to Finite Element Method, 2020, McGraw Hill Education.
3. David Hutton, Introduction to Finite Element Analysis, 2017, McGraw Hill Education
4. Nitin S.Gokhale, Practial Finite Element Analysis, 2020, Finite to Infinite Publisher.
5. https://archive.nptel.ac.in/courses/112/104/112104193/
6. https://nptel.ac.in/courses/112106135

Course Outcomes:

- Formulate stiffness matrices and load vectors for 1D elements and solve solid mechanics problems involving
- Analyze heat transfer problems and vibration characteristics using 1D elements.
- Develop finite element formulations for 2D scalar problems using triangular and quadrilateral elements and apply them to solve engineering problems.
- Construct constitutive and strain-displacement matrices for elasticity problems and compute stresses
- Apply isoparametric formulation and numerical integration to solve nonlinear FEA and coupled field analysis problems.

PO-PSO / CO	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
ME23613.1	3	3	2	-	1	-	-	-	-	-	-	2	1	-	1
ME23613.2	3	3	2	-	1	-	-	-	-	-	-	2	1	-	1
ME23613.3	3	3	2	-	1	-	-	-	-	-	-	2	1	-	1
ME23613.4	3	3	2	-	1	-	-	-	-	-	-	2	1	-	1
ME23613.5	3	3	2	-	1	-	-	-	-	-	-	2	1	-	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Lab Oriented Theory Course)	Category	L	T	P	C
ME23631	ROBOTICS AND CNC PROGRAMMING	PC	2	0	2	3

Objectives:	
•	To understand the fundamentals of robot anatomy, its classification and applications.
•	To infer different types of robot drive system and end effectors.
•	To understand the different types of sensors, image capturing and processing techniques being employed in robots nowadays.
•	To introduce learners to robot programming concepts, coordinate systems, and programming languages for effective robotic control and operation.
•	To equip learners with foundational knowledge and practical skills in CNC programming for turning and milling operations

UNIT-I	FUNDAMENTALS OF ROBOT	6
History of robots, Classification of robots, Present status and future trends. Basic components of robotic system; Robot - Definition - Robot Anatomy - Coordinate Systems, Work Envelope Types and Classification- Specifications-Pitch, Yaw, Roll, Joint Notations, Speed of Motion, Pay Load- Robot Parts and their Functions-Need for Robot.		
UNIT-II	**ROBOT DRIVE SYSTEMS AND END EFFECTORS**	**6**
Introduction-Types of actuators - Pneumatic Drives-Hydraulic Drives-Mechanical Drives-Electrical Drives-D.C. Servo Motors, Stepper Motors, A.C. Servo Motors-Salient Features, Applications and Comparison of all these Drives, End Effectors-Grippers-Mechanical Grippers, Pneumatic and Hydraulic- Grippers, Magnetic Grippers, Vacuum Grippers		
UNIT-III	**SENSORS**	**6**
Position sensors - Piezo Electric Sensor, LVDT, Resolvers, Optical Encoders, pneumatic Position Sensors, Range Sensors; Laser sensor, Touch Sensors, ,binary Sensors., Analog Sensors, Wrist Sensors, Robotic Compliance Sensors, Slip Sensors.		
UNIT-IV	**ROBOT PROGRAMMING**	**6**
Teach Pendant-Coordinate systems of Robot; Lead through Programming, Robot programming Languages-VAL Programming, RAPID Language and AML-Motion Commands, Sensor Commands, End Effector commands and simple Programs.		
UNIT-V	**CNC PROGRAMMING**	**6**
Fundamentals of CNC Programming - CNC codes: G-Codes , M-Codes, Basic structure of a CNC program, Linear and circular interpolation; CNC Programming for Turning – Facing, turning, thread cutting, Multiple turning; CNC Programming for Milling- Contouring, drilling, Pocketing operations. Tool path generation, Introduction to CNC simulation software. Overview of canned cycles and sub-programming.		
	Total Contact Hours : 30	

List of Experiments	
1	Determination of maximum and minimum position of links.
2	Verification of transformation (Position and orientation) with respect to gripper and world coordinate system
3	Estimation of accuracy, repeatability and resolution.
4	Robot programming and simulation for pick and place
5	Robot programming and simulation for Colour identification
6	Trajectory Control Modeling with Inverse Kinematics
7	Check for Environmental Collisions with Manipulators
8	Part Programming - CNC Milling Machine - Linear Cutting, Circular cutting, Cutter Radius Compensation, Canned Cycle Operations.
9	Part Programming - CNC Turning Machine - Straight, Taper and Radius Turning, Rough and Finish turning cycle, Thread Cutting, Drilling and Tapping Cycle.

	Lab Contact Hours	**:**	**30**
	Total Contact Hours	**:**	**60**

Course Outcomes: On Successful completion of the course, students Will be able to	
•	Understand the fundamentals of robots, their classification, and the anatomy of robotic systems.
•	Explain various robot drive systems and the design of end effectors.
•	Analyze the functionality of robotic sensors and their applications.
•	Demonstrate the use of robot programming techniques and languages.
•	Apply CNC programming principles to practical machining operations.

Text Books:	
1	Klafter R.D., Chmielewski T.A and Negin M., "Robotic Engineering - An Integrated Approach", Prentice Hall, 2003.
2	Groover M.P., "Industrial Robotics -Technology Programming and Applications", McGraw Hill, 2001.
3	Peter Smid, CNC Programming Handbook, Industrial Press, 2021

Reference Books(s) / Web links:	
1	Craig J.J., "Introduction to Robotics Mechanics and Control", Pearson Education, 2008.
2	Deb S.R., "Robotics Technology and Flexible Automation" Tata McGraw Hill Book Co., 1994.
3	Koren Y., "Robotics for Engineers", Mc Graw Hill Book Co., 1992.
4	Fu.K.S.,Gonzalz R.C. and Lee C.S.G., "Robotics Control, Sensing, Vision and Intelligence", McGraw Hill Book Co., 1987.
5.	Janakiraman P.A., "Robotics and Image Processing", Tata McGraw Hill, 1995.
6.	Rajput R.K., "Robotics and Industrial Automation", S.Chand and Company, 2008.
7.	Surender Kumar, "Industrial Robots and Computer Integrated Manufacturing", Oxford and IBH Publishing Co. Pvt. Ltd., 1991.
8.	Ken Evans, Programming of Computer Numerically Controlled Machines, Industrial Press, 2007

PO-PSO / CO	POs												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
ME23631.1	3	2	2	-	-	1	-	-	-	-	-	-	1	-	-
ME23631.2	3	2	2	-	1	-	-	-	-	-	-	-	2	-	-
ME23631.3	3	2	-	2	2	-	-	-	-	-	-	-	2	-	-
ME23631.4	3	2	-	-	3	-	-	-	1	-	-	-	2	-	-
ME23631.5	3	-	2	-	3	-	-	-	2	-	-	-	1	-	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	**Course Title (Laboratory Course)**	**Category**	**L**	**T**	**P**	**C**
GE23621	**PROBLEM SOLVING TECHNIQUES**	**EEC**	**0**	**0**	**2**	**1**

Objectives:	
•	To improve the numerical ability
•	To improve problem-solving skills.

Course topics:

S.No.	**Topics**
1	Numbers system
2	Reading comprehension
3	Data arrangements and Blood relations
4	Time and Work
5	Sentence correction
6	Coding & Decoding, Series, Analogy, Odd man out and Visual reasoning
7	Percentages, Simple interest and Compound interest

8	Sentence completion and Para-jumbles
9	Profit and Loss, Partnerships and Averages
10	Permutation, Combination and Probability
11	Data interpretation and Data sufficiency
12	Logarithms, Progressions, Geometry and Quadratic equations.
13	Time, Speed and Distance

Course Outcome:

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

1. Have mental alertness
2. Have numerical ability
3. Solve quantitative aptitude problems with more confident

Course Code	Course Title (Laboratory Course)	Category	L	T	P	C
ME23622	**SIMULATION AND ANALYSIS LABORATORY**	**PC**	**0**	**0**	**4**	**2**

Objectives: The objective of this course is to
• To familiarize students with the concepts of static structural analysis applied to various structures like stepped bars, beams, and trusses.
• To explore the stress concentration and strain behavior in different geometries such as plates, brackets, and 3D solid objects under various load conditions.
• To impart knowledge on the axial, transverse, and harmonic vibration analysis of beams and other structural components.
• To provide insights into temperature distribution and heat flux analysis in components such as fins, composite walls, and slabs
• To offer practical experience with tensile testing and stress analysis of composite materials by explicit dynamic analysis.

List of Exercises:

1. Static structural analysis of a stepped bar and taper bar.
2. Structural analysis of 2D and 3D truss.
3. Static structural analysis of beam with various support and load.
4. Study on stress concentration in plate
5. Static Structural analysis of 2D bracket.
6. Structural analysis of 3D solid object.
7. Axial vibration analysis.
8. Transverse vibration analysis.
9. Harmonic analysis of a beam.
10. Temperature distribution in a fin cooled electronic component (2D & 3D).
11. Heat flux analysis of a composite wall.
12. Transient heat transfer analysis of a rectangular slab
13. Stress analysis of two beam using contact element.
14. Tensile test of a composite plate.

Text Book(s):

1. Department of Mechanical Engineering, REC, Lab Manual.

Reference Books(s) / Web links:

1. https://www.youtube.com/watch?v=KRFeZVMrdoo
2. https://www.ansys.com/en-in/academic/learning-resources
3. https://www.solidprofessor.com/tutorials/ansys

Course Outcomes: On successful completion of the course,	
•	Perform static structural analysis on bars, trusses, and beams.
•	Analyze stress concentration in plates, brackets, and solid objects.
•	Conduct axial, transverse, and harmonic vibration analysis for beams.
•	Perform thermal analysis of temperature distribution and heat flux scenarios.
•	Analyze tensile stress and contact elements in composite structures.

CO - PO – PSO matrices

POs-PSOs	POs												PSOs		
COs	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
ME23622.1	3	3	1	1	2	1	1	1	1	1	1	1	3	1	1
ME23622.2	3	3	1	2	1	1	1	1	1	1	1	1	1	2	1
ME23622.3	3	3	1	1	2	1	1	1	1	1	1	1	3	1	1
ME23622.4	3	2	1	1	3	1	1	1	1	1	1	1	1	2	1
ME23622.5	3	1	2	3	1	1	1	1	1	1	1	1	3	1	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Laboratory Course)	Category	L	T	P	C
GE23627	DESIGN THINKING AND INNOVATION	EEC	0	0	4	2

Objectives:	
•	To understand the design thinking concepts and deep understanding of user needs and experiences.
•	To find the problem statement and To develop innovative design solutions that address identified user challenges
•	To master the process of prototyping and iterating on designs.
•	To conduct thorough market analysis and financial planning
•	To effectively communicate design concepts and findings.

Unit-I: Introduction to Design Thinking: The design thinking concepts - Different design thinking models - Details of Stanford Design thinking process: Empathize, Define, Ideate, Prototype, and Test.

Activities:

- Case studies of successful domain based Design Thinking and Innovative projects
- Group discussions on design thinking

Unit 2: Empathize and Define: User research methods (interviews, surveys, observation, contextual inquiry) - Persona development- Journey mapping – Brainstorming Defining the design problem statement

Activities:

- Conducting user interviews and surveys
- Creating user personas and journey maps
- Identifying key user needs and pain points
- Analyze the user needs and Brainstorming to define problem statement

Unit 3: Ideate and Create: Brainstorming techniques (e.g., mind mapping, SCAMPER) - Ideation tools (e.g., design thinking tools, concept sketching) - Concept generation and evaluation (e.g. Brainstorming)

Activities:

- Group brainstorming sessions to select the best idea
- Creating concept sketches and prototypes
- Evaluating ideas based on user needs and feasibility

Unit 4: Prototype and Test: Low, Medium and high level fidelity for prototyping-Usability testing -Iterative design

Activities:

- Building low-fidelity prototypes (e.g., paper prototypes)
- Conducting usability tests with users
- Iterating on designs based on feedback

Unit 5: Market Analysis and Implementation: Market research and analysis - Business model development- Financial planning-Implementation strategies

Activities:

- Conducting market research
- Developing a business model canvas
- Creating a financial projection
- Developing an implementation plan

Course Outcomes: On completion of the course, the students will be able to	
GE23627.1	Construct design challenge and reframe the design challenge into design opportunity.
GE23627.2	Interview the user, and know the feelings of users to foster deep user understanding and be able to uncover the deep user insights and needs.
GE23627.3	Develop ideas and prototypes by brainstorming.
GE23627.4	Organize the user walkthrough experience to test prototype
GE23627.5	Develop smart strategies and implementation plan that will deliver/achieve the idea/solution deduced from earlier phases.

Assessment:

- Encourage students to work on real-world design challenges based on the user needs
- Group presentations
- Quizzes and exams
- Evaluation of Project report and viva and also encourage the students for filing patent/ copyright / presenting in conference / publishing in journal

Text Book(s):	
1	Handbook of Design Thinking by Christian Müller-Roterberg, Kindle Direct Publishing, 2018**.**
2	Design Thinking – A Beginner's Perspective, by E Balagurusamy, Bindu Vijakumar, MC Graw Hill, 2024

Reference Books:	
1	Design Thinking for Entrepreneurs and Small Businesses: Putting the Power of Design to Work – by Beverly Rudkin Ingle, A press; 1st ed. Edition, 2013
2	Design Thinking: Understanding How Designers Think and Work by Nigel Cross, Bloomsbury Visual Arts; 2 edition 2023

Web links	
1	Design thinking Guide https://www.rcsc.gov.bt/wp-content/uploads/2017/07/dt-guide-book-master-copy.pdf
2	NPTEL Course on Design Thinking and Innovation By Ravi Poovaiah; https://onlinecourses.swayam2.ac.in/aic23_ge17/preview
3	IITB Design course tools and Resources https://www.dsource.in/

CO-PO-PSO Mapping

PO-PSO / CO	POs												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
GE23627.1	3	2	3	3	3	2	2	3	3	3	3	3	2	2	2
GE23627.2	3	2	3	3	3	2	2	3	3	3	3	3	2	2	2
GE23627.3	3	2	3	3	3	2	2	3	3	3	3	3	2	2	2
GE23627.4	3	2	3	3	3	2	2	3	3	3	3	3	2	2	2
GE23627.5	3	2	3	3	3	2	2	3	3	3	3	3	2	2	2

1-Slight (Low), 2- Moderate (Medium), 3- Substantial (High)

SEMESTER VII

Course Code	Course Title (Theory course)	Category	L	T	P	C
ME23711	PROCESS PLANNING AND COST ESTIMATION	PC	3	0	0	3

Objectives:	
●	To provide students with foundational knowledge about process planning and its significance in manufacturing and economics of process planning.
●	To describe the factors influencing the selection of production processes, including process and operation sequencing.
●	To emphasize the importance of costing and estimation in decision-making and resource optimization.
●	To provide in-depth knowledge of cost estimation principles for various production processes, including forging, welding, and foundry operations.
●	To develop an understanding of the procedures and calculations involved in estimating machining time for various conventional machining processes.

UNIT-I	INTRODUCTION TO PROCESS PLANNING	9
Introduction – Activities involved in process planning – Documents required for process planning - Process planning methods – Manual, Computer aided process planning – Retrieval & Generative CAPP Methods. Standardization, Simplification. Introduction to process parameters calculation - Economics of process planning – Break even analysis.		
UNIT-II	**PROCESS PLANNING ACTIVITIES**	**9**
Drawing interpretation –Material selection process and methods, Selection of Production Processes - Factors to be considered in selecting: Process Sequencing; Operation Sequencing; Process parameters Equipment & Tool Selection; Case studies in process planning -Selection of jigs and fixtures.		
UNIT-III	**COST ESTIMATION AND COST ACCOUNTING**	**9**
Aims of costing and estimation, Functions and procedure - Importance of costing and estimation, methods of costing-elements of cost estimation - Types of estimates, Estimating procedure – Estimation labor cost, material cost, and overhead cost – Ladder cost - allocation of overhead charges – Problems in cost estimation. Introduction to depreciation cost.		
UNIT-IV	**COST ESTIMATION OF CASTING, FORGING & WELDING COSTS**	**9**
Estimation of cost for various production processes - Estimation of Forging Shop– Losses inforging –Forging cost, Estimation of Welding Shop– Electric welding cost – Gas Welding cost, Estimation of Foundry Shop– Pattern cost - Casting cost. Introduction to open access software for cost estimation.		
UNIT-V	**ESTIMATION OF MACHINING TIME AND COSTS**	**9**
Estimation of Machining Time - Importance of Machine Time Calculation- Machining Time Calculation for the Conventional Machining Processes-Calculation of Machining Time and Cost for Lathe operations, Drilling, Boring, Milling and Grinding.		
	Total Contact Hours	**45**

Course Outcomes: At the end of the course the students would be able to	
●	Contrast the documents required for effective process planning and do economic analysis of process planning.
●	Recognize the drawing and make a standard and detailed process plan for a given product.
●	Estimate labour, material, and overhead costs and allocate overhead charges effectively.
●	Evaluate the cost for various production processes like casting, forging and welding processes for a given product.
●	Solve practical problems involving machining time and cost estimation, demonstrating analytical and problem-solving skills.

Text Books:	
1	Peter Scallan, Process Planning, The Design/Manufacture Interface, Butterworth Heinemann,2018.
2	Sinha B.P, "Mechanical Estimating and Costing", Tata-McGraw Hill publishing co, 2016.

Reference Books(s) / Web links:	
1	Chitale A. K., and Gupta R. C., Product Design and manufacturing, Prentice Hall of India, New Delhi, 2016.

2	Narang G.B.S. & Kumar. V, Production and Costing, Khanna Publishers, 2020.
3	Phillip F. Ostwald & Jairo Munoz, Manufacturing Processes and Systems‖, 9th Edition, Wileystudent edition, 2016.
4	Robert Creese, Adithan M. & Pabla B. S., Estimating and Costing for the Metal Manufacturing Industries, Marcel Dekker, 2019.
5	https://onlinecourses.nptel.ac.in/noc23_ce59

PO / PSO / CO	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
ME23711.1	3	2	2	2	-	-	-	-	-	-	2	2	-	2	2
ME23711.2	3	2	2	1	-	-	-	-	-	-	2	2	-	2	2
ME23711.3	3	2	2	3	-	-	-	-	-	-	2	2	-	2	2
ME23711.4	3	3	2	3	-	-	-	-	-	-	2	2	-	2	2
ME23711.5	3	3	2	3	-	-	-	-	-	-	2	2	-	2	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Theory course)	Category	L	T	P	C
ME23712	**TOTAL QUALITY MANAGEMENT**	**PC**	**3**	**0**	**0**	**3**

Objectives:	
•	To facilitate the understanding of basic quality management in engineering.
•	To summarize the various principles of TQM.
•	To be acquainted with management tools, Six Sigma and benchmarking.
•	To demonstrate the quality functions and TPM concepts.
•	To implement various quality systems and TQM in the manufacturing and service sectors.

UNIT-I	**INTRODUCTION TO TOTAL QUALITY MANAGEMENT**	**9**
Introduction - Need for quality - Evolution of quality - Definitions of quality - Dimensions of product and service quality - Basic concepts of TQM - TQM Framework - Contributions of Deming, Juran and Crosby - Barriers to TQM - Quality statements - Customer focus - Customer satisfaction, Customer complaints, Customer retention.		
UNIT-II	**TQM PRINCIPLES**	**9**
Leadership, Quality Councils - Employee involvement - Motivation, Empowerment, Team and Teamwork, Recognition and Reward, Performance appraisal - Continuous process improvement – Juran Trilogy, PDCA cycle, 5S, Kaizen, 8D methodology - Supplier partnership - Partnering, Supplier selection and certification, Supplier rating.		
UNIT-III	**TQM TOOLS AND TECHNIQUES I**	**9**
The seven traditional quality tools - New management tools - Six Sigma, Lean Six Sigma: Concepts, Methodology, applications to manufacturing, service sector including IT - Bench marking – Types, Reason to Bench mark, Bench marking process, Benefits - FMEA - Stages, Procedure, Types.		
UNIT-IV	**TQM TOOLS AND TECHNIQUES II**	**9**
Quality Circles – Cost of Quality – Quality Function Deployment (QFD) – House of Quality – QFD Process - Taguchi quality loss function – Total Productive Maintenance (TPM) – Concepts, development program, fundamental activities, benefits, POKA-YOKE, JIT Concepts.		
UNIT-V	**QUALITY MANAGEMENT SYSTEM**	**9**
Introduction—Benefits of ISO Registration—ISO 9000 Series of Standards—Sector-Specific Standards—AS 9100, TS16949 and TL 9000– ISO 9001 Requirements—Implementation—Documentation—Internal Audits—Registration - Environmental Management System: Introduction—ISO 14000 Series Standards—Concepts of ISO 14001—Requirements of ISO 14001— EMS implementation - Benefits of EMS.		
	Total Contact Hours :	**45**

Course Outcomes: At the end of this course, students can able to	
•	Understand the importance of quality in engineering.
•	Conceptualize various principles in TQM and continuous process improvement.
•	Explore the knowledge of implementing various TQM tools.
•	Demonstrate the applications of various tools like QFD and TPM for quality improvement.
•	Implement ISO-9000 & ISO-14000 in manufacturing and service sectors.

Text Book (s):	
1	Dale H.Besterfield, Carol B.Michna, Glen H. Besterfield, Mary B. Sacre, Hemant Urdhwareshe and Rashmi Urdhwareshe ―Total Quality Management, Pearson Education Asia, Revised Third Edition, Indian Reprint, Sixth Impression, 2013.
2	James R. Evans and William M. Lindsay, "The Management and Control of Quality", 8th Edition, First Indian Edition, Cengage Learning, 2012.

Reference Books(s) / Web links:	
1	Suganthi.L and Anand Samuel, "Total Quality Management", Prentice Hall (India) Pvt. Ltd., 2011.
2	Janakiraman. B and Gopal .R.K., "Total Quality Management - Text and Cases", Prentice Hall (India) Pvt. Ltd., 2006.
3	H. Lal, "Organizational Excellence through TQM", New Age Publications, 2008.
4	ISO 9001-2015 standards.

PO-PSO / CO	POs												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
ME23712.1	-	-	-	-	-	-	-	-	2	-	2	2	-	-	2
ME23712.2	-	-	-	-	-	1	-	-	3	2	1	2	-	-	2
ME23712.3	1	1	1	1	3	1	-	-	2	1	2	-	2	-	2
ME23712.4	1	1	1	1	3	1	-	-	2	-	2	-	2	-	2
ME23712.5	-	-	-	-	-	2	3	1	1	2	2	-	-	-	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Lab Oriented Theory Course)	Category	L	T	P	C
ME23731	**Artificial Intelligence for Mechanical Engineers**	**PC**	**1**	**0**	**4**	**3**

Objectives: The objective of this course is to

- This course provides mechanical engineering students with a foundational understanding of Artificial Intelligence (AI) and Machine Learning (ML), focusing on their applications in mechanical engineering.

Introduction to AIML	**15**

Introduction to AI, ML, and Data Science. Types of Learning: Supervised, Unsupervised, and Reinforcement Learning.

Importance of AI/ML in Mechanical Engineering (Optimization, Predictive Maintenance, Automation). Supervised Learning: Linear Regression, Decision Trees, Support Vector Machines. Unsupervised Learning: K-means clustering, Principal Component Analysis (PCA). Introduction to Artificial Neural Networks (ANNs) and Deep Learning. Activation functions, forward and backward propagation.

List of Exercises: **60**

15. Predicting mechanical properties using Simple regression models.
16. Predicting mechanical properties using linear regression models.
17. K-means clustering for grouping mechanical components based on performance.
18. Decision tree for predictive maintenance in machinery.
19. Fault detection in mechanical system using deep learning.
20. Failure prediction of mechanical component using deep learning.
21. Optimizing the design of a mechanical component using AI-based tools.
22. Microstructure property correlation using Machine learning.

Total Contact Hours: 75

Text Book(s):
3. Dinesh C. Verma, Artificial Intelligence and Machine Learning for Engineers. 4. Sebastian Raschka and Vahid Mirjalili, Python Machine Learning: Machine Learning and Deep Learning with Python, scikit-learn, and TensorFlow 2
Reference Books(s) / Web links:
1. Gebrail Bekda , Sinan Melih Nigdeli , and Melda Yücel , Artificial Intelligence and Machine Learning Applications in Civil, Mechanical, and Industrial Engineering (Advances in Computational Intelligence and Robotics),2019, **Business Science Reference**
2. https://onlinecourses.nptel.ac.in/noc22_cs56/preview
3. https://onlinecourses.nptel.ac.in/noc24_ce107/preview

Course Outcomes: On successful completion of the course, students will	
•	Apply supervised learning techniques, such as linear regression and decision trees, to predict mechanical properties and optimize system performance in mechanical engineering
•	Analyze mechanical engineering data using unsupervised learning methods like K-means clustering and PCA to identify patterns and group components based on performance characteristics
•	Demonstrate the ability to implement artificial neural networks (ANNs) and deep learning techniques for fault detection and failure prediction in mechanical systems.
•	Utilize AI/ML tools for predictive maintenance and design optimization in mechanical components, enhancing the efficiency and reliability of engineering systems
•	Correlate material microstructure properties with performance using machine learning techniques to improve the design and analysis of mechanical components.

CO - PO – PSO matrices

PO / PSO	POs												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
ME23731.1	3	3	2	3	3	2	1	1	1	2	2	2	3	3	1
ME23731.2	3	3	2	2	3	2	1	1	1	2	2	2	3	3	3
ME23731.3	3	3	3	3	3	3	2	1	1	2	2	2	3	3	2
ME23731.4	3	3	3	3	3	3	2	1	1	2	2	2	3	3	3
ME23731.5	3	3	3	3	3	3	2	1	1	2	2	2	3	3	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	**Course Title (Lab Oriented Theory Course)**	**Category**	**L**	**T**	**P**	**C**
ME23732	**MECHATRONICS**	**PC**	**3**	**0**	**2**	**4**

Objectives:	
●	To Select the sensors to develop mechatronics systems based on applications.
●	To explain the architecture and timing diagram of microprocessor, Arduino, Raspberry Pi and also interpret and develop programs
●	To Design appropriate interfacing circuits to connect I/O devices with microprocessor
●	To Apply PLC and SCADA system as a controller in mechatronics system.
●	To Design and develop the apt mechatronics system for an application

UNIT-I	**INTRODUCTION AND SENSORS**	**9**
Introduction to Mechatronics – Systems – Concepts of Mechatronics approach - Need for Mechatronics – Emerging areas of Mechatronics – Classification of Mechatronics. Sensors and Transducers: Static and Dynamic Characteristics of Sensor, Potentiometers – LVDT – Capacitance Sensors – Strain Gauges – Eddy Current Sensor – Hall Effect Sensor –Temperature Sensors – Light Sensors – Bio & Nanosensors – Selection of Sensors – Application of Sensors in Healthcare, Agriculture, Manufacturing, Chemical Industries		
UNIT-II	**8085 MICROPROCESSORS**	**9**
Introduction – Architecture of 8085 – Pin Configuration- Addressing Modes – Instruction set, Timing diagram of 8085 – Concepts of 8051 microcontroller – Block diagram – Introduction to Arduino and Raspberry Pi – Applications – Case Studies		

UNIT-III	PROGRAMMABLE PERIPHERAL INTERFACE	9
Introduction – Architecture of 8255, Keyboard Interfacing, LED display – Interfacing, ADC and DAC Interface, Temperature Control – Stepper Motor Control – Traffic Control Interface		
UNIT-IV	**PROGRAMMABLE LOGIC CONTROLLER & SCADA**	**9**
Introduction – Architecture – Input / Output Processing – Programming – Mnemonics - Timers, Counters, Shift Registers and Internal relays – Data Handling – Selection of PLC – Introduction to SCADA - SCADA System Components – Functions – RTU Technology – Applications – Case Studies		
UNIT-V	**ACTUATORS AND MECHATRONICS SYSTEM DESIGN**	**9**
Types of Stepper and Servo motors – Construction – Working Principle – Characteristics, Stages of Mechatronics Design Process – Comparison of Traditional and Mechatronics Design Concepts – Case studies of Mechatronics Systems – Pick and Place Robot – Engine Management system – Automatic Car Park Barrier – Air Craft System – Medical Mechatronics –IoT based Case studies		
	Total Contact Hours : 45	

Course Outcomes: At the end of the course the students would be able to	
●	Select sensors to develop mechatronics systems based on the applications
●	Explain the architecture and timing diagram of microprocessor, Arduino, Raspberry Pi and also interpret and develop programs
●	Design appropriate interfacing circuits to connect I/O devices with microprocessor
●	Apply PLC and SCADA system as a controller in mechatronics system.
●	Design and develop the apt mechatronics system for an application

List of Experiments		
1	Assembly language programming of 8085 – Addition – Subtraction – Multiplication – Division – Sorting Code Conversion.	
2	Stepper motor interface.	
3	Traffic light interface.	
4	Speed control of DC motor	
5	Study of various types of transducers	
6	Study of hydraulic, pneumatic and electro-pneumatic circuits	
7	Modeling and analysis of basic hydraulic, pneumatic and electrical circuits using software.	
8	Study of PLC and its applications	
9	Study of image processing technique	
	Total Contact Hours:	**30**

Text Books:	
1	W. Bolton, “Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering”, Pearson Education, 7th Edition, 2018
2	Ramesh S Gaonkar, “Microprocessor Architecture, Programming, and Applications with the 8085”, Penram International Publishing Private Limited, 6th Edition, 2013

Reference Books(s) / Web links:	
1	Bradley D.A., Dawson D., Buru N.C. and Loader A.J., “Mechatronics”, Chapman and Hall, 1993
2	Davis G.Alciatore and Michael B.Histand, “Introduction to Mechatronics and Measurement systems”, McGraw Hill Education, 2011
3	Nitaigour Premchand Mahalik, “Mechatronics Principles, Concepts and Applications”, McGraw Hill Education, 2015
4	Smaili.A and Mrad.F, “Mechatronics Integrated Technologies for Intelligent Machines”, Oxford University Press, 2007
5	Siamak Najarian“ Mechatronics in Medicine – A Bio medical engg approach" , McGraw – Hill Education , 2011.
6	https://archive.nptel.ac.in/courses/112/107/112107298
7	https://onlinecourses.nptel.ac.in/noc21ee32

PO-PSO / CO	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
ME23732.1	3	1	-	-	-	-	-	-	-	-	-	-	2	-	-
ME23732.2	3	1	1	-	2	-	-	-	-	-	-	2	2	2	1
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ME23732.4	3	1	1	1	2	-	-	-	-	-	-	2	2	2	1
ME23732.5	2	2	3	2	2	1	1	-	-	-	-	2	2	-	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course code	Course Title (Laboratory Course)	Category	L	T	P	C
ME23721	**PROJECT WORK PHASE – I**	**EEC**	**0**	**0**	**4**	**2**

Objectives:	
•	To apply engineering knowledge in practical problem solving.
•	To foster innovation in design of products, processes or systems.
•	To develop creative thinking in finding viable solutions to engineering problems.
•	To evoke the innovation and invention skills in a student
•	To address societal problems and developing indigenous technologies.

Zeroth Review			**7**
Literature study/survey of published literature on the assigned topic and Formulation of objectives			
First Review			**8**
Formulation of hypothesis/ design/ methodology and Formulation of work plan and task allocation.			
Second Review			**8**
Block level design documentation and Seeking project funds from various agencies			
Third Review			**7**
Preliminary Analysis/Modelling/Simulation/Experiment/Design/Feasibility study and Preparation of Phase 1 report			
	Total Contact Hours	:	**30**

S.NO	Description	Marks
1	Review –I	10
2	Review – II	15
3	Review-III	15

Course Outcomes: Upon completion of the course students should be able to:	
•	Apply engineering knowledge in practical problem solving.
•	Foster innovation in design of products, processes or systems.
•	Develop creative thinking in finding viable solutions to engineering problems.
•	Evoke the innovation and invention skills in a student.
•	Address societal problems and developing indigenous technologies.

References:
Google Scholar: https://scholar.google.com/

COs	PO/PSO	POs												PSOs		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
ME23721.1		2	2	2	1	2	2	2	1	2	1	1	1	1	2	2
ME23721.2		2	2	2		1	3	3	1	-	1	1	-	-	1	1
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ME23721.4		-	-	-	-	-	-	-	2	-	-	3	2	2	3	2
ME23721.5		-	-	-	-	-	-	2	-	-	2	2	3	1	1	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course code	Course Title (Laboratory Course)	Category	L	T	P	C
ME23722	**COMPREHENSION**	**EEC**	**0**	**0**	**2**	**1**

Objectives:	
•	To understand basis of thermodynamics concepts and pyschrometric process
•	To know the working of various gas power cycles and their air standard efficiencies in comparison with internal combustion engine
•	To understand the concepts in metal cutting and moulding process
•	To understand the principle involved in the design of shaft and couplings , basic concepts of mechanisms and construct the velocity, and acceleration diagram of mechanisms and cam mechanism, gears and gear trains
•	To impart knowledge on the structure, properties, treatment, testing and applications of metals and non-metallic materials so as to identify and select suitable materials for various engineering applications.

Unit – I	**Basis of thermodynamic process and psychrometry**	**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. 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. Ideal gases undergoing different processes - principle of increase in entropy. Applications of II Law. High- and low-grade energy. Availability and Irreversibility for open and closed system processes - I and II law Efficiency. 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. Application of I and II law for pure substances. Ideal and actual Rankine cycles, Cycle Improvement Methods – Reheat and Regenerative cycles, Economiser, preheater, Binary and Combined cycles. Psychrometric process – adiabatic saturation, sensible heating and cooling, humidification, dehumidification, evaporative cooling and adiabatic mixing. Simple Applications		
Unit – II	**Gas power cycles and Internal combustion engine**	**9**
Otto, Diesel, Dual, Brayton cycles, Calculation of mean effective pressure, and air standard efficiency on cycles, Calculation of mean effective pressure, and air standard efficiency. Classification - Components and their function. Valve timing diagram and port timing diagram - actual and theoretical p-V diagram of four stroke and two stroke engines. Simple and complete Carburettor. MPFI, Diesel pump and injector system. Battery and Magneto Ignition System - Principles of Combustion and knocking in SI and CI Engines. Lubrication and Cooling systems. Performance calculation. Refrigerants - Vapour compression refrigeration cycle- super heat, sub cooling – Performance calculations - working principle of vapour absorption system, Ammonia –Water, Lithium bromide – water systems (Description only). Air conditioning system - Processes, Types and Working Principle - Concept of RSHF, GSHF, ESHF- Cooling Load calculations.		
Unit – III	**Theory of metal cutting and moulding process**	**9**
Mechanics of chip formation, , forces in machining, Merchant‘s Force diagram, 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. Sand Casting: Sand Mould – Type of patterns - Pattern Materials – Pattern allowances –Moulding sand Properties and testing – Cores –Types and applications – Moulding machines– Types and applications; Melting furnaces: Blast and Cupola Furnaces; Principle of special casting processes: Shell - investment – Ceramic mould – Pressure die casting - Centrifugal Casting – Continuous casting, Vacuum casting- CO_2 process – Stir casting; Defects in Sand casting.		

Unit – IV	Design of shaft, coupling, keys, cam and follower mechanism	9
Design of solid and hollow Shaft –For Static and Varying Loads, For Strength and Rigidity-Design of Coupling-Types- Flange, Muff and Flexible Rubber Bushed Coupling– Keys, keyways and splines - Rigid and flexible couplings. 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. 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. Introduction to simulation software. 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 – V	**Engineering Materials and Metallurgy and testing procedure**	**9**
Constitution of alloys – Solid solutions, substitutional and interstitial – phase diagrams, Isomorphous, eutectic, eutectoid, peritectic, and peritectoid reactions, Iron – carbon equilibrium diagram. Classification of steel and cast Iron microstructure, properties and application. Definition – Full annealing, stress relief, recrystallization and spheroidising – normalising, hardening and Tempering of steel. Isothermal transformation diagrams – cooling curves superimposed on I.T. diagram CCR – Hardenability, Jominy end quench test – Austempering, martempering – case hardening, carburizing, Nitriding, cyaniding, carbonitriding – Flame and Induction hardening –Vacuum and Plasma hardening. Mechanisms of plastic deformation, slip and twinning – Types of fracture – Testing of materials under tension, compression and shear loads – Hardness tests (Brinell, Vickers Rockwell and Shore), hardness tests, Nano Indentation test, Impact test- lzod and Charpy, fatigue and creep failure mechanisms.		
	Total Contact Hours :	**45**

Course Outcomes: Upon completion of the course students should be able to:	
•	Evaluate the first law of thermodynamics and can apply it to closed and open systems to calculate specified parameters such as work, heat transfer, internal energy, mass flow rate and enthalpy, second law of thermodynamics and can apply it to closed and open systems to calculate specified parameters such as work, heat transfer, or entropy.
•	Integrate the laws and concepts of thermodynamics into the analysis of gas power cycles. Explain the working of internal combustion engines and analyse their performance.
•	Apply the basic principles in material removal processes and importance of metal cutting parameters.
•	Construct the velocity and acceleration diagrams for a given mechanism and also ability to design and analyse the cam mechanisms.
•	Construct the phase diagram and using of iron-iron carbide phase diagram for microstructure formation and applications of the various testing procedures and failure mechanism in engineering field.

Text Books:
1. Kalpakjian. S, ―Manufacturing Engineering and Technology‖, Pearson Education India,Third Edition, 2009.
2. Rattan, S.S, ―Theory of Machines, McGraw-Hill Education Pvt. Ltd., 5th edition, 2019.
3. Rajput. R. K., ―Thermal Engineering, 10th Edition, Laxmi Publications, 2018.
4. Kenneth G.Budinski and Michael K. Budinski, ―Engineering Materials, Pearson 2009.
Reference Books:
1. Amitabha Ghosh and Asok Kumar Mallik, ―Theory of Mechanisms and Machines, Affiliated East-West Pvt. Ltd. 3rd edition, 1988.
2. Ganesan V. Internal Combustion Engines, Third Edition, Tata Mcgraw-Hill 2007
3. Kothandaraman.C.P. Domkundwar. S,Domkundwar. A.V., ―A course in thermal Engineering", Fifth Edition, Dhanpat Rai & sons , 2004
4. Williams D Callister, ―Material Science and Engineering‖ Wiley India Pvt Ltd, Revised Indian edition 2007
5. Geofrey Boothroyd, Winston A.Knight―Fundamentals of Machining and Machine Tools, Taylo & Francis, CRC press , 2006

COs	PO/PSO	POs												PSOs		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
ME23722.1		-	-	-	1	-	-	-	-	-	3	-	-	-	-	-
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ME23722.4		-	-	-	2	-	-	-	-	1	3	-	-	-	-	-
ME23722.5		-	-	-	1	-	-	-	-	1	3	-	-	-	-	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

SEMESTER VIII

Course code	Course Title (Laboratory Course)	Category	L	T	P	C
ME23821	**PROJECT WORK PHASE II**	**EEC**	**0**	**0**	**16**	**8**

Objectives:	
•	To develop the ability to solve a specific problem right from its identification and literature review till the successful solution of the same.
•	To train the students in preparing project reports and to face reviews and viva voce examination.

The students in a group of 2 to 3 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 project work including Literature survey/Methodology to the satisfaction of the supervisor. 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. 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: 240 PERIODS

Scheme for Internal Evaluation

Sl.No	Description Marks	Review
1	Review – I	10
2	Review – II	15
3	Review – III	15

Course Outcomes: Upon completion of the course students should be able to:	
•	Execute the proposed plan and identify and overcome the bottlenecks during each stage.
•	Position to take up any challenging practical problems and find solution by formulating proper methodology.
•	Students will obtain a hands-on experience in converting a small novel idea / technique into a working model / prototype involving multi-disciplinary skills and / or knowledge and working in at team.
•	Interpret the outcome of their project.
•	Students will take on the challenges of teamwork, prepare a presentation in a professional manner, and document all aspects of design work.

COs	PO/PSO	POs												PSOs		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
ME23821.1		-	3	3	3	-	-	-	-	-	-	-	-	2	-	-
ME23821.2		3	-	3	3	3	-	-	-	-	-	-	-	3	3	1
ME23821.3		3	3	3	3	3	1	1	-	-	-	-	-	2	2	1
ME23821.4		-	-	-	-	-	1	2	1	1	3	3	3	-	-	2
ME23821.5		-	-	-	-	-	-	-	-	2	3	-	2	-	-	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

PROFESSIONAL ELECTIVES / VERTICALS

VERTICAL 1 – COMPUTATIONAL ENGINEERING

Course code	Course Title (Theory Course)	Category	L	T	P	C
ME23A11	MACHINE LEARNING FOR INTELLIGENT SYSTEMS	PE	3	0	0	3

Objectives:	
•	To introduce basic machine learning techniques such as regression, classification
•	To learn about introduction of clustering, types and segmentation methods
•	To learn about introduction of clustering, types and segmentation methods
•	To learn about basics of neural networks and neuro fuzzy networks.
•	To learn about recurrent neural networks and Reinforcement learning

Unit – I	Introduction To Machine Learning	9
Philosophy of learning in computers, Overview of different forms of learning, Classifications vs. Regression, Evaluation metrics and loss functions in Classification, Evaluation metrics and loss Functions in Regression, Applications of AI in Robotics.		
Unit – II	**Clustering And Segmentation Methods**	**9**
Introduction to clustering, Types of Clustering, Agglomerative clustering, K-means clustering, Mean Shift clustering, K-means clustering application study, Introduction to recognition, K- nearest neighbor algorithm, KNN Application case study, Principal component analysis (PCA), PCA Application case study in Feature Selection for Robot Guidance.		
Unit – III	**Fuzzy Logic**	**9**
Introduction to Fuzzy Sets, Classical and Fuzzy Sets, Overview of Classical Sets, Membership Function, Fuzzy rule generation, Fuzzy rule generation, Operations on Fuzzy Sets, Numerical examples, Fuzzy Arithmetic, Numerical examples, Fuzzy Logic, Fuzzification, Fuzzy Sets, Defuzzification, Application Case Study of Fuzzy Logic for Robotics Application.		
Unit – IV	**Neural Networks**	**9**
Mathematical Models of Neurons, ANN architecture, Learning rules, Multi-layer Perceptron‘s, Back propagation, Introduction of Neuro-Fuzzy Systems, Architecture of Neuro Fuzzy Networks, Application Case Study of Neural Networks in Robotics.		
Unit – V	**RNN And Reinforcement Learning**	**9**
Unfolding Computational Graphs, Recurrent neural networks, Application Case Study of recurrent networks in Robotics, Reinforcement learning, Examples for reinforcement learning, Markov decision process, Major components of RL, Q-learning. Application Case Study of reinforcement learning in Robotics.		
	Total Contact Hours :	**45**

Course Outcomes: Upon completion of the course students should be able to:	
•	Understand basic machine learning techniques such as regression, classification
•	Understand about clustering and segmentation
•	Model a fuzzy logic system with Fuzzification and Defuzzification
•	Understand the concepts of neural networks and neuro fuzzy networks.
•	Gain knowledge on Reinforcement learning

S. No	Text Books:
1.	Micheal Negnevitsky, Artificial Intelligence: A Guide to Intelligent Systems, 3rd Edition, 2001.
2.	Machine Learning. Tom Mitchell. First Edition, McGraw- Hill, 1997
S. No	**Reference Books:**
1.	Bruno Siciliano, Oussama Khatib, ―Handbook of Robotics, 2016 2nd Edition, Springer.
2.	Simon Haykin, ―Neural Networks and Learning Machines: A Comprehensive Foundation Third Edition, Pearson, Delhi 2016.
3.	Timothy J Ross, ―Fuzzy Logic with Engineering Applications, 4th Edition, Chichester, 2010.
4.	https://nptel.ac.in/courses/106106202
5.	https://nptel.ac.in/courses/108104049

COs / PO/PSO	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
ME23A11.1	3	2	3	2	1	-	-	-	-	-	1	3	2	-	1
ME23A11.2	3	2	3	2	1	-	-	-	-	-	1	3	-	-	2
ME23A11.3	3	2	3	2	1	-	-	-	-	-	1	3	2	2	3
ME23A11.4	2	2	3	2	1	-	-	-	-	-	1	3	2	2	3
ME23A11.5	3	2	3	2	1	-	-	-	-	-	1	3	1	2	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course code	Course Title (Theory Course)	Category	L	T	P	C
ME23A12	CAD and CAE	PE	3	0	0	3

Objectives:	
•	Applying the fundamental concepts of computer graphics and its tools in a generic framework.
•	Creating and manipulating geometric models using curves, surfaces, and solids.
•	Applying concept of 3D modeling, visual realism, and CAD standard practices in engineering design
•	Developing mathematical models for Boundary Value Problems and their numerical solution.
•	Formulating solution techniques to solve non-linear problems

UNIT-I	FUNDAMENTALS OF COMPUTER GRAPHICS	9

Design process - Computer Aided Design – Computer graphics – co-ordinate systems- 2D and 3D transformations - Graphic primitives (point, line, circle drawing algorithms) - Clipping- viewing transformation. Standards for computer graphics

UNIT-II	GEOMETRIC MODELING	9

Representation of curves - Hermite cubic spline curve, Bezier curve, B-spline curves, Surface Modeling – Surface Entities, Representation of Surface, Bezier Surface, B-Spline Surface and Coons Surface. Solid Modeling - Solid Entities, Solid Representation, Boundary Representation (B- Rep), Sweeps Representation, Constructive Solid Geometry (CSG).

UNIT-III	VISUAL REALISM and CAD STANDARDS	9

Need for hidden surface removal, The Depth - Buffer Algorithm, Properties that help in reducing efforts, Scan Line coherence algorithm, Span - Coherence algorithm, Area-Coherence algorithms, Warnock's Algorithm, Priority Algorithms– shading – coloring – computer animation. Standards for computer graphics- Graphical Kernel System (GKS) - standards for exchange images Open Graphics Library (OpenGL) - Data exchange standards - IGES, STEP, CALS etc.

UNIT-IV	FINITE ELEMENT ANALYSIS	9

Historical Background – Weighted Residual Methods - Basic Concept of FEM – Variational. Formulation of Boundary Value Problems – Ritz Method – Finite Element Modelling – Element Equations – Linear and Higher order Shape functions – Bar, Beam Elements –Applications to Heat Transfer problems.

UNIT-V	NON-LINEAR ANALYSIS	9

Introduction to Non-linear problems - some solution techniques- computational procedure- material non-linearity- Plasticity and visco-plasticity, stress stiffening, contact interfaces- problems of gaps and contact - geometric non-linearity - modeling considerations - Free and Mapped meshing –Mesh quality- Error estimate- Introduction to Analysis Software.

	Total Contact Hours	:	45

Course Outcomes: At the end of the course, the students would be able to	
•	Discuss the fundamental concepts of computer graphics and its tools in a generic framework.
•	Create and manipulate geometric models using curves, surfaces and solids.
•	Discuss concept of 3D modeling, visual realism and standard CAD practices in engineering design.
•	Develop the mathematical models for one dimensional finite element problems and their numerical solutions.
•	Formulate solution techniques to solve non-linear problems.

Text Books:	
1	Ibrahim Zeid ―Mastering CAD CAM‖ Tata McGraw-Hill Publishing Co.2007
2	Seshu.P, ―Textbook of Finite Element Analysis‖, PHI Learning Pvt. Ltd., NewDelhi, 2012.

Reference Books(s) / Web links:	
1	William M Neumann and Robert F.Sproul ―Principles of Computer Graphics‖, McGraw Hill Book Co. Singapore, 1989.
2	Donald Hearn and M. Pauline Baker ―Computer Graphics‖'. Prentice Hall, Inc, 1992.
3	Foley, Wan Dam, Feiner and Hughes – ―Computer graphics principles & practice‖, Pearson Education - 2003
4	Reddy,J.N. ―Introduction to the Finite Element Method‖, 4thEdition, Tata McGrawHill,2018.

COs / PO/PSO	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
ME23A12.1	1	1	1	1	1	2	1	3	2	2	1	2	2	1	1
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ME23A12.4	3	3	2	2	2	1	3	2	3	1	1	1	2	1	1
ME23A12.5	3	3	2	2	2	1	3	2	3	1	1	1	2	1	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course code	Course Title (Theory course)	Category	L	T	P	C
ME23A13	**NUMERICAL HEAT TRANSFER**	**PE**	**3**	**0**	**0**	**3**

Objectives:	
1	To analyse mathematical and computational methods for fluid flow and heat transfer simulations
2	To use the Nature of Numerical Methods and Methods of Deriving the Discretization Equations
3	To assess the Conduction flow analysis
4	To assess the flow of Convection and Diffusion flow analysis
5	To assess the flow parameters in internal and external flows

Unit – I	**Mathematical Description of Physical Phenomena**	**9**
Governing Differential Equation – Meaning of Differential Equation, Conservation of Chemical Species, The Energy Equation, A Momentum Equation, and The Time -Average Equation for Turbulent -Flow, The General Differential Equations. Nature of Coordinates – Independent variables, Proper choice of coordinates, one-way and two-way coordinates problem.		
Unit – II	**Discretization Methods**	**9**
The Nature of Numerical Methods – The Task, The Discretization concept, The structure of Discretization Equation. Methods of Deriving the Discretization Equations- Taylor Series Formulation, Variation Formulation , Method of Weighted Residuals, Control volume Formulation and examples		
Unit – III	**Heat Conduction**	**9**
Steady one-dimensional conductions, The Basic Equations, The Grid Spacing, The interface Conductivity, Nonlinearity, Source-term Linearization, Boundary Conditions. Unsteady oneDimensional Conduction- The General Discretization‘s Equation, Explicit, Crank-Nicolson and Fully Implicit Schemes. Two and Three Dimensional Situations, Geometric considerations.		
Unit – IV	**Convection and Diffusion**	**9**
Steady One-dimensional convection and Diffusion – Upwind scheme, The exact solution, The Exponential Scheme, Hybrid scheme. Discretization Equation for Two Dimensions, Discretization Equation for Three Dimensions, One way space coordinate and False Diffusion.		
Unit – V	**Calculation of the Flow Field**	**9**
Need for a special procedure, Representation of the Pressure-Gradient Term and Continuity Equation. The Momentum Equation, The Pressure and Velocity Corrections, The SIMPLE Algorithm, The SIMPLER Algorithm and PISO Algorithms, an open source software can be used for flow problems.		
	Total Contact Hours :	**45**

Course Outcomes: Upon completion of the course students should be able to:	
1	Derive and apply the governing equations and boundary conditions for Fluid dynamics
2	Analyse Discretization concept and Discretization Equations
3	Analyse Finite difference and Finite volume method for Conduction problems
4	Analyse Finite difference and Finite volume method for Convection and Diffusion problems
5	Analyse Flow field problems

Text Books:	
1	Patankar, S.V. ―Numerical Heat Transfer and Fluid Flow, Hemisphere Publishing Corporation, 2004.
2	P. S. Ghoshdastidar, Computer Simulation of Flow and heat transfer, Tata McGraw Hill Publications, New Delhi.
3	Suhas V. Patankar, Numerical Heat Transfer and Fluid Flow, Tata McGraw Hill Book Company 2018.
4	Varsteeg, Malalasekera, An introduction to Computational Fluid Dynamics The finite volume method, Pearson Prentice hall, 1995.
Reference Books:	
1	Chung, T.J. ―Computational Fluid Dynamics, Cambridge University, Press, 2002
2	Fletcher, C. A. J., ―Computational Techniques for Fluid Dynamics, Springer Verlag, 2011
3	Hyoung Woo Oh, ―Applied Computational Fluid Dynamics, InTech Publishers, 2012
4	John F Wendt ―Computational Fluid Dynamics‖ Springer, 2012.

COs / PO/PSO	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
ME23A13.1	3	2	3	2	1	1	1	-	-	-	-	1	3	2	3
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ME23A13.4	3	2	3	2	2	1	1	-	-	-	-	1	3	2	3
ME23A13.5	3	2	3	2	2	1	1	-	-	-	-	1	3	2	3

Course code	Course Title (Theory Course)	Category	L	T	P	C
ME23A14	**THEORY ON COMPUTATION AND VISUALIZATION**	**PE**	**3**	**0**	**0**	**3**

Objectives:	
•	To develop a comprehensive understanding of finite automata.
•	To Master the concept of regular expressions
•	To Understand the Chomsky hierarchy, explore context-free grammars and languages
•	To Acquire a foundational understanding of data visualization
•	To develop proficiency in visualizing spatial, geospatial, and multivariate data using various techniques.

Unit – I	**Automata And Regular Expression**	**9**
Need for automata theory - Introduction to formal proof – Finite Automata (FA) – Deterministic Finite Automata (DFA) – Non-deterministic Finite Automata (NFA) – Equivalence between NFA and DFA – Finite Automata with Epsilon transitions – Equivalence of NFA and DFA Equivalence of NFAs with and without ε-moves- Conversion of NFA into DFA – Minimization of DFAs		
Unit – II	**Regular Expressions And Languages**	**9**
Regular expression – Regular Languages- Equivalence of Finite Automata and regular expressions – Proving languages to be not regular (Pumping Lemma) – Closure properties of regular languages.		
Unit – III	**Context Free Grammar And Push Down Automata**	**9**
Types of Grammar - Chomsky hierarchy of languages -Context-Free Grammar (CFG) and Languages – Derivations and Parse trees – Ambiguity in grammars and languages – Push Down Automata (PDA): Definition – Moves - Instantaneous descriptions -Languages of pushdown automata – Equivalence of pushdown automata and CFG-CFG to PDA-PDA to CFG – Deterministic Pushdown Automata.		
Unit – IV	**Foundations For Visualization**	**9**
Visualization stages - Semiology of Graphical Symbols - The Eight Visual Variables – Historical Perspective - Taxonomies - Experimental Semiotics based on Perception Gibson's Affordance theory – A Model of Perceptual Processing.		
Unit – V	**Visualization Techniques**	**9**
Spatial Data: One-Dimensional Data - Two-Dimensional Data – Three Dimensional Data - Dynamic Data - Combining Techniques. Geospatial Data : Visualizing Spatial Data - Visualization of Point Data -Visualization of Line Data - Visualization of Area Data – Other Issues in Geospatial Data Visualization Multivariate Data : Point-Based Techniques – Line Based Techniques - Region-Based Techniques - Combinations of Techniques – Trees Displaying Hierarchical Structures – Graphics and Networks- Displaying Arbitrary Graphs/Networks.		
	Total Contact Hours :	**45**

Course Outcomes: Upon completion of the course students should be able to:	
•	Analyse a given language and design an appropriate finite automaton
•	Formulate regular expressions for specific languages and prove the equivalence between finite automata and regular expressions.
•	classify grammars based on Chomsky's hierarchy, generate languages using context-free grammars
•	Capable of designing effective visualizations and appreciating the historical development of visualization techniques.
•	Apply appropriate visualization techniques to represent different types of data effectively

S. No	**Text Books:**
1	Hopcroft J.E., Motwani R. & Ullman J.D., "Introduction to Automata Theory, Languages and Computations", 3rd Edition, Pearson Education, 2008.
2	John C Martin, "Introduction to Languages and the Theory of Computation", 4th Edition, Tata McGraw Hill, 2011.
S. No	**Reference Books:**
1	Harry R Lewis and Christos H Papadimitriou, "Elements of the Theory of Computation", 2nd Edition, Prentice Hall of India, 2015
2	Peter Linz, "An Introduction to Formal Language and Automata", 6th Edition, Jones & Bartlett, 2016.
3	Colin Ware, Information Visualization Perception for Design, 4th edition, Morgan Kaufmann Publishers, 2021.

COs / PO/PSO	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
ME23A14.1	2	2	1	-	-	-	-	-	1	-	-	1	2	1	1
ME23A14.2	2	2	1	-	-	-	-	-	1	-	-	1	2	1	1
ME23A14.3	2	2	1	-	-	-	-	-	1	-	-	1	2	1	1
ME23A14.4	2	2	1	-	-	-	-	-	1	-	-	1	2	1	1
ME23A14.5	2	2	1	-	-	-	-	-	1	-	-	1	2	1	1

VERTICAL 2 – LOGISTICS AND SUPPLY CHAIN MANAGEMENT

Course Code	Course Title (Theory course)	Category	L	T	P	C
ME23B11	RELIABILITY AND MAINTENANCE ENGINEERING	PE	3	0	0	3

Objectives:	
●	To understand the fundamentals of reliability engineering.
●	To apply reliability estimation techniques and design systems with improved reliability.
●	To describe basic maintenance concepts and practices.
●	To evaluate different maintenance policies.
●	To explore the root cause for maintenance problems.

UNIT-I	**RELIABILITY CONCEPTS**	**9**
Fundamentals of reliability engineering – Mortality curves concept of burn-in period, useful life and wear out phase of a system – Failure data analysis, mean failure rate, Mean Time To Failure (MTTF), Mean Time Between Failure (MTBF), hazard rate – Failure density and conditional reliability – Maintainability and availability – Simple problems.		
UNIT-II	**RELIABILITY ESTIMATION**	**9**
System reliability – Series, Parallel and Mixed configurations, Reliability improvement techniques, use of Pareto analysis – Design for reliability – Redundancy unit and standby redundancy – Fault tree analysis – Optimization in reliability – Product design – Product analysis – Product development – Product life cycles.		
UNIT-III	**MAINTENANCE CONCEPT**	**9**
Maintenance definition – Maintenance objectives and scope – Maintenance challenges and functions – Terotechnology – Maintenance costs – General introduction to maintenance Types		
UNIT-IV	**MAINTENANCE MODELS**	**9**
Proactive and reactive maintenance – Maintenance policies – Imperfect maintenance – Preventive and breakdown maintenance – Optimal preventive maintenance schedule – Product characteristics – Inspection decisions – Maximizing profit – Minimizing downtime – Replacement decisions.		
UNIT-V	**MAINTENANCE QUALITY**	**9**
Total Productive Maintenance fundamentals – Chronic and sporadic losses – TPM pillars – Five zero concept – Failure Modes and Effects Analysis (FMEA) – Failure Modes, Effects and Criticality Analysis (FMECA) – Root cause analysis – Repair time distribution – Analysis of downtime – Maintainability prediction – Design for maintainability – Reliability Centered Maintenance.		
	Total Contact Hours : 45	

Course Outcomes: Upon completion of this course, the students will be able to:	
●	Calculate and interpret different reliability concepts for engineering systems.
●	Develop and analyze reliability models for complex systems and implement reliability improvement techniques.
●	Identify and classify different types of maintenance practices and their applications in industrial scenarios.
●	Formulate optimal maintenance policies and apply decision-making techniques.
●	Perform root cause analysis of maintenance problems.

Text Book (s):	
1	Andrew K.S. Jardine& Albert H.C. Tsang, "Maintenance, Replacement and Reliability", Taylor and Francis, Third Edition 2021.
2	Srinath. L.S., "Reliability Engineering", 4th edition Affiliated East west press, 2011

Reference Books(s) / Web links:	
1	Balaguruswamy.E., "Reliability Engineering", McGraw Hill Education India, 2017
2	Bikas Badhury & S.K.Basu, "Terotechnology: Reliability Engineering and Maintenance Management", Asian Books, 2003.
3	Mishra R.C, "Reliability and Maintenance Engineering" New age International publisher, First Edition, 2006.
4	Venkataraman. K "Maintenance Engineering and Management", PHI Learning, Pvt. Ltd., Fourth Edition, 2010

PO-PSO / CO	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
ME23B11.1	2	3	1	-	2	2	2	-	2	-	-	2	-	-	1
ME23B11.2	2	2	1	-	1	-	1	-	2	1	-	1	-	-	2
ME23B11.3	3	1	1	-	2	3	1	1	2	1	2	1	-	-	1
ME23B11.4	1	2	1	-	1	1	1	-	1	-	1	-	-	-	1
ME23B11.5	2	1	1	-	1	1	1	1	1	1	-	1	-	-	2

Course Code	Course Title (Theory course)	Category	L	T	P	C
ME23B12	WAREHOUSING AUTOMATION	PE	3	0	0	3

Objectives:	
●	To understand the concept of warehousing and its role in decision-making and operational strategies within the supply chain.
●	To explore the various stages involved in receiving goods in a warehouse, including the use of advanced shipment notices (ASN) or invoice item lists for operational efficiency.
●	To examine the significance of warehouse activities, including receiving, sorting, loading, unloading, picking, packing, and dispatch, and their role in optimizing warehouse operations.
●	To introduce the principles of inventory management and the integration of inbound and outbound operations in warehouse management.
●	To explain the importance of health, safety, and environmental practices, including the use of safety equipment and personal protective equipment (PPE) in warehouse operations.

UNIT-I	Introduction To Warehouse	9
Introduction to Warehousing Concept, Decision making, Operations, Need for warehousing, Issues affecting warehousing, Various warehousing facilities, Different types of ware houses, Characteristics of ideal ware houses - Broad functions in a warehouse -warehouse layouts and layout related to functions Warehouse Organization Structure -Benefits of Warehousing.		
UNIT-II	**Warehouse Inbound and Outbound Operations**	**9**
Receiving and Dispatch of Goods in warehouse Various stages involved in receiving goods – Stages involved receipt of goods-Advanced shipment notice (ASN) or invoice items list-Procedure for Arranging of goods on dock for counting and Visual inspection of goods unloaded-Formats for recording of goods unloaded from carriers-Generation of goods receipt note using computer- - put away of goods into storage locations -Storage location codes and its application- Automated Storage/ Retrieval System (AS/RS)-specialised equipment- Technical advancements.		
UNIT-III	**Warehouse Operations and Quality Control**	**9**
Receiving, sorting, loading, unloading, Picking Packing and dispatch, activities and their importance in a warehouse - quality parameters -Quality check-need for quality check-importance of quality check. Procedure to develop Packing list / Dispatch note-Cross docking method -Situations suited for application of cross docking -Information required for coordinating cross docking-Importance of proper packing-Packing materials -Packing machines -Reading labels.		
UNIT-IV	**Integrated Warehouse Management and Automation**	**9**
Warehouse Utilization Management -Study on emerging trends in warehousing sector -DG handling -use of Material Handling Equipment's in a warehouse -Inventory Management of a warehouse - Always Better Control (ABC) Inventory system- Inbound & Outbound operations of a warehouse and handling of Inbound & Outbound operations. Automation Systems: Over-view, Applications, Costs, Benefits. Receiving Automation: Pallet Inverter -Material Flow Automation: Conveyors -Lifts -Automated Guided Vehicles -Monorail - Picking/Outbound Automation: Pick / Put To Light -A Frame -Automated Order Selection – Pick-N-Go - Outbound Sorters -Automatic Truck Loading.		
UNIT-V	**Warehouse Safety Regulations and Operational Performance**	**9**
The safety rules and 'Procedures to be observed in a Warehouse - Hazardous cargo – Procedure for Identification of Hazardous Cargo -Safety data sheet-Instructions to handle hazardous cargo - Familiarization with the industry. Health, Safety & Environment - Safety Equipment's and their uses -5S Concept on shop floor. Personal protective Equipment's (PPE) and their uses. The Principles and Performance Measures of Material Handling Systems Introduction. Vehicle travel path(time), Handling time, vehicle utilization, no of loads completed, congestion, Effective performance systems.		
	Total Contact Hours : 45	

Course Outcomes:	
●	Illustrate the need for warehousing, identifying the various factors and issues that affect warehousing decisions.
●	Apply best practices in preparing and managing warehouse dispatches to maintain accurate and timely outbound logistics.
●	Design efficient warehouse operations by integrating activities such as receiving, sorting, loading, unloading, picking, packing, and dispatch, ensuring each function contributes to the overall efficiency.
●	Evaluate the effectiveness of warehouse utilization management strategies and assess their impact on operational efficiency in modern warehouses
●	Develop protocols for the use of safety equipment and personal protective equipment (PPE) in warehouse operations, ensuring worker safety.
Text Book (s):	
1	Gwynne Richards, 'Warehouse Management: A Complete Guide to Improving Efficiency and Minimizing Costs in the Modern Warehouse', Kogan Page Publishers, ,2017
2	Frazelle, Edward H, 'World-Class Warehousing and Material Handling', Second Edition. New York: McGraw-Hill Education, 2016.

3	J P Saxena, Warehouse Management and Inventory Control- Vikas Publication House Pvt Ltd, First Edition, 2003.

Reference Books(s) / Web links:	
1	Martin Christopher, 'Stores Management and Logistics', S. Chand and Co., 2003.
2	J.R. Tony Arnold , 'Stephen N. Chapman and M. Clive Introduction to Materials Management', Pearson,2008
3	Raghuram G , ' Logistics and Supply Chain Management', Pearson Education, 2015
4	Nada R. Sanders, Big data driven supply chain management: A framework for implementing analytics and turning information into intelligence, Pearson Education,2014.
5	Michael Watson, Sara Lewis, Peter Cacioppi, Jay Jayaraman, Supply Chain Network Design: Applying Optimization and Analytics to the Global Supply Chain, Pearson Education,2013.

PO-PSO / CO	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
ME23B12.1	3	-	2	-	2	-	-	-	-	-	-	-	2	-	-
ME23B12.2	-	3	-	2	3	-	-	-	-	-	-	-	-	1	-
ME23B12.3	3	-	-	2	-	2	-	-	-	-	-	-	2	-	-
ME23B12.4	-	-	3	-	3	-	-	-	2	-	-	-	-	-	3
ME23B12.5	-	-	-	-	-	3	2	-	-	2	-	-	-	-	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	**Course Title (Theory course)**	**Category**	**L**	**T**	**P**	**C**
ME23B13	**OPERATIONS MANAGEMENT**	**PE**	**3**	**0**	**0**	**3**

Objectives:	
●	To understand the basics of production and operations management and its role in product design and development.
●	To analyze the various aspects of process planning and other controlling operations.
●	To evaluate the different factors influencing plant location and layout.
●	To apply the knowledge of materials and inventory management activities.
●	To understand the concepts of quality and various quality control techniques.

UNIT-I	**INTRODUCTION TO OPERATIONS MANAGEMENT**	**9**
Operations Management – Introduction , nature, importance, historical development – Understanding similarities and difference among Products, Goods and Services and their interrelationships – Value Analysis – Production & Operations Strategy for Competitive Advantage , Types of Production System – Recent Trends in Production and Operations Management, Role of Operations in Strategic Management. Production and Operations strategy – Elements and Competitive Priorities, Nature of International Operations Management - Product Design – New Product Development, Make or Buy Decisions.		
UNIT-II	**PLANNING AND CONTROL OF OPERATIONS**	**9**
Process Planning – Process Redesigning, Procedure for designing a process – Production Planning and Control– Objectives, Elements, Stages of PPC – Demand Forecasting – Need, Types, Objectives and Steps. Overview of Qualitative and Quantitative methods. Capacity Planning – Long range, Types, Rough cut plan, Capacity Requirements Planning (CRP) - Aggregate Planning – Approaches, costs – Overview of MRP, MRP II and ERP		
UNIT-III	**PLANT LOCATION AND LAYOUT**	**9**
Facility Location – Factors influencing Plant Location, Break even Analysis. Plant Layout – Classification of Layout, Layout Design Procedures – CRAFT, ALDEP, CORELAP. Line Balancing – Objectives of Assembly Line Balancing, Ranked Positional Weight Method, COMSOAL		
UNIT-IV	**MATERIALS MANAGEMENT AND INVENTORY CONTROL**	**9**
Materials Management – Objectives, Planning, Budgeting and Control. Overview of Materials Management Information Systems (MMIS). Purchasing – Objectives, Functions, Policies, Vendor rating and Value Analysis. Stores Management – Nature, Layout, Classification and Coding - Overview of JIT. Inventory – Types of Inventory – Deterministic demand model – EOQ – Continuous and Periodic review Inventory models – Selective Inventory Control – ABC, VED, FSN Techniques		
UNIT-V	**QUALITY MANAGEMENT**	**9**
Definitions of quality, Quality revolution, quality gurus, TQM philosophies, Quality management tools – Quality Control – Objectives, importance, Quality Control Techniques – Control Charts – certification and awards. Lean Management – philosophy, elements of JIT manufacturing, continuous improvement. Six sigma – Human factors in		

job design – Ergonomics – Work Environment and workers Safety. Introduction to ERP and Optimisation software tools			
	Total Contact Hours	**:**	**45**

Course Outcomes: Upon Completion of this course, students will be able to	
●	Gain a foundational understanding the concept of production and operations management, including its critical role in product design and development.
●	Examine the various aspects of process planning and controlling operations.
●	Investigate and understand the different factors influencing plant location and layout to make decisions
●	Understand and explain the various key activities involved in materials and inventory management
●	Formulate strategies to optimize production processes and enhance overall quality management using various quality control techniques

Text Book (s):	
1	Jay Heizer, Barry Render (2020), "Operations Management", 13th Edition, Pearson Education
2	Robert S.Russell, Bernard W.Taylor, (2019), " Operations and supply chain Management", 10th edition, Wiley.

Reference Books(s) / Web links:	
1	Mahadevan B, Operations management: Theory and practice. Pearson Education India; 2015
2	E.S. Buffa, (2007), Modern Production / Operation Management, 8th edition, Wiley
3	R. B. Kanna, Production and Operations Management, PHI Learning Private Ltd, 2nd edition, 2015.
4	S. N. Chary, Production and Operations Management, Tata McGraw Hill Education Private Limited, 4th edition, 2009
5	R. Panneerselvam, (2013), Production and Operations Management, 3rd edition, PHI
6	Norman Gaither and Gregory Frazier, Operations Management, South Western Cengage Learning,9 th edition, 2015
	https://onlinecourses.nptel.ac.in/noc20_me30/preview

PO-PSO Mapping

PO-PSO / CO	POs												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
ME23B13.1	3	3	2	1	1	1	-	-	-	-	1	2	3	2	3
ME23B13.2	3	3	2	1	1	1	1	-	-	-	1	2	3	2	3
ME23B13.3	3	3	2	1	1	1	1	-	-	-	1	2	3	2	3
ME23B13.4	3	3	2	1	1	1	-	-	-	-	1	2	3	2	3
ME23B13.5	3	3	2	1	1	1	-	-	-	-	1	2	3	2	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	**Course Title (Theory Course)**	**Category**	**L**	**T**	**P**	**C**
ME23B14	**MATERIAL HANDLING EQUIPMENT, REPAIR AND MAINTENANCE**	**PE**	**3**	**0**	**0**	**3**

Objectives:	
●	To provide knowledge of the classification and functional categories of material handling equipment.
●	To familiarize with the design, features, and functions of various hand trucks and power trucks, including their advantages and limitations.
●	To analyse conveyor systems and their role in enhancing automation and efficiency in material handling processes.
●	To impart the knowledge on industrial applications and advancements Auxiliary Equipment and Hoisting Equipment.
●	To study operational functions of 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 utilization 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 – Vibrating and actuating 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 un loaders -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 – Maintenance and safety of material handling equipment.		
	Total Contact Hours : 45	

Course Outcomes: At the end of the course the students would be able to	
●	Evaluate and select suitable material handling equipment considering operational, financial, and safety factors.
●	Recognize and describe various types of hand trucks, power trucks, and forklifts, including their functional differences and industrial applications.
●	Develop material handling strategies by selecting the appropriate type of conveyor system.
●	Elaborate the basic working principles of various Auxiliary Equipment and Hoisting Equipment.
●	Explain the basic working principles of various Bulk Handling Equipment and Systems.

Text Books:	
1	Allegri (Sr.), T.H., Material Handling, Principles and Practices, CBS Publishers and Distributors, Delhi, 2019.
2	Siddharta Ray, Introduction to Materials Handling, New Age International Publishers, 2017.
Reference Books(s) / Web links:	
1	Bolz, H. A and Hagemann, G. E (ed.), ‘‘Materials Handling Handbook’’, Ronald Press 2011
2	8005:1976, Classification of Unit Loads, Bureau of Indian Standards.
3	Apple, J.A., ‘‘Material Handling System Design’’, John Wiley & Sons, 2021
4	Theodore H., Allegre Sr., Material Handling Principles and Practice, CBS Publishers and Distributors, 2019

PO / PSO	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
ME23B14.1	2	1	1	1	1	-	-	-	-	-	-	1	-	1	2
ME23B14.2	2	1	1	1	1	-	-	-	-	-	-	1	-	1	2
ME23B14.3	2	1	1	1	1	-	-	-	-	-	-	1	-	1	2
ME23B14.4	2	1	1	1	1	-	-	-	-	-	-	1	-	1	2
ME23B14.5	2	1	1	1	1	-	-	-	-	-	-	1	-	1	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

VERTICAL 3 – ROBOTICS AND AUTOMATION

Course Code	Course Title (Theory course)	Category	L	T	P	C
ME23C11	DRONE TECHNOLOGIES	PE	3	0	0	3

Objectives:	
●	To learn and understand the fundaments of design, fabrication and programming of drone
●	To learn and understand the fundaments of design, fabrication and programming of drone
●	To impart the knowledge on flying and operation of drone
●	To know about the Drone Design Mechanism For Various applications
●	To understand the safety risks and guidelines of fly safely

UNIT-I	INTRODUCTION TO DRONE TECHNOLOGY	9
History of Drone - Drone Concept - Vocabulary Terminology- Classifications of the UAV - UAV Materials, Launching system, attachment of UAV. Drone technology impact on the businesses- Drone business through entrepreneurship- Opportunities/applications for entrepreneurship and employability		
UNIT-II	**DRONE DESIGN, FABRICATION AND PROGRAMMING**	**9**
Components of UAV – Battery of UAV - Function of the component parts - Aerodynamic forces, Viscosity, Stall speed, Compressibility, Earth's atmosphere -Assembling a drone- Payload - The energy sources- Level of autonomy- Drones configurations - Drone Programming and Simulation – Multi rotor stabilization.		
UNIT-III	**DRONE FLYING AND OPERATION**	**9**
Flight modes- Flight control system –- Drone Controls Flight operations –Management tool - Operate a small drone in a controlled environment –Sensors- Lidar, sonar, IMU, Optical flow and other sensors –Auto pilot -Sense and avoid technique Onboard storage capacity - Removable storage devices Linked mobile devices and applications – Radio Communication – Ground control system – First person view – Data Fusion.		
UNIT-IV	**DESIGN OF DRONE MECHANISM FOR COMMERCIAL APPLICATIONS**	**9**
Situational awareness – Flight operation – Decision making – analysis of weather factor – weather information - 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 defense – Drones in Healthcare - Drones in inspection of transmission lines and power distribution -Drones in filming and panoramic picturing		
UNIT-V	**FUTURE DRONES AND SAFETY**	**9**
Drones - Safety risks- Maintenance -Risk analysis and prevention. -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 Contact Hours : 45	

Course Outcomes: At the end of the course the students would be able to	
●	Know about a various type of drone technology
●	Drone fabrication and programming and execute the suitable operating procedures for functioning a drone
●	Select appropriate sensors and actuators for Drones
●	Develop a drone mechanism for specific applications
●	Create the programs for various drones

Text Books:	
1	Daniel Tal and John Altschuld, ―Drone Technology in Architecture, Engineering and Constructi A Strategic Guide to Unmanned Aerial Vehicle Operation and Implementation‖, 2021 John Wile Sons, Inc.
2	Terry Kilby and Belinda Kilby, ―Make: Getting Started with Drones ―, Maker Media, Inc, 2016.
3	Maryam Farsi, Alireza Daneshkhah, et al., Digital Twin Technologies and Smart Cities, Academic Press (Elsevier), 1st Edition, 2020.

Reference Books(s) / Web links:	
1	John Baichtal, ―Building Your Own Drones: A Beginners' Guide to Drones, UAVs, and ROVs‖, Publishing, 2016.
2	Ales Zavrsnik, ―Drones and Unmanned Aerial Systems: Legal and Social Implications for Secu and Surveillance‖, Springer, 2018.

PO-PSO / CO	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
ME23C11.1	1	2	2	1	3	2	-	-	-	-	-	1	2	1	3
ME23C11.2	1	2	2	1	3	2	-	-	-	-	-	1	2	1	3
ME23C11.3	1	2	2	1	3	2	-	-	-	-	-	1	2	1	3
ME23C11.4	1	2	2	1	3	2	-	-	-	-	-	1	2	1	3
ME23C11.5	1	2	2	1	3	2	-	-	-	-	-	1	2	1	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Theory course)	Category	L	T	P	C
ME23C12	**ELECTRICAL DRIVES AND ACTUATOR**	**PE**	**3**	**0**	**0**	**3**

Objectives:	
●	To understand the characteristics of electric drive.
●	To enrich the knowledge about the characteristics and performance of an induction motor drive.
●	To gain the knowledge about the performance of synchronous motor drive.
●	To analyze and design the controllers for electric drive.
●	To familiarize the construction and working of hydraulic actuators.

UNIT-I	**DRIVE CHARACTERISTICS**	**9**
Electric drive – Equations governing motor load dynamics – steady state stability – multi quadrant Dynamics: acceleration, deceleration, torque, and direction starting & stopping – typical load torque characteristics – Selection of motor		
UNIT-II	**INDUCTION MOTOR DRIVE**	**9**
Introduction – Induction motor drives - Speed control of 3-phase induction motor - Stator voltage control – energy efficient drive – voltage/frequency control – constant air gap flux – field weakening mode – voltage / current fed inverter – closed loop control		
UNIT-III	**SYNCHRONOUS MOTOR DRIVE**	**9**
Voltage/frequency control and self-control of synchronous motor: Margin angle control and power factor control – permanent magnet synchronous motor.		
UNIT-IV	**DESIGN OF CONTROLLERS FOR DRIVE**	**9**
Transfer function for DC motor / load and converter – closed loop control with current and speed feedback – armature voltage control and field weakening mode – design of controllers; current controller and speed controller-converter selection and characteristics.		
UNIT-V	**ACTUATORS**	**9**
Hydraulic Actuators: Cylinders – Types and construction, Hydraulic motors -Types and construction Control Components: Direction control, Flow control and Pressure control valves-Types, Construction Operation Applications – Types of actuations. Accessories: Reservoirs, Accumulators, Intensification, Pressure Switches Classification and functions- Applications- Fluid Power ANSI Symbol - Introduction to hydraulic simulation software.		
	Total Contact Hours : 45	

Course Outcomes: At the end of the course the students would be able to	
●	Familiarize the characteristics of electric drive.
●	Evaluate the characteristics and performance of an induction motor drive.
●	Estimate the performance of synchronous motor drive
●	Design and develop the controllers for electric drive.
●	Select suitable hydraulic actuators for real time application.

Text Books:	
1	S.K.Pillai, A First course on Electrical Drives, New Age International Publishers, 4th Edition, 2022.
2	T Jagadeesha, Hydraulics and Pneumatics, I K International Publishing House Pvt. Ltd, 2015.

Reference Books(s) / Web links:	
1	Austin Hughes and Bill Drury, Electric Motors and Drives: Fundamentals, Types and Applications, Newnes (an imprint of Butterworth-Heinemann Ltd), 5th Edition, 2019.

2	Stefanos Manias, Power Electronics and Motor Drive Systems, Academic Press Inc., 2016.
3	R.Krishnan, Electric Motor Drives: Modeling Analysis and Control, Pearson Education, 1st Edition, 2015.
4	Nathan Ida, Sensors, Actuators, and Their Interfaces- A multidisciplinary introduction, IET Digital Library, 2nd Edition, 2020.
5	https://www.famictech.com/en/Products/Automation-Studio/Professional-Edition/Technologies/Hydraulic-Simulation.
6	https://www.art-systems.de/www/site/en/fluidsim.

PO-PSO / CO	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
ME23C12.1	3	2	-	-	-	-	-	-	-	-	-	2	-	-	1
ME23C12.2	3	2	-	-	-	2	-	-	-	-	-	-	-	-	1
ME23C12.3	3	2	-	-	-	2	-	-	-	-	-	-	-	-	1
ME23C12.4	2	-	3	-	-	2	-	-	-	-	-	-	-	-	1
ME23C12.5	2	-	3	-	-	-	-	-	-	-	-	-	-	-	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Theory course)	Category	L	T	P	C
ME23C13	AUTOMATION IN MANUFACTURING	PE	3	0	0	3

Objectives:
• To introduce fundamental concepts of manufacturing, automation, and their integration with CAD/CAM.
• To provide an overview of manufacturing support systems and their role in process and production planning.
• To familiarize students with material handling and storage systems and their automation.
• To explore group technology, coding systems, and flexible manufacturing concepts.
• To introduce industrial robotics and smart manufacturing technologies.

UNIT-I	FUNDAMENTALS OF MANUFACTURING & AUTOMATION	9
Brief introduction to CAD and CAM – Manufacturing Planning, Manufacturing control- Axiomatic Design- Concurrent Engineering-CIM concepts – Computerized elements of CIM system –Types of production - Manufacturing models and Metrics – Mathematical models of Production Performance– Simple problems – Manufacturing Control – Simple Problems – Basic Elements of an Automated system – Levels of Automation – Lean Production and Just-In-Time Production.		
UNIT-II	**MANUFACTURING SUPPORT SYSTEMS**	**9**
Process planning – Computer Aided Process Planning Logical steps in Computer Aided Process Planning – Aggregate Production Planning and the Master Production Schedule – Material Requirement planning – Capacity Planning- Control Systems-Shop Floor Control-Inventory Control –Brief on Manufacturing Resource Planning-II-ERP & PLM.		
UNIT-III	**MATERIAL HANDLING & STORAGE SYSTEMS**	**9**
Material Handling Systems - Conveyors, Feeders, Stackers &Reclaimers, automatic pallet changers-Types and applications- AGV-Guidance, steering, routing& Vehicle Management- Tool Handling Systems, ATC, Tool Fault Detection Systems- AS/RS, Functions and its types		
UNIT-IV	**CELLULAR MANUFACTURING & FLEXIBLE MANUFACTURING SYSTEMS**	**9**
Group Technology, Product and Process based Layouts-Types of Coding & Classification systems, Optiz Coding Systems, Composite Part Concept, Production Flow Analysis- Cellular Manufacturing- FMS & its Components, Application & Benefits, Planning and Implementation, Quantitative Analysis of FMS, Fundamentals and Analysis of Transfer Lines		
UNIT-V	**INDUSTRIAL ROBOTICS & SMART MANUFACTURING**	**9**
Robot Configuration & Anatomy, Industrial robots Applications & Case Study- Manufacturing processes, Assembly, Inspection, Material handling & Warehousing. Digital manufacturing- Need & Case study, Advantages over conventional manufacturing-Smart manufacturing Techniques-IOT, Dark Factory, Big data processing, Cyber-Physical Systems-Automated Inspection, CMM, Machine Vision systems.		
	Total Contact Hours : 45	

Course Outcomes: At the end of this course, Students will be able to
1. Explain the types, levels, and benefits of automation in manufacturing systems.
2. Apply process planning steps and evaluate inventory control techniques in manufacturing.
3. Differentiate between various material handling systems and assess their applications.
4. Design and analyze layouts and systems for cellular and flexible manufacturing.
5. Describe robot configurations and assess smart manufacturing techniques, including IoT and cyber-physical systems.

Text Books:	
1	Automation, Production Systems and Computer Integrated Manufacturing, M.P. Groover, Pearson Education.
2	Industrial Automation: W.P.David, John Wiley and Sons.
Reference Books(s) / Web links:	
1	Hand book of design, manufacturing and Automation: R.C. Dorf,John Wiley and Sons.
2	Computer Based Industrial Control, Krishna Kant, EEE- PHI
3	Kant Vajpayee S, “Principles of Computer Integrated Manufacturing”, Prentice Hall India,2003.
4	Rao. P, N Tewari &T.K. Kundra, “Computer Aided Manufacturing”, Tata McGraw Hill Publishing Company, 2000.

POs – PSOs COs	POs												PSOs		
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ME23C13.1	2	1	1	-	-	1	1	-	-	-	1	2	-	-	2
ME23C13.2	2	2	2	-	1	1	1	-	-	-	1	2	-	-	2
ME23C13.3	2	2	2	-	-	1	1	-	-	-	1	2	-	-	2
ME23C13.4	2	1	1	-	-	1	1	-	-	-	1	2	-	-	2
ME23C13.5	2	1	1	-	-	1	1	-	-	-	1	2	-	-	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Lab Oriented Theory Course)	Category	L	T	P	C
ME23C34	EMBEDDED SYSTEMS AND PROGRAMMING	PE	2	0	2	3

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

UNIT-I	INTRODUCTION TO MICROCONTROLLER	6
Fundamentals Functions of ALU - Microprocessor - Microcontrollers – Comparison between Microprocessors and 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 - 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, Mechanical switches, Sensors - Relays - Solenoid Valve and Heater - Stepper Motors, Servomotors, AC 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.		
UNIT-V	**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 Contact Hours : 30	

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	Stepper Motor (Unipolar & Bipolar Motor) and PWM Servo Motor Control to Interfacing with 805		
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.		
	Contact Hours	**:**	**30**
	Total Contact Hours	**:**	**60**

Course Outcomes: At the end of this course, students should be able to	
●	Recognize the various functional units of microcontrollers, processors and system-on-chip based on the features and specifications.
●	Implement the microcontroller programming methods and interfacing techniques.
●	Interface the sensors, actuators and other I/O devices with microcontrollers and processors.
●	Design the ARM processor architecture and develop its programming.
●	Develop the applications using an Embedded system.

Text Book (s):	
1	Frank Vahid and Tony Givagis, "Embedded System Design", Wiley, 2011.
2	Kenneth J. Aylala, "The 8051 Microcontroller, the Architecture and Programming Applications", West Publishing Company, 2003.

Reference Books(s) / Web links:	
1	Muhammad Ali Mazidi and Janice Gillispic Mazdi, "The 8051 Microcontroller and Embedded Systems", Pearson Education, 2006.
2	Simon Monk, "Programming the Raspberry Pi", Second Edition: Getting Started with Python, McGraw Hill, 2nd edition, 2015.
3	James W. Stewart, "The 8051 Microcontroller Hardware, Software and Interfacing", Regents Prentice Hall, 2003.
4	David E. Simon, "An Embedded Software Primer", Pearson Education, 2000.

PO-PSO / CO	POs												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
ME23C34.1	2	1	-	1	2	1	1	-	-	-	-	-	-	-	-
ME23C34.2	2	1	1	1	2	1	1	-	-	-	-	-	-	-	-
ME23C34.3	2	1	1	1	2	1	1	-	-	-	-	-	-	-	-
ME23C34.4	2	1	1	1	2	1	1	-	-	-	-	-	-	-	1
ME23C34.5	2	1	1	1	2	1	1	-	-	-	-	-	-	-	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

VERTICAL 4 – PRODUCT DESIGN

Course Code	Course Title (Theory course)	Category	L	T	P	C
ME23D11	PRODUCT DESIGN AND DEVELOPMENT	PE	3	0	0	3

Objectives:	
●	To introduce the core concepts and processes of product design.
●	To develop problem-solving abilities through design thinking and user-centered approaches.
●	To enable students to systematically develop and refine design concepts.
●	To familiarize students with material selection and manufacturing principles for product design.
●	To provide skills in prototyping, testing, and refining product designs.

UNIT-I	INTRODUCTION TO PRODUCT DESIGN	9
Overview of Product Design- Definition and significance, Evolution of product design; Key Principles of Product Design - Functionality, aesthetics, ergonomics; The Role of a product Designer - Responsibilities and skills; Product Development Process - Stages: Concept, Design, Prototype, Testing; Product Design vs. Industrial Design - Differences and synergies		
UNIT-II	**DESIGN THINKING AND CREATIVE PROBLEM SOLVING**	**9**
Introduction to Design Thinking - Empathize, Define, Ideate, Prototype, Test; Creative Problem Solving Techniques - Brainstorming, mind mapping, lateral thinking; User-Centered Design - Understanding user needs and experiences; Prototyping and Iteration - Importance of rapid prototyping and feedback loops; Case Studies on Design Thinking - Real-world examples of design thinking in action		
UNIT-III	**IDEATION AND CONCEPT DEVELOPMENT**	**9**
Idea Generation Techniques - Brainstorming, sketching, SCAMPER; Concept Screening and Evaluation - Criteria for evaluating design concepts; Concept Development Process - From rough sketches to detailed concepts; Refining Design Concepts - Iteration and evolving ideas; Case Studies - Successful concept development in product design		
UNIT-IV	**MATERIALS AND MANUFACTURING CONSIDERATIONS**	**9**
Introduction to Materials in Product Design - Types of materials: metals, plastics, ceramics, composites; Material Selection for Functionality and Aesthetics - Trade-offs in material choice; Design for Manufacturing (DFM) - Principles and guidelines for manufacturability; Basic Manufacturing Processes - Casting, molding, machining, and assembly; Sustainability in Material Selection - Eco-friendly and sustainable design choices		
UNIT-V	**PRODUCT PROTOTYPING, TESTING, AND FINAL DESIGN**	**9**
Prototyping Techniques - Low fidelity vs. high fidelity prototypes; Testing and Validation - User testing, performance testing, and feedback; Design Refinement Based on Testing - Iterative improvements and adjustments; Final Design Presentation - Communicating ideas through models and sketches; Case Studies - Examples of product testing and final design evolution		
	Total Contact Hours : 45	

Course Outcomes: At the end of the course the students would be able to	
●	Understand the significance, principles, and stages involved in product design.
●	Apply design thinking to solve user-centric problems creatively.
●	Generate and refine innovative product concepts using structured approaches.
●	Choose appropriate materials and processes with an emphasis on sustainability.
●	Create and validate prototypes, refine designs, and effectively present final solutions.

Text Books:	
1	Karl T. Ulrich and Steven D. Eppinger, Product Design and Development, McGraw Hill, 7th Edition, 2020.
2	Kevin Otto and Kristin Wood, Product Design: Techniques in Reverse Engineering and New Product Development, Pearson, 1st Edition, 2001.
3	Nigel Cross, Engineering Design Methods: Strategies for Product Design, Wiley, 4th Edition, 2008.
4	A.K. Chitale and R.C. Gupta, Product Design and Manufacturing, PHI Learning Pvt. Ltd., 2020, 6th Edition.
5	P.C. Gope, Principles of Product Design and Manufacturing, McGraw Hill Education, 2012, 1st Edition.

Reference Books(s) / Web links:	
1	Tim Brown, Change by Design: How Design Thinking Creates New Alternatives for Business and Society, Harper Business, 2009.
2	Don Norman, The Design of Everyday Things, Basic Books, Revised Edition, 2013.

PO-PSO / CO	POs												PSOs		
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ME23D11.1	3	2	1	1	-	-	-	-	-	-	-	-	1	-	-
ME23D11.2	2	3	3	2	2	-	-	-	-	-	-	-	1	-	-
ME23D11.3	2	2	3	3	2	-	-	-	-	-	-	-	1	-	-
ME23D11.4	3	2	2	2	1	2	3	-	-	-	-	-	1	-	-
ME23D11.5	2	3	3	3	2	-	-	-	-	2	-	-	1	-	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Theory course)	Category	L	T	P	C
ME23D12	COMPUTER AIDED DESIGN	PE	3	0	0	3

Objectives:	
●	To Introduce and understand the fundamentals of Computer graphics in Design.
●	To study the two dimensional drafting, surface modeling and bill of material creation. .
●	To learn three dimensional modelling techniques and its advantages.
●	To study the basic and purpose of assembling modeling and tolerance analysis.
●	To study the importance of CAD standards and their applications in Engineering Analysis.

UNIT-I	**PRINCIPLES OF COMPUTER GRAPHICS IN DESIGN.**	**9**
Introduction- graphic primitives, point plotting, lines- Bresenham's circle algorithm-transformation in graphics-coordinate systems, view port, 2D and 3D transformation- hidden surface removal- shading techniques.		
UNIT-II	**2D DRAFTING & SURFACE MODELING OF SPECIAL CURVES**	**9**
Projection views – Orthographic view, Axillary view, Full & Half Section views, Broken Section view, Offset Section view – Title Block creation – BOM Creation – Notes creation – Ballooning of 2D drawing and its features for Inspection reporting. Surface model, plane surface, rule surface, surface of revolution, COONs surface, Surface patches- Synthetic curves Hermit cubic splines- Bezier curves- B-Splines rational curves- NURBS.		
UNIT-III	**3D MODELING TOOLS & TECHNIQUES OF SOLID GEOMETRY.**	**9**
Conversion of Views – 2D to 3D & 3D to 2D – Parametric and Non-Parametric Modeling – Tree features of 3D Modelling and its advantages – BIW (Body In White) – Solid Modelling -CSG, B- Rep concepts - Boolean operations - hidden solid removal- Z Algorithm- Rendering techniques.		
UNIT-IV	**ASSEMBLY MODELLING & INTERFERENCE ANAYSIS**	**9**
Basics of Assembly modelling, Purpose of Assembly modelling- advantages – Top to Down & Bottom Up modelling approaches – Analysis of Clearances – Undercuts – Interferences –Stack up analysis –Cumulative effect of Tolerances in after assembly conditions.-Tolerance analysis calculation methods- worst case, RSS, and Monte Carlo simulation analysis.		
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,STL, STEP, CALS, ACIS & DXF		
	Total Contact Hours : 45	

Course Outcomes: At the end of the course the students would be able to	
●	Explain the fundamentals of the design and concepts of 2D & 3D.
●	Demonstrate the two dimensional drafting and projection views.
●	Differentiate the three dimensional modelling, parametric and Non-parametric modelling
●	Implement the assembly modelling and top down, bottom up approaches.
●	Illustrate the various CAD standards for different file formats of data transfer.

Text Books:	
1	Computer Aided Design & Manufacturing - Jacob Moses & Ruchi Agarwal, TechnicPublications, 2020.
2	J. Srinivas, CAD / CAM Principles & Application, Oxford Press, 2016.
3	Dr. Sadhu Singh, Computer Aided Design, Publisher S.K. Kataria & Sons, 2023

Reference Books(s) / Web links:	
1	Ibrahim Zeid ―Mastering CAD CAM‖ Tata McGraw-Hill Publishing Co.2007.
2	Grewal, ‖CAD / CAM‖ – Chandandeep Grewal, S. Chand Publishing, 2008.
3	Farazdak Haideri, ―CAD/CAM and Automation‖, Nirali Prakashan publishers, 2016.
4	Computer Aided Design & Manufacturing, Anup Goel, Technical Publications, 2018
5	https://nptel.ac.in/courses/112104031
6	https://nptel.ac.in/courses/112102101

PO-PSO / CO	POs												PSOs		
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ME23D12.3	2	2	-	1	-	-	-	-	-	1	-	-	-	-	-
ME23D12.4	2	-	2	-	-	-	3	-	-	1	-	-	-	-	-
ME23D12.5	2	-	2	2	-	-	-	-	-	-	-	-	-	-	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Theory course)	Category	L	T	P	C
ME23D13	GEOMETRIC DIMENSIONING AND TOLERANCING	PE	3	0	0	3

Objectives:	
●	Recognize the key GD&T terminology and comprehend the applied meaning of each
●	Identify the engineering drawing symbols most closely associated with GD&T
●	Differentiate between datums, datum features, and the parts of datum systems
●	Understand various forms and orientation
●	Understand various tolerances and its application

UNIT-I	INTRODUCTION	9
Dimensioning and Tolerancing - Dimensioning Units - Fundamental Dimensioning Rules Tolerancing Fundamentals - Maximum Material Condition (MMC) - Least Material Condition (LMC) , Basics of Fits , Dimensioning, Rules and Concepts of GD&T		
UNIT-II	**DATUM CONTROL**	**9**
Datums - Datum Feature Symbol - Datum Feature - The Datum Reference Frame Concept - Datum Target Symbols - Partial Datum Surface - Coplanar Surface Datums – Datum Axis - Movable Datum Target Symbols and Datum Target Points - Movable Datum Target Symbols and Datum Target Spheres. Datum Center Plane - The Center of a Pattern of Features as the Datum Axis		
UNIT-III	**FORM AND ORIENTATION CONTROL**	**9**
Introduction - Straightness, Flatness, Circularity, Free State Variation, Cylindricity Tolerance , Applying Form Control toa Datum Feature . Orientation Tolerances - Parallelism Tolerance - Perpendicularity Tolerance, Angularity Tolerance		
UNIT-IV	**LOCATION TOLERANCE**	**9**
Positional Tolerance - Locating Multiple Features - Positional Tolerancing of Coaxial Features- Positional Tolerancing of Nonparallel Holes - Locating Slotted Features -Positional Tolerancing of Spherical Features. Fasteners - Projected Tolerance Zone - Virtual Condition - Concentricity Tolerance - Positional Tolerancing for Coaxiality - Symmetry- Composite. Mini Project – GD&T analysis of real-time product		
UNIT-V	**PROFILE AND RUNOUT TOLERANCE**	**9**
Non-Uniform Profile Tolerance Zone - Specifying Basic Dimensions in a Note - Combination of Geometric Tolerances. Runout Tolerances - Combination of Geometric Tolerances Specifying Independency. Development of gauge design using GD&T. Applying GD&T with CADD software Mini Project -GD&T analysis of real-time product		
	Total Contact Hours : 45	

Course Outcomes: Upon completion of the course students should be able to	
●	Read and understand basic GDT symbols on a print.
●	Explain basic GDT concepts.
●	Identify minimum and maximum material conditions
●	Measure and verify position tolerances with applied material conditions
●	Set up and use basic rectangular datum reference frames

Text Books:	
1	Dimensioning and Tolerancing, Engineering Product Definition and Related Documentation Practices, ASMEY14.5-2018,2019.
2	James D Meadows, Geometric Dimensioning and Tolerancing applications and techniques for use in design, manufacturing and inspection, Marcel Dekker Inc. 2009
3	N D Bhatt and VM Panchal, Machine Drawing, Charotar Publishing, 2014.
4	P.S. Gill, Geometric Dimensioning & Tolerancing, S.K. Kataria & Sons, 2013

Reference Books(s) / Web links:	
1	David A. Madsen and David P. Madsen. Geometric Dimensioning and Tolerancing, 9th Edition, The Goodheart-Wilcox Company Inc, USA,2013.
2	Hoda A. ElMaraghy. Geometric Design Tolerancing: Theories, Standards and Applications. 2nd editi Springer US. 2012
3	Henzold. G. Geometrical Dimensioning and Tolerancing for Design, Manufacturing and Inspection. 2ndedition, Elsevier Science, 2006
4	P.S.Gill Geometric Dimensioning and Tolerancing, S K Kataria and Sons, 2009

PO-PSO / CO	POs												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
ME23D13.1	2	1	-	1	-	-	-	-	-	-	-	2	1	-	2
ME23D13.2	2	1	-	1	-	-	-	-	-	-	-	2	1	-	2
ME23D13.3	2	1	-	1	-	-	-	-	-	-	-	2	1	-	2
ME23D13.4	2	1	-	1	-	-	-	-	-	-	-	2	1	-	2
ME23D13.5	2	1	-	1	-	-	-	-	-	-	-	2	1	-	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

ourse Code	**Course Title (Theory course)**	**Category**	**L**	**T**	**P**	**C**
ME23D14	**DESIGN OF EXPERIMENTS**	**PE**	**3**	**0**	**0**	**3**

Objectives:	
●	To understand the concepts of Classical Design of Experiments (DOE).
●	To illustrate Single Factor Experiment and Post hoc tests.
●	To understand Factorial experiments and its extensions.
●	To recognize Taguchi method for parameter Optimization
●	To expose the student to Response Surface Method and Shainin DOE.

UNIT-I	**FUNDAMENTALS OF EXPERIMENTAL DESIGNS**	**9**
Hypothesis testing – single mean, two means, dependent/ correlated samples – confidence intervals, Experimentation – need, Conventional test strategies, F-test, terminology, basic principles of design, steps in experimentation – choice of sample size – Normal and half normal probability plot – simple linear and multiple linear regression, Analysis of variance.		
UNIT-II	**SINGLE FACTOR EXPERIMENTS**	**9**
Completely Randomized Design- effect of coding the observations- model adequacy checking - estimation of model parameters, residuals analysis- treatment comparison methods- Duncan‘s multiple range test, Newman-Keuel‘s test, Fisher‘s LSD test, Tukey‘s test- Testing using contrasts, Randomized Block Design – Latin Square Design- Graeco Latin Square Design – Applications.		
UNIT-III	**FACTORIAL DESIGNS**	**9**
Main and Interaction effects - Two and three factor full factorial designs- Fixed effects and random effects model - Rule for sum of squares and Expected Mean Squares- 2^k Design with two and three factors- Yate‘s Algorithm - Fitting regression model- Randomized Block Factorial Design. Blocking and Confounding in 2^k Designs- blocking in replicated design – 2^k Factorial Design in two blocks- Complete and partial confounding- Confounding 2^k Design in four blocks - Two level Fractional Factorial Designs- Construction of one-half and one-quarter fraction of 2^k Design. Illustrations using available software packages.		
UNIT-IV	**TAGUCHI METHODS**	**9**
Design of experiments using Orthogonal Arrays, Data analysis from Orthogonal experiments, Response Graph Method, ANOVA- Attribute data analysis- Robust design- noise factors, Signal to Noise ratios, Inner/outer OA design- case studies - Illustrations using software packages.		
UNIT-V	**RESPONSE SURFACE METHODS AND SHAININ DOE**	**9**
Introduction to Response Surface Methods, Central Composite Design, Creation of custom response surface designs, Basics of Shainin DOE – Problem Solving Algorithm - Problem Identification Tools- Shainin DOE Tools - Case studies- Illustrations using software packages.		
	Total Contact Hours : 45	

Course Outcomes: At the end of the course the students would be able to	
●	Appreciate the fundamental principles of Classical Design of Experiments.
●	Apply single factor experiment for process parameter understanding and optimization.
●	Explain Factorial Design principles for understanding of process parameters and its optimization
●	Design Taguchi‘s approach to experimental design for attaining robustness
●	Apply Response Surface Method and Shainin DOE to evaluate quality.

Text Books:	
1	Montgomery, D.C., Design and Analysis of Experiments, 10th Edition, John Wiley and Sons, 2020
2	Krishnaiah K and Shahabudeen P, Applied Design of Experiments and Taguchi Methods, PHI, 1st Edition, 2019

Reference Books(s) / Web links:	
1	Box, G. E., Hunter, W.G., Hunter, J.S., Hunter, W.G, Statistics for Experimenters, Design, Innovation, and Discovery, 2nd Edition, Wiley, 2015
2	Krishnaiah K, Applied Statistical Quality Control and Improvement‖, 1st Edition,2018
3	Phillip J. Ross, Taguchi Techniques for Quality Engineering‖, Tata McGraw-Hill, India, 2015
4	https://archive.nptel.ac.in/courses/110/105/110105087
5	https://onlinecourses.nptel.ac.in/noc21_mg48/preview
6	https://archive.nptel.ac.in/courses/111/104/111104075
7	https://home.iitk.ac.in/~shalab/spanova.htm
8	https://pythonhosted.org/pyDOE
9	https://www.youtube.com/watch?v=KhjM8YI3agk
10	https://www.udemy.com/course/design-of-experiments-experimental-design-doe

PO-PSO / CO	POs												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
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ME23D14.5	3	3	3	2	3	-	-	1	-	-	-	2	-	2	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

VERTICAL 5 – DIGITAL MANUFACTURING

Course Code	Course Title (Theory course)	Category	L	T	P	C
ME23E11	DIGITAL MANUFACTURING AND IoT	PE	3	0	0	3

Objectives:	
●	To understand the evolution, need, and emerging trends of digital manufacturing.
●	To explore digital tools and collaborative approaches in lifecycle and supply chain management.
●	To examine smart factory technologies and principles for intelligent manufacturing.
●	To introduce Industry 4.0 concepts and technologies for connected manufacturing systems.
●	To understand the core concepts and applications of digital twin technology.

UNIT-I	INTRODUCTION TO DIGITAL MANUFACTURING	9
Introduction and Need for Digital Manufacturing - Overview and Evolution of Digital Manufacturing - Key Aspects: Product Life Cycle - Smart Factory - Value Chain Management Practical Benefits of Digital Manufacturing - Emerging Trends: Autonomous Manufacturing - Sustainable Digital Practices		
UNIT-II	**DIGITAL LIFE CYCLE & SUPPLY CHAIN MANAGEMENT**	**9**
Collaborative Product Development - Cloud-Based Collaboration - Digital Product Lifecycle: Part Numbering - Engineering Vaulting – Reuse- Engineering Change Management - Digital BOM - Process Consistency -Digital Mock-Up - Prototyping - Virtual Testing - Digital Supply Chain: Scope - Challenges - Blockchain-Driven Transparency Future-Ready SCM Practices with AI - Predictive Analytics		
UNIT-III	**SMART FACTORY**	**9**
Smart Factory Concepts and Levels - Benefits and Key Technologies: AI - IoT - Edge Computing - Smart Factory in IoT - Real-Time Data Processing - Principles of Smart Factory Design – Cybersecurity - Integrating Digital Twins - AR for Factory Optimization.		
UNIT-IV	**INDUSTRY 4.0 AND CONNECTIVITY**	**9**
Introduction to Industry 4.0 - Core Components - IoT and Industrial IoT for Connected Manufacturing - Intelligent Networks - Edge Computing in Manufacturing - Data Analytics - Cloud Computing - Cyber-Physical Systems (CPS) - Machine-to-Machine (M2M) Communication - Real-World Applications		
UNIT-V	**DIGITAL TWIN TECHNOLOGY**	**9**
Core Concepts and Features of Digital Twins - Digital Thread - Digital Shadow in Lifecycle Management - Building Blocks of Digital Twin Platforms: Sensors - AI - Data Models - Types and Characteristics of Digital Twin Platforms - Benefits - Challenges in implementation - Future Directions: Autonomous Systems - Smart Logistics.		
	Total Contact Hours : 45	

Course Outcomes: At the end of the course the students would be able to	
●	Explain the key aspects of the product lifecycle, smart factories, and sustainable practices.
●	Apply modern practices like block chain and AI for transparent and predictive supply chain management.
●	Design secure and optimized manufacturing systems using IoT, edge computing, and digital twins.
●	Evaluate the role of IoT, CPS, and cloud computing in intelligent manufacturing applications.
●	Develop solutions for autonomous systems and logistics using digital twin platforms.

Text Books:	
1	Anthony Tarantino, Smart Manufacturing: The Lean Industry 4.0 Revolution, Wiley, 1st Edition, 2022.
2	Alp Ustundag and Emre Cevikcan, Industry 4.0: Managing the Digital Transformation, Springer, 1st Edition,2017.
3	Maryam Farsi, Alireza Daneshkhah, et al., Digital Twin Technologies and Smart Cities, Academic Press (Elsevier), 1st Edition, 2020.

Reference Books(s) / Web links:	
1	Bernhard Scholz-Reiter and Florian Freitag, Design Principles for Industry 4.0, Springer, 1st Edition, 2019. (Elsevier), 1st Edition, 2020.
2	Rajesh Agnihotri and Shashwat Agnihotri, Digital Transformation of Industry: Industry 4.0, Publisher unclear, 1st Edition, 2020
3	Raj Rajkumar, Dionisio de Niz, and Mark Klein, Cyber-Physical Systems: Foundations, Principles, and Applications, Pearson Education, 1st Edition, 2016.
4	Adedeji B. Badiru and Vhance V. Valencia, Additive and Digital Manufacturing: Practices and Applications, CRC Press (Taylor & Francis), 1st Edition, 2020.

PO-PSO / CO	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
ME23E11.1	3	-	-	-	-	-	2	-	-	-	-	3	-	-	1
ME23E11.2	-	3	-	-	3	-	-	-	2	-	-	-	-	-	1
ME23E11.3	-	-	-	3	3	-	-	-	-	2	-	-	-	-	1
ME23E11.4	3	-	-	-	3	2	-	-	-	-	-	-	-	-	1
ME23E11.5	-	-	2	-	3	-	-	-	-	-	2	-	-	-	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Theory course)	Category	L	T	P	C
ME23E12	**LEAN MANUFACTURING**	**PE**	**3**	**0**	**0**	**3**

Objectives:	
●	To make the students understand how the philosophy and core methods of lean manufacturing are applied to any business
●	To impart knowledge on systematic approach for implementing value stream mapping
●	To develop a future state vision of lean systems by using kaizens to eliminate the causes of waste by identifying new ways to achieve continuous flow through manufacturing cells
●	To make the students to use their leadership skills needed to drive lean initiatives.
●	To inculcate the practice of operational excellence through Toyoto's way.

UNIT-I	**INTRODUCTION TO LEAN MANUFACTURING**	**9**
Definition and concept of lean manufacturing - Principles of lean manufacturing – Just in time –Types of pull systems - Toyota Production systems – Benefits of lean manufacturing – Theory of constraints – Reduction of wastes.		
UNIT-II	**LEAN MANUFACTURING TOOLS**	**9**
Standardized work - standard work sequence - Timing and work in progress - Quality at source – Jidoka -Visual management system - Poka-yoke- 5S technique; Advantages and benefits, 5S audit - Visual control aids for Improvement.		
UNIT-III	**STRATEGIC ISSUES AND LEAN IMPLEMENTATION**	**8**
Strategic Issues - Leadership - Management of Teams – Focused factory concept – Availability, Variability, Lean Implementation strategies- Causes for Failures - Sustaining Lean - Constraint Management.		
UNIT-IV	**TOTAL PRODUCTIVE MAINTENANCE**	**10**
Goals and benefits - Hidden Factory - The six big losses - Types of Maintenance -Overall Equipment Effectiveness - Pillars of TPM and implementation; Changeover and setup time reduction techniques - Temple of quality - OEE calculations.		
UNIT-V	**LEAN METRICS AND LEAN SUSTENANCE**	**9**
Identify Lean Metrics - Steps involved in Goal Setting - Corporate Goals - Kaizen Cloud - Identification in VSM - Lean Assessment - Cultural Change – Reviews –Recognition - Improving Targets and Benchmarks.		
	Total Contact Hours : 45	

Course Outcomes: At the end of the course the students would be able to	
●	Identify key requirements and concepts in lean production system.
●	Apply the tools in lean manufacturing to analyze a manufacturing system and plan for its improvements.
●	Understand strategic issues and develop skills to effectively implement and sustain lean practices, including leadership, team management, focused factory concepts, and constraint management.
●	Learn to enhance productivity through TPM, minimize losses, and improve Overall Equipment Effectiveness (OEE) with practical implementation techniques.
●	Develop the ability to identify lean metrics, set goals, sustain lean practices, and drive continuous improvement through cultural change and benchmarking

Text Books:	
1	Pascal Dennis, Lean Production Simplified: A Plain-Language Guide to the World's Most Powerful Production System, 2015, Seventh Edition, CRC Press-Taylor & Francis,UK.
2	Don Tapping, Tom Luyster and Tom Shuker, Value Stream Management: Eight Steps to Planning, Mapping, and Sustaining Lean Improvements, Productivity Press, New York, 2017

Reference Books(s) / Web links:	
1	John Allen, Charles Robinson and David Stewart, Lean Manufacturing: A Plant Floor Guide, Society of Manufacturing Engineers, Michigan,2012.
2	Mike Rother, "Toyota Kata: Managing People for Improvement, Addictiveness, and Superior Results", Tata MaGraw-Hill Edition,2010
3	James P. Womack and Daniel T. Jones, Lean Thinking: Banish Waste & Create Wealth in Your Corporation, Revised Edition, Simon & Shuste,2008.
4	https://archive.nptel.ac.in/courses/110/107/110107130/

PO-PSO / CO	POs												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
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ME23E12.2	2	-	1	-	1	-	1	-	-	-	1	2	-	1	2
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ME23E12.4	1	-	2	1	1	-	1	-	2	2	1	2	-	-	2
ME23E12.5	1	-	2	1	2	-	1	-	2	1	1	2	-	-	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Theory course)	Category	L	T	P	C
ME23E13	ADVANCED MACHINING PROCESSES	PE	3	0	0	3

Objectives:	
●	To understand the importance of non-traditional machining and mechanical energy-based processes.
●	To get aware of the Working principles of different chemical and electro chemical energy based processes and its process parameters.
●	To explore the Working principles of thermo-electric energy-based processes and its process parameters.
●	To study about various nano finishing processes.
●	To learn about the Different types of Hybrid non-traditional machining processes and their applications.

UNIT-I	INTRODUCTION AND MECHANICAL ENERGY BASED PROCESSES	9
Introduction - Need for non-traditional machining processes - Classification of non-traditional machining processes– Brief overview - Abrasive jet machining, Water jet Machining, Ultrasonic machining their principles, equipment, effect of process parameters, applications, advantages and limitations- Case studies.		
UNIT-II	**CHEMICAL AND ELECTRO CHEMICAL ENERGY BASED PROCESSES**	9
Principles, effect of process parameters, applications, advantages and limitations of Chemical machining, Maskant applying techniques. Principles, equipment, effect of process parameters, applications, advantages and limitations of Electro-chemical machining, Electro-chemical honing, Electro-chemical grinding and Electro chemical deburring - Case studies – Virtual demo on ECM process.		
UNIT-III	**THERMO-ELECTRIC ENERGY BASED PROCESSES**	9
Principles, equipment, 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 - Case studies. – Virtual demo on ECM process.		
UNIT-IV	**NANO FINISHING PROCESSES**	9
Principles, equipment, 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 - Case studies.		
UNIT-V	**HYBRID NON-TRADITIONAL MACHINING PROCESSES**	9
Introduction and classification of Hybrid Machining processes, Principles, equipment's of Assisted hybrid processes and combined or mixed-type processes. Assisted hybrid processes-Vibration assisted EDM, Ultrasonic-Assisted ECM (USECM), Laser assisted ECM (LAECM), Laser-Assisted EDM (LAEDM). Combined hybrid machining - Electrochemical Discharge Machining (ECDM), Electric Discharge Grinding (EDG), Abrasive water jet machining-Case studies.		
	Total Contact Hours : 45	

Course Outcomes: At the end of the course the students would be able to	
●	Familiar about different types of non-traditional machining processes and explain mechanical energy based non-traditional machining processes.
●	Recognise the working principles of chemical and electro chemical energy-based processes.
●	Describe the working principles of thermo-electric energy-based processes.
●	Appreciate about the various nano finishing processes.
●	Understand the working of different hybrid non-traditional machining processes.

Text Book (s):	
1	Vijay.K. Jain, Advanced Machining Processes, Allied Publishers Pvt. Ltd., New Delhi, 2007.
2	Kapil Gupta, Neelesh K. Jain and Laubscher R.F, Hybrid Machining Processes: Perspectives on Machining and Finishing, 1st edition, Springer International Publishing., Switzerland, 2016.
3	Amey Khot Ashok More and Manish Agarwal, Advanced Manufacturing Process, ISBN-13 : 978-9350162583, 2014.

Reference Books(s) / Web links:	
1	Pandey.P and Shan.H, Modern Machining Processes, McGraw Hill Education, ISBN-13, 978-0070965539, 2017.
2	Adithan. M, Unconventional Machining Processes, Atlantic, New Delhi, India, 2009.
3	Gary F. Benedict, Non-traditional Manufacturing Processes, Routledge, 2017.
4	Vijay.K. Jain Nanofinishing Science and Technology: Basic and Advanced Finishing and Polishing Processes, CRC Press, 2016.
5	XichunLuo, Yi Qin, Hybrid Machining, Elsevier, 2018.
6	Streeter, V. L. and Wylie E. B., Fluid Mechanics, McGraw Hill Publishing Co. (2010).
7	https://nptel.ac.in/courses/112/103/112103202/ -:Advanced Machining Processes.

PO-PSO / CO	POs												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
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ME23E13.2	2	-	-	-	2	2	-	-	-	-	-	2		1	1
ME23E13.3	2	-	-	-	2	2	-	-	-	-	-	2		1	1
ME23E13.4	2	-	-	-	-	2	-	-	-	-	-	2		1	1
ME23E13.5	2	-	-	-	-	2	-	-	-	-	-	2		1	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Theory course)	Category	L	T	P	C
ME23E14	GREEN MANUFACTURING DESIGN AND PRACTICES	PE	3	0	0	3

Objectives:	
	To introduce the concept of environmental design and industrial ecology.
	To impart knowledge about air pollution and its effects on the environment
	To enlighten the students with knowledge about noise and its effects on the environment.
	To enlighten the students with knowledge about water pollution and its effects on theenvironment.
	To introduce the concept of green co-rating and its need

UNIT-I	DESIGN FOR ENVIRONMENT AND LIFE CYCLE ASSESSMENT	9
Environmental effects of design -selection of natural friendly material - Eco design – Environmentaldamage Material flow and cycles – Material recycling – Emission less manufacturing- Industrial Ecology – Pollution prevention – Reduction of toxic emission – design for recycle- **Case study on environmental friendly material and its life cycle.**		
UNIT-II	**AIR POLLUTION SAMPLING AND MEASUREMENT**	**9**
Primary and Secondary Pollutants, Automobile Pollutants, Industrial Pollution, Ambient air qualityStandards, Metrological aspects of air Pollution, Temperature lapse Rates and Stability-wind velocity and turbulence-Pump behavior dispersion of air Pollutants-solution to the atmosphere dispersion equation the Gaussian Plume Model, Air pollution sampling-collection of gaseous air pollutants-collection of particulate pollutants-stock sampling, analysis of air pollutants-sulfur dioxide-nitrogen dioxide, carbon monoxide, oxidants and ozone.**Case study on effect of air pollution level and its impact.**		
UNIT-III	**NOISE POLLUTION AND CONTROL**	**9**
Frequency and Sound Levels, Units of Noise based power radio, contours of Loudness. Effect of human, environment and properties, Natural and Anthrogenic Noise Sources, Measuring Instruments for frequency and Noise levels, Masking of sound, Types, Kinetics, Selection of different reactors used for waste treatment, Treatment of noise at source, Path and Reception, Sources of noise, Effects of noise- Occupational Health hazards, thermal Comforts, Heat Island Effects, Radiation Effects. **Case study on effect of noise pollution and its impact.**		
UNIT-IV	**WATER DEMAND AND WATER QUALITY**	**9**
Factors affecting consumption, Variation, Contaminants in water, Nitrates, Fluorides, Detergents, taste and odour, Radio activity in water, Criteria, for different impurities in water for portable and non-portable use, Point and non-point Source of pollution, Major pollutants of Water, Water Quality Requirement for different uses, Global water crisis issues.**Case study on effect of water pollution and its impact.**		
UNIT-V	**GREEN CO-RATING**	**9**
Ecological Footprint - Need for Green Co-Rating – Green Co-Rating System – Intent – System Approach – Weightage-Assessment Process – Types Of Rating – Green Co-Benefits – Case Studies of Green Co- Rating.		
	TotalContact Hours : 45	

CourseOutcomes: At the end of the course the students are able to:
Explain the environmental design and selection of eco-friendly materials.
Analyzethe best manufacturing processes towards minimization or prevention of air pollution.
Applythe appropriate manufacturing processes towards minimization or prevention of noise pollution.
Examine the manufacturing processes towards minimization or prevention of water pollution.
Evaluate green co-rating and its benefits.

TextBooks:	
1	Gradel.T.E. and B.R. Allenby – Industrial Ecology – Prentice Hall – 2010
2	Rao M.N. and Dutta A.K. “Wastewater treatment”, Oxford & IBH publishing Co. Pvt. Ltd., New

ReferenceBooks(s)/Weblinks:	
1	Gradel.T.E. and B.R. Allenby – Industrial Ecology – Prentice Hall – 2010.
2	Frances Cairncross– Costing the Earth: The Challenge for Governments, the Opportunities for Business – Harvard Business School Press – 1993.
3	World Commission on Environment and Development (WCED), Our Common Future, Oxford University Press 2005.
4	Rao M.N. and Dutta A.K. "Wastewater treatment", Oxford & IBH publishing Co. Pvt. Ltd., New Delhi, Second Edition, 2006
5	Rao CS Environmental Pollution Control Engineering-, Wiley Eastern Ltd., New Delhi, 2006.
6.	Lewis H Bell and Douglas H Bell, Industrial noise control, Fundamentals and applications, Marcel Decker, 1994
7	https://archive.nptel.ac.in/courses/112/104/112104225/

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	1	1	3	1	-	2	3	-	1	-	-	1	-	-	-
CO 2	1	1	3	1	-	2	3	-	1	-	-	1	-	-	-
CO 3	1	1	3	1	-	2	3	-	1	-	-	1	-	-	-
CO 4	1	1	3	1	-	2	3	-	1	-	-	1	-	-	-
CO 5	1	1	3	1	-	2	3	-	1	-	-	1	-	-	-

1:Slight(Low) 2:Moderate(Medium)3:Substantial(High)

VERTICAL 6 – ENERGY SYSTEMS

Course code	Course Title (Theory Course)	Category	L	T	P	C
ME23F11	MEASUREMENT AND CONTROL FOR ENERGY SYSTEM	PE	3	0	0	3

Objectives:	
•	To impart knowledge about characteristics of measurement system and statistical analysis Measured data.
•	To make students conversant with the electrical measurements and signal conditioning circuits.
•	To provide insight into the digital measuring techniques of physical quantities and Solarinstruments.
•	To make the students get acquainted with the measurement of Thermo-Physical properties and ai pollutants.
•	To inculcate skills in the design and development of measurement and control systems.

UNIT-I	Measurement System: Characteristics and Statistical Analysis	9
Introduction to measurement system, Errors in Measurement, Static and Dynamic characteristics transducers, Statistical analysis of experimental data–Uncertainty analysis, Regression analysis, Design experiments–Full and Half factorial design.		
UNIT-II	**Electrical Measurements and Signal Conditioning**	**9**
Voltage, Current, Power, Energy, Time and Frequency measurement, Frequency Counter, Sig conditioning Circuits: Wheatstone bridge–Differential Amplifier–V to I Converter, I to V Conver Integrator, Differentiator, Instrumentation Amplifier, Attenuators and Filters, DAC, ADC, PID Control		
UNIT-III	**Digital Measurement of Physical Quantities**	**9**
Digital measuring techniques of Displacement, Temperature, Pressure, Force, Torque, Vibration, Acceleration, Velocity, Level, Flow, Thermal and Nuclear Radiation. Solar instruments: Pyrheliometers – Pyranometers – Pyrheliometers – Albedometers – Pyrradiometers – Pyrgeometers – Net Pyrradiometers – Sun photometers.		
UNIT-IV	**Measurement of Thermo-Physical Properties and Air Pollutants**	**9**
Measurement of Thermal Conductivity–Solids, Liquids and Gas, Viscosity, Gas Diffusion. CalorimeterBomb Calorimeter – Continuous flow Calorimeter. Measurement of Heat Transfer, Humidity, Heat pH, Air pollution Sampling and Measurement–Particulate Sampling techniques –Measurement of Sulphur Dioxide, Combustion products, Opacity and Odour.		
UNIT-V	**Control Systems**	**9**
Introduction to Controller – Interfacing with I/O devices of system: Sensors, Display devices, StepperServomotors. Measurement by Data Acquisition System. Introduction to Internet of Things (IoT Application of IoT with Raspberry Pi for Process monitoring and control–Energy management. Controller in thermal systems-Application of Smart Sensors and Intelligent instrumentation and Control		
	Total Contact Hours :	**45**

Course Outcomes: Upon completion of the course students should be able to:	
•	Analyze and evaluate the uncertainties in measurement data.
•	Identify appropriate sensors for measuring electrical quantities and signal conditioning Circuits.
•	Explain the digital measurement techniques of physical quantities and solar instruments.
•	Compare the thermo-physical properties of air pollutants and identify air pollutant measurement techniques.
•	Design and develop the appropriate measurement and control system for an application

S. No	Text Books:
1	Stoecker, W.F., Design of Thermal Systems, McGraw Hill, 1989.
2	Bejan, A, Tsatsaronis, G and Moran, M., Thermal Design and Optimization, John Wiley & Sons 1996.
S. No	**Reference Books(s) / Web links:**
1	Barney G.C., ―Intelligent instrumentation: microprocessor applications in measurement and Controll‖, Prentice Hall,1988.
2	Bell C., ―Beginning Sensor Networks with Arduino and Raspberry Pi, A press, 2013.
3	Doebelin E. and Manik D.N., ―Doebelin's Measurement Systems‖, Tata McGraw Hill, 2011.
4	George, B., Roy, J.K., Kumar, V.J., Mukhopadhyay, S.C., ―Advanced Interfacing Techniques for Sensors‖, Springer, 2017. 5. Holman J.P., ―Experimental methods for Engineers, TataMcGraw Hill, 2007.

COs / PO/PSO	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
ME23F11.1	1	2	1	-	-	-	-	-	-	-	-	-	1	-	1
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ME23F11.4	1	-	2	2	1	2	2	1	-	1	1	2	-	1	2
ME23F11.5	1	-	-	2	2	2	1	1	-	2	2	2	1	1	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course code	Course Title (Theory Course)	Category	L	T	P	C
ME23F12	ENERGY CONSERVATION AND WASTE HEAT RECOVERY	PE	3	0	0	3

Objectives:	
•	Quantifying the energy demand and energy supply scenario of nation and explaining the need for energy auditing for becoming environmentally benign.
•	Analysing factors behind energy billing and applying the concept of demand side management for lowering energy costs
•	Computing the stoichiometric air requirement for any given fuel and quantifying the energy losses associated with thermal utilities of industries
•	Diagnosing the causes for under performance of various electrical utilities and suggesting remedies for improving their efficiency
•	Understand the significance of waste heat recovery systems and carry out its economic analysis.

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. Ro 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 a 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	**Waste Heat Recovery**	**9**
Sources of waste heat and its potential applications, Waste heat survey and measurements, Da collection, Limitations and affecting factors. Heat recovery equipment and systems, He Exchangers, Incinerators Regenerators and Recuperates. Waste Heat boilers. System Integration.		
	Total Contact Hours :	**45**

Course Outcomes: Upon completion of the course students should be able to:	
•	Understand the energy demand and energy supply scenario of nation and appreciate the need for energy auditing for becoming environmentally benign.
•	Analyse factors behind energy billing and apply the concept of demand side management for lowering energy costs.
•	Compute the stoichiometric air requirement for any given fuel and quantify the energy losses associated with thermal utilities of industries.
•	Diagnose the causes for under performance of various electrical utilities and suggest remedies for improving their efficiency.
•	Familiar with significance of waste heat recovery systems in the context of energy conservation.

S. No	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 Administered by Bureau of Energy Efficiency (BEE), a statutory body under Ministry Power, Government of India.
2	K. Nagabhushan Raju, Industrial Energy Conservation Techniques: (concepts, Application and

	Case Studies), Atlantic Publishers & Dist, 2007.
S. No	**Reference Books:**
1	J. H. Harlock, Combined Heat and Power, Pergaman Press, 1987
2	F. Kreith and R. E. West, Energy Efficiency, CRC handbook, CRC Press,1999
3	Kays and London, Compact Heat Exchangers, 3rd edition, McGraw-Hill, New York, 1998.
4	https://beeindia.gov.in/sites/default/files/2Ch8.pdf

CO s	**PO/PSO**	**POs**												**PSOs**		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
ME23F12.1		1	1	1	1	-	-	1	-	-	-	-	-	1	-	1
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ME23F12.3		2	2	3	3	-	-	1	-	-	-	-	-	2	2	2
ME23F12.4		2	2	3	3	-	-	1	-	-	-	-	-	2	2	2
ME23F12.5		2	2	3	3	-	-	1	-	-	-	2	2	2	2	2

Course code	Course Title (Theory Course)	Category	L	T	P	C
ME23F13	RENEWABLE SOURCES OF ENERGY	PE	3	0	0	3

Objectives:	
•	To identify the sources available to mankind, in relation to available technologies.
•	To discuss the human being's, need for energy
•	To Understand basic characteristics of renewable sources of energy and technologies for their utilization.
•	To Apply the principle of energy conversion technologies of various renewable energy resources.
•	To give effective review on utilization trends of renewable sources of energy.

Unit – I	Energy Scenario	9
Introduction to energy – Present energy status - Global and Indian energy scenario – sector wise energy consumption in India – Energy needs of growing economy – Integrated energy policy – Energy intensity on purchasing power parity-long term energy scenario for India – Energy security - Potential of renewable energy - Sustainability development - Global Environmental issues – Emission of carbon dioxide – Review on new technologies and future energy plans.		
Unit – II	**Solar Energy**	**9**
Spectral distribution of Solar radiation - Solar radiation measurement - Solar thermal collectors – Flat plate and concentrating collectors - Basics of solar concentrators - Solar thermal power generation - Solar thermal energy storage - Solar thermal applications - Solar stills - Solar pond - Physics of solar cells - Cell types - Fundamentals of solar photo voltaic conversion - PV system configurations - System components: Battery, charge controller and inverter - Solar PV applications - Building Integrated Solar.		
Unit – III	**Wind Energy**	**9**
Power in the wind- Wind data and energy estimation – Wind rose diagram - Betz limit - Site select for wind farms - Types of wind mills - Horizontal axis wind turbine - Vertical axis wind turbine components of wind mill – Wind turbine generators and its performance - Building Integrated Wind Energy - Environmental issues - Applications - Indian wind potential, Introduction to onshore offshore wind farms.		
Unit – IV	**Bio-Energy**	**9**
Bio resources - Biomass direct combustion - biochemical conversion-thermochemical conversion mechanical conversion - Biomass combustion and power generation- Biomass gratifier - Types gasifiers - Cogeneration - Carbonization - Pyrolysis - Biogas plants - Digesters - Biodiesel production Ethanol production - Waste to energy technologies - Heat Pumps.		
Unit – V	**Water And Other Renewable Energy Resources**	**9**
Technologies for harnessing Water energy - small hydro - Tidal energy - types of Tidal energy - Ocean Thermal Energy - Open and Closed OTEC – Geothermal energy – Types of Geothermal energy – Hydrogen energy technology - Fuel Cells – Types of fuel cell – Energy storage technology Hybrid technology - Environmental impact assessment.		
	Total Contact Hours :	**45**

Course Outcomes: Upon completion of the course students should be able to:	
•	Analyse the current energy scenario in terms of conventional renewable energy and future plan.
•	Understand basic properties of different renewable sources of energy and technologies for their utilization
•	Describe main elements of technical systems designed for utilization of renewable source of energy.
•	Explain the correlation between different operational parameters.
•	Select Engineering approach to problem solving when implementing the projects to renewable sources of energy.

Text Books:

1. John T widell, Tony Weir, and Anthony D. Weir, Renewable Energy Resources, Taylor &Francis, 2006.
2. G.D. Rai, ―Non-Conventional Energy Sources‖, Standard Publishers Distributors, 1992.

Reference Books:

1. K. Bansal, Non-Conventional Energy Resources, Vikas Publishing House, 2014.
2. Godfrey Boyle, ―Renewable Energy, Power for a Sustainable Future‖, Oxford University Press, 20
3. B.H. Khan, ―Non-Conventional Energy Resources‖, McGraw Hill, 2009.
4. J John A. Duffie and William A. Beckman (2006), Solar Engineering of Thermal Process, 3rd Edition Wiley & Sons.

CO	PO/PSO	POs												PSOs		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
ME23F13.1		3	-	-	1	-	2	1	1	-	-	-	2	-	1	1
ME23F13.2		3	-	-	1	1	1	1	1	-	-	-	2	-	1	1
ME23F13.3		3	-	-	1	1	1	1	1	-	-	-	2	-	1	1
ME23F13.4		3	-	-	1	-	1	1	1	-	-	-	2	-	1	1
ME23F13.5		3	-	-	1	-	1	1	1	-	-	-	2	-	1	1

Course code	Course Title (Theory Course)	Category	L	T	P	C
ME23F14	**HYBRID AND ELECTRIC VEHICLES**	**Theory**	**3**	**0**	**0**	**3**

Objectives:	
•	To understand upcoming technology of electric and hybrid electric vehicles
•	Analyse different aspects of drive train topologies
•	Learn different energy management strategies
•	To understand different communication systems used in electric and Hybrid electric vehicles
•	Explain the concept of vehicle to grid configurations

Unit – I	**Introduction of HEV's**	**9**
Social and environmental importance of hybrid and electric vehicles, Impact of modern drivetrains on energy supplies, Basics of vehicle performance, vehicle power source characterization, Transmission characteristics, Mathematical models to describe vehicle performance.		
Unit – II	**Basic concept of Hybrid Traction**	**9**
Introduction to various hybrid drive-train topologies, Power flow control in hybrid drive-train topologies, Fuel efficiency analysis, braking fundamentals and regenerative braking in EVs		
Unit – III	**Introduction to Electric Components**	**9**
Configuration and control of DC Motor drives, Configuration and control of Introduction Motor drives, configuration and control of Permanent Magnet Motor Drives, Configuration and control of Switch Reluctance Motor drives, drive system efficiency.		
Unit – IV	**Matching the Electric Machine and the Internal Combustion Engine (ICE)**	**9**
Sizing the propulsion motor, sizing the power electronics Selecting the energy storage technology, Communications, supporting subsystems		
Unit – V	**Introduction to Energy Management and their Strategies**	**9**
Classification of different energy management strategies Comparison of different energy management strategies Implementation issues of energy strategies. Plug-in electric vehicles, Vehicle to grid (V2G) and G2V fundamentals, battery thermal management for electric vehicle.		
	Total Contact Hours :	**45**

Course Outcomes:	
•	Understand the Impact of conventional vehicles on the society and different types of drive train topologies.
•	Apply the load modelling based on the road profile and braking concepts.
•	Analyse the different types of motors used in electric and hybrid electric vehicles.
•	Analyse the different types of energy storage systems.
•	The concept vehicle to grid (V2G) and grid to vehicle (G2V).

Text Books:

1. Mehrdad Ehsani, Yimin Gao, Ali Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals", CRC Press, 2010.
2. James Larminie, "Electric Vehicle Technology Explained", John Wiley & Sons, 2003
3. Iqbal Hussain, "Electric & Hybrid Vehicles – Design Fundamentals", Second Edition, CRC Press, 2011.

Reference Books:

1. Hybrid Vehicles and the future of personal transportation, Allen Fuhs, CRC Press, 2011.
2. Xi Zhang, Chris Mi, Vehicle Power Management: Modeling, Control and Optimization, Springer London Ltd; 2011th edition, 2013.

CO s	PO/PSO	POs												PSOs		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
ME23F14.1		2	2	2	-	-	-	-	-	-	-	2	-	1	2	2
ME23F14.2		2	2	2	-	-	-	-	-	-	-	2	-	1	2	-
ME23F14.3		2	2	2	-	-	-	-	-	-	-	2	-	-	2	2
ME23F14.4		2	2	2	-	-	-	-	-	-	-	2	-	-	2	--
ME23F14.5		2	2	2	-	-	-	-	-	-	-	2	-	-	2	2

VERTICAL 7 – DIVERSIFIED COURSES

Course Code	Course Title (Theory course)	Category	L	T	P	C
ME23G11	AUTOMOBILE ENGINEERING	PE	3	0	0	3

Objectives:	
●	To evaluate the various types of automobiles, their power packs, and types of vehicle bodies
●	To remember the various types of power train and fuel supply and management systems.
●	To apply the various types of transmission& clutch systems for a vehicle.
●	To understand the working parameters of various braking , suspension& Steering system in a vehicle.
●	To create the working parameters of various electrical and electronic devices in a vehicle.

UNIT-I	INTRODUCTON TO AUTOMOBILE ENGINEERING	9
An overview of different types of automobiles and their power sources. Specifications, Performance Parameters, Types of power delivery, Car body construction, Bus Body Details, General consideration relating to chassis layout. Introduction to Motor Vehicle Act & Regulations, Safety standards –N-CAP Test ,Aerodynamic test ,Stability test etc.		
UNIT-II	**POWERTRAIN AND FUEL MANAGEMENT SYSTEMS**	9
Reciprocating Engine Systems, Hybrid Systems, Fuel cells & Electric Vehicle. Pollution Norms (EURO & Bharat Stage), Emissions and their control; Catalytic converter systems. Engine Management systems with Electrical & Mechanical for SI and CI engines. Alternate fuels & properties - Alcohol, LPG, CNG, and Hydrogen.		
UNIT-III	**CLUTCH AND TRANSMISSION SYSTEMS**	9
Clutch system and types, Gear box and types – Manual & Automatic, propeller shaft & Joints, Differential, Axles & its types, Wheels, Wheel balancing & Tyres - function and types.		
UNIT-IV	**BRAKING , SUSPENSION & STEERING SYSTEMS**	9
Braking system – Working Principle and its types (Anti-Locking braking, Electronic distribution braking system), Specification of Suspension system - types and function. Steering system - working, types and steering geometry parameters.		
UNIT-V	**ELECTRICAL AND ELECTRONIC SYSTEMS**	9
Introduction to Battery, Alternator, and Starter Motor systems- working principle, and circuitry. Safety systems - Seat belts, Air-Bag. Modern Electronic features in vehicles like Tyre pressure monitoring, Electronic Stability Program , Forward collision warning ,Hill assist control, Advanced Driver Assistance System, Automatic headlamp control, Rain sensing wipers, Speed sensing, Auto locking, On-Board Diagnostics, HVAC system etc.		
	Total Contact Hours : 45	

Course Outcomes: At the end of the course the students would be able to	
●	Remember the various types of automobiles, their power packs, and types of vehicle bodies.
●	Evaluate the various types of power train and fuel supply and management systems.
●	Analysis the various types of transmission systems for a vehicle.
●	Apply the working parameters of various braking ,Suspension & Steering system in a vehicle
●	Understand various working parameters of various electrical and electronic devices in a vehicle.

Text Books:	
1	Kirpal Singh, Automobile Engineering Volume I and II, Standard Publishers &Distributors, 14th Edition, 2017.
2	William H. Crouse and Donald L. Anglin, “Automotive Mechanics”, Tata McGraw Hill, 10thEdition, 2004

Reference Books(s) / Web links:	
1	Gill P.S., “A Textbook of Automobile Engineering – Vol. I , II and III”, S.K.Kataria and Sons, 2ndEdition, 2012
2	Giri, N.K., “Automotive Technology”, Khanna Publishers, 2ndEdition, 2002.
3	Jack Erjavek, “Automotive Technology – A Systems Approach”, Thomson Learning, 3rdEdition, 1999
4	Kumar D.S., “Automobile Engineering”, S.K.Kataria and Sons, 2nd Edition, 2017.
5	Robert Bosch GmbH, “Automotive Handbook”, Robert Bosch, 2004.

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

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Theory course)	Category	L	T	P	C
ME23G12	INDUSTRIAL SAFETY	PE	3	0	0	3

Objectives:	
•	To explain the working principles of mechanical engineering processes such as metal forming, highlighting associated safety risks
•	To identify and evaluate faults in various tools, equipment, and machines used in industrial operations.
•	To assess the capabilities of different software tools available for risk quantification in industrial systems.
•	To demonstrate knowledge of design features for process industries and ensure safe operation of various industrial equipment.
•	To develop and apply safety and pollution control measures for sustainable operations in the process industry.

UNIT-I	SAFETY IN COLD FARMING AND HOT WORKING OF METALS	9
Cold working, power presses, point of operation safe guarding, auxiliary mechanisms, feeding and cutting mechanism, hand or foot-operated presses, power press electric controls, power press set up and die removal, Hot working safety in forging, hot rolling mill operation, safe guards in hot rolling mills – hot bending of pipes, hazards and control measures. Safety in gas furnace operation, cupola, crucibles, ovens, foundry health hazards, work environment, material handling in foundries, foundry production cleaning and finishing foundry processes.		
UNIT-II	**FAULT TRACING**	9
Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like any one machine tool, . Pump, Air compressor, Internal combustion engine, Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes		
UNIT-III	**RISK ANALYSIS QUANTIFICATION AND SOFTWARES**	9
Introduction to Discrete and Continuous Systems Simulation- Fault Tree Analysis and Event Tree Analysis, Logic symbols, methodology, minimal cut set ranking - fire explosion and toxicity index(FETI), various indices - Hazard analysis(HAZAN)- Failure Mode and Effect Analysis(FMEA)- Basic concepts of Reliability- Software on Risk analysis, CISCON, FETI, HAMGARS modules on Heat radiation, Pool fire, Jet, Explosion. Reliability soft wares on FMEA for mechanical and electrical systems.		
UNIT-IV	**SAFETY IN PROCESS DESIGN AND PRESSURE SYSTEM DESIGN**	9
Design process, conceptual design and detail design, assessment, inherently safer design- chemical reactor, types, batch reactors, reaction hazard evaluation, assessment, reactor safety, operating conditions, unit operations and equipment's, utilities. Pressure system, pressure vessel design, standards and codes- pipe works and valves- heat exchangers- process machinery- over pressure protection, pressure relief devices and design, fire relief, vacuum and thermal relief, special situations, disposal- flare and vent systems- failures in pressure system.		
UNIT-V	**SAFETY AND POLLUTION CONTROL**	**9**
Dust suppression techniques and worker safety protocols in cement and paper industries, Fire and explosion safety, handling of hazardous materials, and spill prevention in Petroleum industries, Worker safety in handling chemicals, waste treatment processes, and air pollution control in textile tanneries-Safety in boiler operations, ash handling systems, and reduction of greenhouse gas emissions in thermal power plants		
	Total Contact Hours :	45

Course Outcomes: At the end of the course the students would be able to	
•	Implement safety concepts effectively in metal forming processes to ensure operational safety and efficiency
•	Assess faults in tools, equipment, and machines to improve safety and reliability.
•	Utilize risk assessment techniques to quantify and mitigate risks in industrial operations
•	Design safe equipment and processes, leading to the development of secure and sustainable process industries
•	Analyse and apply safety and pollution control strategies in process industries effectively.

Text Books:	
1	L M Deshmukh, Industrial Safety Management, Tata McGraw-Hill Education, 2005.
2	Safety in Industry" N.V. Krishnan Jaico Publishery House, 1996.
3	S. P. Mahajan, "Pollution control in process industries", Tata McGraw Hill Publishing Company, New Delhi, 2006.

Reference Books(s) / Web links:	
1	Rao, CS, "Environmental pollution engineering:, Wiley Eastern Limited, New Delhi, 1 st January 2018.
2	Quantitative Risk assessment in Chemical Industries, Institute of Chemical Industries, Centre for Chemical process safety.
3	"Accident Prevention Manual for Industrial Operations" NSC, Chicago, 1982.

PO-PSO / CO	POs												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
ME23G12.1	3	-	-	-	-	3		-	-	-	-	-	-	-	3
ME23G12.2	-	3	-	3	-	-	-	-	-	-	-	-	-	-	3
ME23G12.3	-	-	-	-	2	3	-	-	-	-	-	-	-	-	3
ME23G12.4	-	-	3	-	-	-	2	-	-	-	-	-	-	-	3
ME23G12.5	3	-	-	-	-	-	3	-	-	-	2	-	-	-	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Theory course)	Category	L	T	P	C
ME23G13	COMPOSITE MATERIALS AND MECHANICS	PE	3	0	0	3

Objectives:	
●	To provide students with a fundamental understanding of the classification and properties of modern materials, including polymers, ceramics, metals, and composites.
●	To introduce students to the various processing techniques used in the manufacturing of polymer matrix, metal matrix, and ceramic matrix composites.
●	To develop the ability to analyze composite materials at the micromechanical level, focusing on the calculation of mechanical properties such as elastic moduli and strength.
●	To equip students with the knowledge of macromechanical behavior of composite lamina and laminates, including stress-strain relationships and failure theories.
●	To enable students to design composite structures and apply their knowledge in real-world case studies, integrating laminate analysis and structural design concepts.

UNIT-I	BASICS OF COMPOSITE MATERIALS	9
Modern materials in design: Types, metals, polymers, ceramics, composites; Polymers: Classification, properties of thermo plastics, properties of thermo setting plastics, applications, merits and demerits; Classification of composites: advantages, applications; Matrices and reinforcements: roles, classification, properties and composite structures.,		
UNIT-II	**PROCESSING OF COMPOSITES**	9
Manufacture of polymer matrix composites: Layup and curing, open and closed mould processes, bag moulding, filament winding, pultrusion, pulforming, thermoforming, advantages and limitations of different processes; Manufacture of metal matrix and ceramic matrix composites, advantages, limitations and characteristics of ceramic and metal matrix composites		
UNIT-III	**MICROMECHANICAL ANALYSIS OF A COMPOSITE LAMINA**	9
Rule of mixture - Volume and mass fractions: Density and void content, evaluation of elastic moduli, ultimate strengths of unidirectional lamina; Coefficients of thermal and moisture absorption.		
UNIT-IV	**MACRO MECHANICAL BEHAVIOUR OF A LAMINATE**	9
Stress strain relationships: Generalized Hook's Law for different types of materials, 2D unidirectional and angular lamina, co-ordinate transformation, material symmetry; Evaluation of elastic moduli, engineering constants for unidirectional and angular lamina; Strength failure theories of unidirectional and angular lamina.		
UNIT-V	**MACRO MECHANICAL BEHAVIOUR OF A LAMINATE**	**9**
Laminate code, stress - strain behaviour in a laminate; Resultant forces and moments in a laminate, inter laminar stresses in laminates; Design of composite structures - Case studies.		
	Total Contact Hours :	45

Course Outcomes: Upon successful completion of this course, students will be able to:	
●	Explain the classification, properties, and applications of modern materials, particularly polymers and composites.
●	Identify and compare various processing techniques for polymer matrix, metal matrix, and ceramic matrix composites, assessing their advantages and limitations.
●	Perform micromechanical analysis to evaluate elastic moduli, ultimate strength, and thermal/moisture absorption coefficients of composite lamina.
●	Analyze the macromechanical behavior of unidirectional and angular composite lamina, applying material symmetry and strength failure theories.
●	Design composite structures by applying laminate code principles, predicting stress-strain behavior, and calculating resultant forces and moments in composite laminates through case studies.

Text Books:	
1	Autar K Kaw, "Mechanics of Composite Materials", 2 nd Edition, CRC Press, 2007.
2	Krishan K Chawla. Composite Materials: Science and Engineering, Springer India,2015

Reference Books(s) / Web links:	
1	Madhujit Mukhopadhyay, Mechanics of Composite Materials and Structures, Universities Press, 2022.
2	Ronald F. Gibson, Principles of Composite Material Mechanics, CRC Press, 2016.
3	https://archive.nptel.ac.in/courses/112/104/112104229/
4	https://archive.nptel.ac.in/courses/101/104/101104010/

PO-PSO / CO	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
ME23G13.1	3	1	1	2	1	1	1	1	1	1	1	2	3	1	1
ME23G13.2	3	2	2	3	1	1	1	1	1	1	2	2	3	1	1
ME23G13.3	3	3	3	3	1	1	2	1	1	2	2	2	2	1	1
ME23G13.4	3	3	3	3	3	1	1	1	1	2	2	2	3	1	1
ME23G13.5	3	3	3	3	3	1	2	1	2	2	2	2	3	1	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Theory course)	Category	L	T	P	C
ME23G14	MATERIAL CHARACTERISATION TECHNIQUES	PE	3	0	0	3

Objectives:	
●	To analyze the crystal structure of materials through various evaluation techniques.
●	To Illustrate the principles and applications of microstructural analysis using optical microscopy.
●	To introduce the microstructure and surface topography of materials by electron microscopy.
●	To summarize the methods of surface-chemical characterization of materials using spectroscopy techniques.
●	To understand and apply different thermal analysis techniques for evaluating material properties.

UNIT-I	CRYSTAL STRUCTURE ANALYSIS	9
Elements of Crystallography – X- ray Diffraction – Bragg ‘s law – Techniques of X-ray Crystallography – analysis of Diffraction patterns – Inter planer spacing – Identification of Crystal Structure- Wide Angle X-ray Diffraction and Scattering.		
UNIT-II	**OPTICAL MICROSCOPY**	**9**
Principles of Optical Microscopy – Specimen Preparation Techniques – Polishing and Etching – polarization Techniques – Quantitative Metallography – Estimation of grain size – ASTM grain size numbers – Microstructure of Engineering Materials.		
UNIT-III	**ELECTRON MICROSCOPY**	**9**
Interaction of Electron Beam with Materials-Scanning Electron Microscopy – Construction and working of SEM - Back scattered and Secondary Electron Imaging Techniques – Applications- – Transmission Electron Microscopy – Specimen Preparation – Imaging Techniques – BF and DF – SAD – Electron Probe Microanalysis – Atomic Force Microscopy- Construction and working of AFM - Contact and Non-Contact modes Applications.		
UNIT-IV	**SURFACE CHEMICAL ANALYSIS**	**9**
Basic Principles, Practice and Applications of X-Ray Spectrometry–Energy dispersive and Wave Dispersive X-Ray Spectrometry–Secondary Ion Mass Spectroscopy–atomic absorption spectrometry– Infrared spectroscopy - Raman spectroscopy Auger electron spectroscopy, X-ray photoelectron spectroscopy.		
UNIT-V	**THERMAL ANALYSIS**	**9**
Classification, Basic Principles, Practice and applications of Thermo gravimetric analysis, Differential thermal analysis, Differential Scanning Calorimetry, Thermo mechanical analysis, Dynamic mechanical analysis, and Dilatometry.		
	Total Contact Hours : 45	

Course Outcomes: At the end of the course the students would be able to	
●	Understand the crystal structure evaluation of materials by XRD.
●	Illustrate the microstructural analysis by optical microscopy
●	Select the suitable electron microscopy method for different applications.
●	Choose suitable spectroscopy methods for surface - chemical characterisation of materials
●	Recommend suitable thermal analysis techniques.

Text Books:	
1	Angelo, P.C., “Materials Characterisation”, 1st Edition Cengage Publication, 2016.
2	Sam Zhang, Lin Li, Ashok Kumar, “Materials Characterization Techniques”, CRC Press, 2008.
3	Cullity, B. D., Stock, S.R. “Elements of X-ray diffraction”, Pearson New International Edition, 3rd Edition, 2014

Reference Books(s) / Web links:	
1	Yang Leng: Materials Characterization-Introduction to Microscopic and Spectroscopic Methods, John Wiley & Sons (Asia) Pte Ltd., 2008.
2	ASM Handbook: Materials Characterization, ASM International, 2008
3	https://nptel.ac.in/courses/115/103/115103030/

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

PO-PSO / CO	POs												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
ME23G14.1	2	2	1	2	1	-	-	-	1	2	1	1	1	2	1
ME23G14.2	2	2	1	2	1	-	-	-	1	2	1	1	1	2	1
ME23G14.3	2	2	1	2	1	-	-	-	1	2	1	1	1	2	1
ME23G14.4	2	2	1	2	1	-	-	-	1	2	1	1	1	2	1
ME23G14.5	2	2	1	2	1	-	-	-	1	2	1	1	1	2	1