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

25 years OF ACADEMIC EXCELLENCE

DEPARTMENT OF MECHANICAL ENGINEERING

Regulation 2019 – 2021 Batch

Choice Based Credit System

(CBCS)

Curriculum and Syllabus

RAJALAKSHMI ENGINEERING COLLEGE
(An Autonomous Institution Affiliated to Anna University Chennai**)**

DEPARTMENT OF MECHANICAL ENGINEERING

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

REGULATIONS 2019 for Batch 2021 Onwards

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.	HS19151	Technical English	HS	3	2	1	0	**3**
2.	MA19151	Algebra and Calculus	BS	4	3	1	0	**4**
3.	PH19141	Physics of Materials	BS	5	3	0	2	**4**
4.	GE19101	Engineering Graphics	ES	4	2	2	0	**4**
Practical								
5.	GE19121	Engineering Practices - Civil and Mechanical	ES	2	0	0	2	**1**
Non-Credit – Mandatory Course								
6.	MC19101	Environmental Science and Engineering (Non-Credit)	MC	3	3	0	0	**0**
			Total	**21**	**13**	**4**	**4**	**16**

SEMESTER II

S.No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
Theory								
1.	MA19251	Differential Equations and Vector	BS	4	3	1	0	**4**
2.	CY19241	Engineering Chemistry	BS	5	3	0	2	**4**
3.	ME19201	Manufacturing Processes	PC	3	3	0	0	**3**
4.	GE19201	Engineering Mechanics	ES	3	2	1	0	**3**
5.	GE19207	தமிழர் மரபு / Heritage of Tamils	ES	1	1	0	0	**1**
Practical								
6.	GE19211	Problem solving and programming in Python	ES	5	1	0	4	**3**
7.	GE19122	Engineering Practices- Electrical and Electronics	ES	2	0	0	2	**1**
Non-Credit – Mandatory Course								
8.	MC19102	Indian Constitution and Freedom Movement (Non-Credit)	MC	3	3	0	0	**0**
			Total	**26**	**15**	**2**	**8**	**19**

SEMESTER III

S.No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
Theory								
1.	MA19355	Transforms and Applications	BS	4	3	1	0	**4**
2.	ME19301	Engineering Thermodynamics	PC	4	3	1	0	**4**
3.	ME19302	Metal cutting and Machine tools	PC	3	3	0	0	**3**
4.	ME19303	Kinematics of Machinery	PC	3	2	1	0	**3**
5.	EE19241	Basic Electrical Engineering	ES	5	3	0	2	**4**
6.	GE19307	தமிழரும் தொழில்நுட்பமும் / Tamils and Technology	ES	1	1	0	0	**1**
Practical								
6.	ME19311	Machine Drawing Laboratory	PC	3	0	0	3	**1.5**
7.	ME19312	Manufacturing Technology Laboratory	PC	3	0	0	3	**1.5**
8.	CS19411	Python programming for machine learning	ES	5	1	0	4	**3**
			Total	**30**	**16**	**3**	**12**	**25**

SEMESTER IV

S.No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
Theory								
1.	MA19455	Statistics and Numerical Methods	BS	4	3	1	0	**4**
2.	ME19401	Thermal Engineering	PC	3	3	0	0	**3**
3.	ME19402	Strength of Materials	PC	3	3	0	0	**3**
4.	ME19403	Fluid Mechanics and Machinery	PC	3	3	0	0	**3**
5.	ME19404	Engineering Materials and Metallurgy	PC	3	3	0	0	**3**
6.	GE19303	Economics for Engineers	HS	3	3	0	0	**3**
Practical								
7.	ME19411	Strength of Materials and Fluid Mechanics and Machinery Laboratory	PC	3	0	0	3	**1.5**
8.	ME19412	Thermal Engineering Laboratory- I	PC	3	0	0	3	**1.5**
9.	GE19421	Soft Skills - I	EEC	2	0	0	2	**1**
Non-Credit – Mandatory Course								
10.	MC19301	Essence of Indian Traditional knowledge (Non-Credit)	MC	3	3	0	0	0
			Total	**30**	**21**	**1**	**8**	**23**

SEMESTER V

S.No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
Theory								
1.	ME19501	Design of Machine Elements	PC	3	3	0	0	**3**
2.	ME19502	Heat and Mass Transfer	PC	3	3	0	0	**3**
3.	ME19541	Dynamics of Machines	PC	5	3	0	2	**4**
4.	ME19542	Metrology and Measurements	PC	5	3	0	2	**4**
5.	EC19351	Basic Electronics Engineering	ES	3	3	0	0	**3**
6.		Open Elective - I	OE	3	3	0	0	**3**
Practical								
7.	ME19511	CAD/CAM Laboratory	PC	3	0	0	3	**1.5**
8.	ME19512	Thermal Engineering Laboratory-II	PC	3	0	0	3	**1.5**
9.	GE19521	Soft Skills - II	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.	ME19601	Finite Element Analysis	PC	3	3	0	0	**3**
2.	ME19602	Gas Dynamics and Jet Propulsion	PC	3	3	0	0	**3**
3.	ME19603	Total Quality Management	PC	3	3	0	0	**3**
4.	ME19604	Design of Transmission systems	PC	3	3	0	0	**3**
5.		Professional Elective-I / Verticals	PE	3	3	0	0	**3**
6.		Open Elective - II	OE	3	3	0	0	**3**
Practical								
7.	GE19621	Problem Solving Techniques	EEC	2	0	0	2	**1**
8.	ME19611	Simulation and Analysis Laboratory	PC	3	0	0	3	**1.5**
9.	ME19612	Innovation and Design thinking for Mechanical Engineer	EEC	3	0	0	3	**1.5**
			Total	**26**	**18**	**0**	**8**	**22**

SEMESTER VII

S.No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
Theory								
1.	ME19701	Automobile Engineering	PC	3	3	0	0	**3**
2.	ME19702	Automation in Manufacturing	PC	3	3	0	0	**3**
3.	ME19741	Mechatronics	PC	5	3	0	2	**4**
4.		Professional Elective II / Verticals	PE	3	3	0	0	**3**
5.		Professional Elective III / Verticals	PE	3	3	0	0	**3**
Practical								
6.	ME19711	Project Phase-I	EEC	2	0	0	2	**1**
7.	ME19712	Comprehension	EEC	2	0	0	2	**1**
8.	ME19713	Artificial Intelligence for Mechanical Engineers	PC	6	0	0	6	**3**
			Total	**27**	**15**	**0**	**12**	**21**

SEMESTER VIII

S.No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
Theory								
1.		Professional Elective IV / Verticals	PE	3	3	0	0	**3**
2.		Professional Elective V / Verticals	PE	3	3	0	0	**3**
Practical								
3.	ME19812	Project -Phase-II	EEC	18	0	0	18	**9**
			Total	**24**	**6**	**0**	**18**	**15**

Summary of Credits:

CATEGORY	I	II	III	IV	V	VI	VII	VIII	Credits	(%)
BS	8	8	4	4	0	0	0	0	24	**14.72**
HS	3	0	0	3	0	0	-	-	6	**3.68**
ES	5	8	8	0	3	-	-	-	24	**13.5**
PC	0	3	13	15	17	13.5	13	0	74.5	**45.71**
PE	0	0	0	0	0	3	6	6	15	**9.2**
EEC	0	0	0	1	1	2.5	2	10	16.5	**10.12**
OE	0	0	0	0	3	3	0	0	6	**3.68**
Non-Credit*/ (Mandatory)	√	√		√						
TOTAL	**16**	**19**	**25**	**23**	**24**	**22**	**21**	**15**	**165**	**100**

Department of Mechanical Engineering REGULATIONS 2019 (From 2021 Intake batch) VERTICALS / PROFESSIONAL ELECTIVES							
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/VI SEM	ME19A11 Machine Learning for Intelligent Systems	ME19B11 Reliability and Maintenance Engineering	ME19C11 Drone Technologies	ME19D11 Design For X	ME19E11 Digital Manufacturing and IoT	ME 19F11 Measurement and control for energy system	ME19G11 Precision Manufacturing
V/VI SEM	ME19A12 CAD and CAE	ME19B12 Warehousing Automation	ME19C12 Electrical Drives and Actuators	ME19D12 Computer Aided Design	ME19E12 Lean Manufacturing	ME 19F12 Energy conservation and waste heat recovery	-
V/VI SEM	ME19A13 Numerical heat transfer	ME19B13 Operations Management	-				
VI SEM			ME 19C13 Robotics	ME 19D13 Geometric Dimensioning and Tolerancing	ME 19E13 Advanced Machining Processes	ME 19F13 Renewable sources of Energy	ME19G12 Industrial Safety
VI SEM							ME19G13 Composite Materials and Mechanics

VII SEM	ME19A14 Theory on Computation and Visualization	ME19B14 Material Handling Equipment, Repair and Maintenance	ME19C14 Embedded Systems and Programming	ME19D14 Design of Experiments	ME19E14 Green Manufacturing Design and Practices	ME 19F14 Hybrid and Electrical Vehicles	ME19G14 Material Characterisation Techniques
VII SEM	ME19A15 Computational Bio- Mechanics	ME19B15 Container Logistics	ME 19C15 Sensors and Instrumentation	ME 19D15 Design with Advanced materials	ME 19E15 Additive Manufacturing	ME19F15 Introduction to Power Plant Engineering	ME19G15 Principles of Management
VII SEM	ME19A16 Advanced Statistics and Data Analytics	ME19B16 Production Planning and Control	ME19C16 Hydraulics and Pneumatics	ME 19D16 Process planning and cost estimation	ME 19E16 Welding Technology	ME 19F16 Refrigeration and Air conditioning	ME19G16 Entrepreneurship Development
VIII SEM	ME19A17 Noise Acoustics and Vibration	ME19B17 Operations Research	ME19C17 Smart Mobility and Intelligent Vehicles	ME19D17 Product Life Cycle Management	ME19E17 Electronics Manufacturing technology	ME19F17 Advanced energy storage technologies	ME19G17 Marketing Management
VIII SEM	ME19A18 Computational Solid Mechanics	ME19B18 Supply chain and Logistics Management	ME 19C18 Haptics and Immersive Technologies	ME 19D18 New Product Development	ME 19E18 Digital Twin & Industry 4.0	ME 19F18 Energy systems modelling and analysis	ME19G18 Research Methodology and Intellectual Property Rights
VIII SEM	ME19A19 Computational Fluid Dynamics	ME19B19 Data Science	ME 19C19 Robot dynamics Applications	ME 19D19 Design of Jigs, Fixture & Press tools	ME 19E19 Non-Destructive Testing and Evaluation	ME 19F19 Energy Engineering and Management	ME19G19 Corrosion and Surface Engineering

PROFESSIONAL ELECTIVE COURSES: VERTICALS

VERTICAL 1 : COMPUTATIONAL ENGINEERING

S.No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
1.	ME19A11	Machine Learning for Intelligent Systems	PE	3	3	0	0	**3**
2.	ME19A12	CAD and CAE	PE	3	3	0	0	**3**
3.	ME19A13	Numerical heat transfer	PE	3	3	0	0	**3**
4.	ME19A14	Theory on Computation and Visualization	PE	3	3	0	0	**3**
5.	ME19A15	Computational Bio- Mechanics	PE	3	3	0	0	**3**
6.	ME19A16	Advanced Statistics and Data Analytics	PE	3	3	0	0	**3**
7.	ME19A17	Noise acoustics & vibration	PE	3	3	0	0	**3**
8.	ME19A18	Computational Solid Mechanics	PE	3	2	0	2	**3**
9.	ME19A19	Computational Fluid Dynamics	PE	3	3	0	0	**3**

VERTICAL 2 : LOGISTICS AND SUPPLY CHAIN MANAGEMENT

S.No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
1.	ME19B11	Reliability and Maintenance Engineering	PE	3	3	0	0	**3**
2.	ME19B12	Warehousing Automation	PE	3	3	0	0	**3**
3.	ME19B13	Operations Management	PE	3	3	0	0	**3**
4.	ME19B14	Material Handling Equipment, Repair and Maintenance	PE	3	3	0	0	**3**
5.	ME19B15	Container Logistics	PE	3	3	0	0	**3**
6.	ME19B16	Production Planning and Control	PE	3	3	0	0	**3**
7.	ME19B17	Operations Research	PE	3	3	0	0	**3**
8.	ME19B18	Supply chain and Logistics Management	PE	3	3	0	0	**3**
9.	ME19B19	Data Science	PE	3	3	0	0	**3**

VERTICAL 3 : ROBOTICS AND AUTOMATION

S.No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
1.	ME19C11	Drone Technologies	PE	3	3	0	0	**3**
2.	ME19C12	Electrical Drives and Actuators	PE	3	3	0	0	**3**
3.	ME19C13	Robotics	PE	3	3	0	0	**3**
4.	ME19C14	Embedded Systems and Programming	PE	4	2	0	2	**3**
5.	ME19C15	Sensors and Instrumentation	PE	3	3	0	0	**3**
6.	ME19C16	Hydraulics and Pneumatics	PE	3	3	0	0	**3**
7.	ME19C17	Smart Mobility and Intelligent Vehicles	PE	3	3	0	0	**3**
8.	ME19C18	Haptics and Immersive Technologies	PE	3	3	0	0	**3**
9.	ME19C19	Robot dynamics Applications	PE	3	3	0	0	**3**

VERTICAL 4 : PRODUCT DESIGN

S.No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
1.	ME19D11	Design For X	PE	3	3	0	0	**3**
2.	ME19D12	Computer Aided Design	PE	3	3	0	0	**3**
3.	ME19D13	Geometric Dimensioning and Tolerancing	PE	3	3	0	0	**3**
4.	ME19D14	Design of Experiments	PE	3	3	0	0	**3**
5.	ME19D15	Design with Advanced materials	PE	3	3	0	0	**3**
6.	ME19D16	Process planning and cost estimation	PE	3	3	0	0	**3**
7.	ME19D17	Product Life Cycle Management	PE	3	3	0	0	**3**
8.	ME19D18	New Product Development	PE	3	3	0	0	**3**
9.	ME19D19	Design of Jigs, Fixture & Press tools	PE	3	3	0	0	**3**

VERTICAL 5 : DIGITAL MANUFACTURING

S.No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
1.	ME19E11	Digital Manufacturing and IoT	PE	3	3	0	0	**3**
2.	ME19E12	Lean Manufacturing	PE	3	3	0	0	**3**
3.	ME19E13	Advanced Machining Processes	PE	3	3	0	0	**3**
4.	ME19E14	Green Manufacturing Design and Practices	PE	3	3	0	0	**3**
5.	ME19E15	Additive Manufacturing	PE	3	3	0	0	**3**
6.	ME19E16	Welding Technology	PE	3	3	0	0	**3**
7.	ME19E17	Electronics Manufacturing technology	PE	3	3	0	0	**3**
8.	ME19E18	Digital Twin & Industry 4.0	PE	3	3	0	0	**3**
9.	ME19E19	Non-Destructive Testing and Evaluation	PE	3	3	0	0	**3**

VERTICAL 6 : ENERGY SYSTEMS

S.No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
1.	ME19F11	Measurement and control for energy system	PE	3	3	0	0	**3**
2.	ME19F12	Energy conservation and waste heat recovery	PE	3	3	0	0	**3**
3.	ME19F13	Renewable sources of Energy	PE	3	3	0	0	**3**
4.	ME19F14	Hybrid and Electrical Vehicles	PE	3	3	0	0	**3**
5.	ME19F15	Introduction to Power Plant Engineering	PE	3	3	0	0	**3**
6.	ME19F16	Refrigeration and Air conditioning	PE	3	3	0	0	**3**
7.	ME19F17	Advanced energy storage technologies	PE	3	3	0	0	**3**
8.	ME19F18	Energy systems modelling and analysis	PE	3	3	0	0	**3**
9.	ME19F19	Energy Engineering and Management	PE	3	3	0	0	**3**

VERTICAL 7 : DIVERSIFIED COURSES

S.No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
1.	ME19G11	Precision Manufacturing	PE	3	3	0	0	**3**
2.	ME19G12	Industrial Safety	PE	3	3	0	0	**3**
3.	ME19G13	Composite Materials and Mechanics	PE	3	3	0	0	**3**
4.	ME19G14	Material Characterisation Techniques	PE	3	3	0	0	**3**
5.	ME19G15	Principles of Management	PE	3	3	0	0	**3**
6.	ME19G16	Entrepreneurship Development	PE	3	3	0	0	**3**
7.	ME19G17	Marketing Management	PE	3	3	0	0	**3**
8.	ME19G18	Research Methodology and Intellectual Property Rights	PE	3	3	0	0	**3**
9.	ME19G19	Corrosion and Surface Engineering	PE	3	3	0	0	**3**

OPEN ELECTIVES OFFERED BY MECHANICAL ENGINEERING DEPARTMENT

1. OME1901 – Supply Chain Management
2. OME1902 – Basics of 3D printing and Additive Manufacturing
3. OME1903 – Industrial Safety Engineering

Course Code	Course Name	Category	L	T	P	C
HS19151	TECHNICAL ENGLISH Common to all branches of B.E./ B.Tech programmes – I semester	HS	2	1	0	3

Objectives:

- To enable learners to acquire basic proficiency in English reading and listening.
- To write in English precisely and effectively.
- To speak flawlessly in all kinds of communicative contexts.

UNIT-I	**Vocabulary Building**	**9**

The concept of word formation - Root words from foreign languages and their use in English - Acquaintance with prefixes and suffixes from foreign languages in English to form derivatives - Synonyms, antonyms, and standard abbreviations. Compound words – abbreviation – single word substitution – **Listening:** Listening comprehension, listening to motivational speeches, podcasts and poetry. **Speaking:** Short talks on incidents - place of visit – admiring personalities, etc.

UNIT-II	**Basic Writing Skills**	**9**

Sentence structures - Use of phrases and clauses in sentences - punctuation - coherence - Organizing principles of paragraphs in documents - Techniques for writing precisely. Reading & Writing – Free writing – paragraphs - article reading and writing criticism - change of tense forms in short text or story – inferential reading – rewrite or interpret text - prepare questions based on the text. Speaking everyday situations – conversations and dialogues, speaking for and against.

UNIT-II	**Grammar And Language Development**	**9**

Subject-verb agreement- Noun-pronoun agreement - Articles – Prepositions – Redundancies. Reading & Writing: Read from innovation and ideas that changed the world, newspaper column writing – Speaking: Demonstrative speaking practice using visual aids (charts, graphs, maps, pictures, etc,.).

UNIT-IV	**Writing For Formal Presentation**	**9**

Nature and Style of sensible Writing - Describing – Defining – Classifying - Providing examples or evidence - Writing introduction and conclusion. Reading & Writing – Read from Literary pieces – identify different parts text – difference between print and digital writing. Writing: Recommendations - Foreword - Review of book. Speaking- Formal Presentations – Debate on social issues/taboos and solutions.

UNIT-V	**Extended Writing And Speaking**	**9**

Writing: Précis writing – Essay writing – workplace communication: Resume – Business letters and emails – Proposals. Speaking: Panel discussion – reporting an event – mock interview – Master Ceremony.

Total Contact Hour	**45**

Course Outcomes:

On completion of course students will be able to

- Discuss and respond to the listening content.
- Read and comprehend different texts and appreciate them
- Understand structures and techniques of precise writing
- Analyze different genres of communication and get familiarized with new words, phrases, and sentence structures.
- Write and speak appropriately in varied formal and informal contexts.

Text Books:

1. English for Technologists & Engineers, Orient Black Swan Publications, Chennai 2012.

Reference Books / Web links:
1 Technical Communication, Meenakshi Raman & Sangeeta Sharma, Oxford University Press
2 Effective Communication Skills, Kulbushan Kumar, Khanna Publishing House, Delhi
3 Communication Skills, Pushplata, Sanjay Kumar, Oxford University Press
4 Practical English Usage. Michael Swan. OUP. 1995.
5 Remedial English Grammar. F.T. Wood. Macmillan.2007
6 On Writing Well. William Zinsser. Harper Resource Book. 2001
7 Study Writing. Liz Hamp-Lyons and Ben Heasly. Cambridge University Press. 2006.
8 Exercises in Spoken English. Parts. I-III. CIEFL, Hyderabad. Oxford University Press

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

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

Course Code	**Course Name**	**Category**	**L**	**T**	**P**	**C**
MA19151	**ALGEBRA AND CALCULUS** **Common to I sem. B.E. – Aeronautical Engineering, Automobile Engineering, Civil Engineering, Mechatroni & Mechanical Engineering**	**BS**	**3**	**1**	**0**	**4**

Objectives:

- To gain knowledge in using matrix algebra techniques and the limitations of using infinite series approximations for those problems arising in mathematical modelling.
- To understand the techniques of calculus which are applied in the Engineering problems.

UNIT-I	**Matrices**	**12**

Symmetric and skew – symmetric matrices, orthogonal matrices – Eigen values and Eigen vectors - Cayley – Hamilton theorem (without proof) and applications - orthogonal transformation and quadratic forms to canonical forms - Nature of quadratic forms.

UNIT-II	**Sequences And Series**	**12**

Convergence of sequence and series – Test for convergence: Comparison Test, D'Alembert Ratio Test, Leibnitz Test, Integral test – Binomial series, Exponential series and logarithmic series: Summations and approximations.

UNIT-III	**Applications Of Differential Calculus**	**12**

Curvature in Cartesian co-ordinates – Centre and radius of curvature – Circle of curvature – Evolutes – Envelopes - Evolute as envelope of normal.

UNIT-IV	**Functions Of Several Variables**	**12**

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

UNIT-V	Application Of Integration	12
Centre of Gravity – Moment of inertia - Double integrals in Cartesian and polar coordinates – Change of order of integration - Area of a curved surface - Triple integrals – Volume of Solids.		
	Total Contact Hour	**60**

Course Outcomes:

On completion of the course students will be able to

●	Apply the concept of Eigenvalues and eigenvectors, diagonalization of a matrix for solving problems.
●	Develop skills in solving problems involving sequences and series.
●	Analyze, sketch and study the properties of different curves and to handle functions of several variables and problems of maxima and minima.
●	Obtain the Centre of gravity, moment of inertia for rigid bodies and also surface area and volume using multiple integrals.
●	Processes the data collected and analyze the data for central tendencies.

Text Books:

1	Grewal B.S., ―Higher Engineering Mathematics‖, Khanna Publishers, New Delhi, 43rd Edition, 2014.
2	T Veerarajan, Engineering Mathematics –I , Mc Graw Hill Education, 2014

Reference Books / Web links:

1	Ramana. B.V., ―Higher Engineering Mathematics ", McGraw Hill Education Pvt. Ltd, New Delhi, 2016.
2	Erwin Kreyszig ," Advanced Engineering Mathematics ", John Wiley and Sons, 10th Edition, New Delhi, 2016.
3	Bali, N.P. and Manish Goyal, A Text Book of Engineering Mathematics, Lakshmi Publications Pvt. Ltd., New Delhi, 2006.

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

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

Course Code	Course Name	Category	L	T	P	C
PH19141	PHYSICS OF MATERIALS Common to I sem. B.E. – Aeronautical Engineering, Automobile Engineering, Civil Engineering, Mechanic Engineering & Mechatronics	BS	3	0	2	4

Objectives:

- To enhance the fundamental knowledge in Physics and its applications relevant to mechanical engineering streams.
- To familiarize students in various experimental setups and instruments that are used to study / determine the various properties of materials.

UNIT-I	Mechanics & Properties Of Matter	9

Basic definitions - Newton‘s laws – forces -solving Newton‘s equations - constraints and friction - cylindrical and spherical coordinates - potential energy function - conservative and non-conservative forces - central forces - conservation of angular momentum - non-inertial frames of reference - rotating coordinate system - centripetal and Coriolis accelerations – Elasticity - stress-strain diagram - bending of beams - cantilever depression - Young‘s modulus determination - I-shape girders.

UNIT-II	Crystal Physics	9

Basis – lattices - symmetry operations and crystal systems -Bravaislattics - atomic radius and packing fraction - SC, BCC, FCC, HCP lattices - Miller indices - diffraction by crystals - reciprocal lattice - interpreting diffraction patterns - crystal growth techniques-Czochralski and Bridgmann, crystal defects.

UNIT-III	Physics Of Materials	9

Solid solutions - Hume-Rothery‘s rules –Gibb‘s phase rule - binary phase diagrams -isomporhpus systems - tie-line and lever rule - eutectic, eutectoid, peritectic, peritectoid, monotectic and syntectic systems - formation of microstructures - homogeneous and non-homogenous cooling – nucleation - iron-carbon phase diagram - eutectoid steel - hypo and hypereutectoid steel – diffusion - Fick‘s laws – T-T-T diagrams.

UNIT-IV	Engineering Materials & Testing	9

Metallic glasses – preparation and properties - Ceramics – types, manufacturing methods and properties - Composites – types and properties - Shape memory alloys – properties and applications - Nano-materials – top down and bottom-up approaches – properties - Tensile strength – Hardness – Fatigue - Impact strength – Creep - Fracture – types of fracture.

UNIT-V	Quantum Physics	9

Blackbody problem -Planck‘s radiation law - duality of light -De Broglie hypothesis - properties of matter waves - wave packets –Schrodinger‘s equations (time dependent and time independent) - Born interpretation (physical significance of wave function) - probability current - operator formalism (qualitative) - expectation values - uncertainty principle - particle in a box -eigen function and eigen values -Dirac notation (qualitative).

	Contact Hours		45

List of Experiments	
1	Determination of Laser characteristics (wavelength and angular spread).
2	Determination of Young‘s modulus by non-uniform bending method
3	Determination of thermal conductivity of a bad conductor – Lee‘s Disc method.
4	Determination of velocity of sound and compressibility of liquid – Ultrasonic interferometer
5	Coupled oscillators - Two compound pendulums;
6	Experiment on moment of inertia measurement- Torsional pendulum by resonance,

7	LC circuit, LCR circuit and Resonance phenomena in LCR circuits;			
8	Experiments on electromagnetic induction – BH-Curve experiment			
9	Determination of thickness of a thin wire – Air wedge method			
10	Determination of solar cell characteristics.			
11	Measurement of hysteresis loss:B -H curve.			
12	Determination of creep characteristics of a metallic wire			
		Contact Hours		**30**
		Total Contact Hours		**75**

Course Outcomes: On completion of the course students will be able to	
●	Apply foundational mechanics and elastic nature of materials and determine the elastic moduli o materials.
●	Apply the basic knowledge of crystallography in materials preparation and treatments.
●	Create binary phase diagrams and TTT charts and use them to analyse and measure the propertie of alloys.
●	Use various engineering materials, test or measure their properties and use them in suitable applications.
●	Apply the concepts of quantum theory and the nature of light and determine the characteristics o a given laser source.

Text Books:	
1	Bhattacharya, D.K. & Poonam, T. *"Engineering Physics".* Oxford University Press, 2018.
2	Raghavan, V. *"Physical Metallurgy: Principles and Practice"*. PHI Learning, 2019.

Reference Books / Web links:	
1	Balasubramaniam, R. *"Callister's Materials Science and Engineering".* Wiley India Pvt. Ltd., 2017.
2	Raghavan, V. *"Materials Science and Engineering: A First course"*. PHI Learning, 2019.
3	Resnick, R., Halliday, D., & Walker, J. *"Principles of Physics*‖, Wiley India Pvt., 2018.
4	Gaur, R.K. & Gupta, S.L. *"Engineering Physics".*DhanpatRai Publishers, 2018.

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

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

Course code	Course Name	Category	L	T	P	C
GE19101	ENGINEERING GRAPHICS	ES	2	2	0	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 these 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	Planecurves And Free Hand Sketch	11

Curves used in engineering practices: Conics–Construction of ellipse, parabola and hyperbola by eccentricity method– Construction of cycloids, Construction of involutes of square and circle drawing of tangents and normal to the above curves.

Visualization concepts and Free Hand sketching: Visualization principles –Representation of Three-Dimensional objects – Layout of views- Freehand sketching of multiple views from pictorial views of objects

UNIT-II	Projection Ofpoints, Linesand Planesurface	12

Orthographic projection- principles-Principal planes- projection of points. First angle projection - Projection of straight lines 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	Projectionofsolids	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.

UNIT-IV	Projection Of Sectioned Solids And Developmentof Surfaces	12

Sectioning of solids in simple vertical position when the cutting plane is inclined to the one of the principal planes and perpendicular to the other – obtaining true shape of the section.

Development of lateral surfaces of simple and sectioned solids – Prisms, pyramids cylinders and cones.

UNIT-V	Isometric And Perspectiveprojections	12

Principles of isometric projection–isometric scale–Isometric projections of simple solids and truncated solids - Prisms, pyramids, cylinders and cones.

Perspective projection of simple solids-Prisms, pyramids and cylinders by visual ray method.

	Total Contact Hour	60

Course Outcomes: After learning the course, the students should be able

- To construct different plane curves and free hand sketching of multiple views from pictorial objec
- To comprehend the theory of projection and to draw the basic views related to projection of points lines and planes
- To draw the projection of solids in different views
- To draw the projection of Sectioned solids and development of surfaces of solids
- To visualize and prepare Isometric and 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 Books(s) / Web links:	
1	Varghese P I., ―Engineering Graphics‖, McGraw Hill Education (I) Pvt.Ltd., 2013.
2	Venugopal K. and PrabhuRaja V., ―Engineering Graphics‖, New Age International (P)Limited, 2008.
3	Gopalakrishna K.R., ―Engineering Drawing‖ (Vol. I&II combined), Subhas Stores, Bangalore, 2017.
4	Basant Agarwal and Agarwal C.M., ―Engineering Drawing‖, McGraw Hill Publishing Company Limited, New Delhi, 2018.
5	https://nptel.ac.in/courses/112103019/

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

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

Course code	Course Name (Laboratory Course)	Categor	L	T	P	C
GE19121	ENGINEERING PRACTICES – Civil & Mechanical	ES				

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

List of Exercises

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 chiseling.

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 Hour **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

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

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

Course code	Course Name	Category	L	T	P	C
MC19101	ENVIROMENTAL SCIENCE AND ENGINEERING Common to All Branches	MC	3	0	0	0

Objectives:

- To understand the importance of natural resources, pollution control and waste management.
- To provide the students about the current social issues and environmental legislations.

UNIT-I	Natural Resources	9

Environment -definition - scope and importance - forest resources -use and overexploitation -water resources -use and over utilization - dams - benefits and problems - water conservation -energy resources - growing energy needs - renewable and non-renewable energy sources - use of alternate energy sources -land resources -land degradation - role of an individual in conservation of natural resources.

UNIT-II	Environmental Pollution	9

Definition - causes, effects and control measures of air pollution -chemical and photochemical reactions in the atmosphere - formation of smog, PAN, acid rain, and ozone depletion- noise pollution -mitigation procedures - control of particulate and gaseous emission(Control of SO_2, NO_X, CO and HC).

Water pollution - definition-causes-effects of water pollutants–marine pollution-thermal pollution-radioactive pollution-control of water pollution by physical, chemical and biological processes–waste water treatment-primary, secondary and tertiary treatment.

Soil pollution: definition-causes-effects and control of soil pollution.

UNIT-III	Solid Waste Management	9

Solid wastes - sources and classification of solid wastes -solid waste management options - sanitary landfill, recycling, composting, incineration, energy recovery options from wastes

Hazardous waste -definition -sources of hazardous waste-classification (biomedical waste, radioactive waste, chemical waste, household hazardous waste)-characteristics of hazardous waste ignitability (flammable) reactivity, corrosivity, toxicity -effects of hazardous waste -case study-bhopal gas tragedy - disposal of hazardous waste-recycling, neutralization, incineration, pyrolysis, secured landfill - E-waste management -definition-sources-effects -electronic waste recycling technology.

UNIT-IV	Social Issues And The Environment	9

Sustainable development -concept, components and strategies - social impact of growing human population and affluence, food security, hunger, poverty, malnutrition, famine - consumerism and waste products - environment and human health - role of information technology in environment and human health -disaster management– floods, earthquake, cyclone and landslide.

UNIT-V	Tools For Environmental Management	9

Environmental impact assessment (EIA) structure -strategies for risk assessment–EIS-environmental audit-ISO 14000-precautionary principle and polluter pays principle- constitutional provisions- -pollution control boards and pollution control acts- environmental protection act1986- role of non-government organizations- international conventions and protocols.

Contact Hours	45

Course Outcomes:	
On completion of the course students will be able to	
●	Be conversant to utilize resources in a sustainable manner.
●	Find ways to protect the environment and play proactive roles.
●	Apply the strategies to handle different wastes
●	Develop and improve the standard of better living.
●	Be conversant with tools of EIA and environmental legislation.

Text Books:	
1	Benny Joseph, ―Environmental Science and Engineering‖, 2nd edition, Tata McGraw-Hill, New Delhi,2008.
2	Gilbert M.Masters, ―Introduction to Environmental Engineering and Science‖, 2nd edition, Pearson Education, 2004.
Reference Books / Web links:	
1	Dharmendra S. Sengar, ―Environmental law‖, Prentice hall of India Pvt Ltd, New Delhi,2007.
2	ErachBharucha, ―Textbook of Environmental Studies‖, 3rd edition, Universities Press(I) Pvt Ltd, Hydrabad, 2015.,
3	Tyler Miller.G and Scott E. Spoolman, ―Environmental Science‖, 15th edition, Cengage Learning India PVT, LTD, Delhi, 2014.
4	Rajagopalan, R, ―Environmental Studies-From Crisis to Cure‖, 3rdedition, Oxford University Press,2015.
5	De. A.K., ―Environmental Chemistry‖, New Age International, New Delhi,1996.
6	Wager.K.D, Environmental Management, W. B. Saunders Co., Philadelphia, USA, 1998.

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

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

SEMESTER II

Course code	Course Name	Category	L	T	P	C
MA19251	**DIFFERENTIAL EQUATIONS AND VECTOR CALCULUS** Common to II sem. B.E. – Aeronautical Engineering, Automobile Engineering, Civil Engineering, Mechatronics & Mechanical Engineering and B. Tech. - Biotechnology, Food Technology & Chemic Engineering	BS	3	1	0	4

Objectives:

- To handle practical problems arising in the field of engineering and technology using differential equations.
- To solve problems using the concept of Vectors calculus, Complex analysis, Laplace transforms.

UNIT-I	**Second And Higher Order Differential Equations**	**12**

Second and higher order Linear differential equations with constant coefficients - Method of variation of parameters – Cauchy‘s and Legendre‘s linear equations - Simultaneous first order linear equations with constant coefficients.

UNIT-II	**Partial Differential Equations**	**12**

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

UNIT-III	**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-IV	**Analytic Functions**	**12**

Analytic functions – Necessary and sufficient conditions for analyticity in Cartesian and polar coordinates - Properties – Harmonic conjugates – Construction of analytic function - Conformal mapping and Bilinear transformation-Cauchy‘s integral theorem and Cauchy‘s integral formula (proof excluded) – Taylor‘s series and Laurent‘s series – Singularities – Residues – Residue theorem (without proof), simple problems.

UNIT-V	**Laplace Transform**	**12**

Laplace transform – Sufficient condition for existence – Transform of elementary functions – Basic properties – Transforms of derivatives and integrals of functions - Derivatives and integrals of transforms - Transforms of unit step function and impulse functions, periodic functions. Inverse Laplace transform – Problems using Convolution theorem – Initial and final value theorems – Solution of linear ODE of second order with constant coefficients using Laplace transformation techniques.

Total Contact Hours	**:**	**60**

Course Outcomes:

On completion of course students will be able to

- Apply various techniques in solving ordinary differential equations.
- Develop skills to solve different types of partial differential equations
- Use the concept of Gradient, divergence and curl to evaluate line, surface and volume integrals.

●	Use the concept of Analytic functions, conformal mapping and complex integration for solving Engineering problems.
●	Use Laplace transform and inverse transform techniques in solving differential equations.
Text Books:	
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
Reference Books / Web links:	
1	Ramana. B.V., " Higher Engineering Mathematics ", McGraw Hill Education Pvt. Ltd, New Delhi, 2016.
2	Erwin Kreyszig ," Advanced Engineering Mathematics ", John Wiley and Sons, 10th Edition, New Delhi, 2016.
3	Bali, N.P. and Manish Goyal, A Text Book of Engineering Mathematics, Lakshmi Publications Pvt. Ltd., New Delhi, 2006.
4	T Veerarajan, Transforms and Partial Differential Equations, Third Edition, 2018.

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

Course code	**Course Name**	**Categor**	**L**	**T**	**P**	**C**
CY19241	**ENGINEERING CHEMISTRY** **Common to II sem. B.E. – Aeronautical Engineering, Automobile Engineering, Mechanical Engineering and Mechatronics**	**BS**	**3**	**0**	**2**	**4**

Objectives:	
●	To understand the theoretical and practical principles of corrosion and its control
●	To familiarise the fundamentals of chemical energy conversions in batteries and fuels
●	To acquaint knowledge on alloys and analytical techniques

UNIT-I	**Corrosion And Protective Coatings**	**9**
Cause and effects of corrosion - theories of chemical and electrochemical corrosion –EMF series-types of corrosion: Galvanic, water-line , intergranular and pitting corrosion – passivity - factors affecting rate of corrosion - corrosion control methods- cathodic protection -sacrificial anode and impressed current cathodic methods - corrosion inhibitors - metal cladding - anodizing - electroplating - electroless plating - factors influencing electroplating - polarisation - decomposition potential - over voltage - current density - electrolyte concentration- additives - organic coatings - paints - constituents - functions - special paints - fire retardant - water repellent - temperature indicating and luminous paints.		

UNIT-II	**Energy Storage Devices**	**9**
Batteries - primary battery - alkaline battery - secondary battery (Lead acid storage battery, Nickel - Cadmium battery and Lithium – ion battery) -flow battery -components, working principle and applications of hydrogen-oxygen, solid oxide, direct methanol and proton exchange membrane fuel cells.		
UNIT-III	**Phase Rule And Alloys**	**9**
Phase rule - definition of terms - one component system -water system - reduced phase rule - thermal analysis - two-component system- eutectic system - lead silver system - safety fuses and solders. Alloys - purpose of alloying - function and effects of alloying elements - properties of alloys - classification of alloys - Ferrous alloys - nichrome and stainless steel - Non-ferrous alloys - brass and bronze - heat treatment of alloys (annealing, hardening, tempering, normalising, carburizing and nitriding)		
UNIT-IV	**Fundamental Spectroscopic Techniques And Thermal Analysis**	**9**
Principles of spectroscopy - UV,visible and IR spectroscopy principle - instrumentation (block diagram) - applications.Principles, block diagram, instrumentation and applications of TGA, DTA, DSC and Flame photometry		
UNIT-V	**Fuels And Combustion**	**9**
Fuels- classification -coal-ranking of coal- proximate and ultimate analysis metallurgical coke - manufacture by Otto-Hoffmann method - Petroleum processing and fractions -knocking - octane number and cetane number - synthetic petrol - Fischer Tropsch and Bergius processes -power alcohol, biodiesel- Gaseous fuels CNG and LPG. Combustion-calorific value- Dulongs formula-problems- flue gas analysis – Orsat apparatus– theoretical air for combustion – problems		
	Total Contact Hours	**45**

	List of Experiments		
1	Determination of corrosion rate on mild steel by weight loss method		
2	Estimation of DO by winkler‘s method		
3	Determination of total, temporary and permanent hardness by EDTA method.		
4	Estimation of alkalinity by indicator method.		
5	Estimation of chloride by argentometric method		
6	Estimation of extent of corrosion of Iron pieces by potentiometry		
7	Estimation of mixture of acids by conductometry.		
8	Estimation of acid by pH metry		
9	Estimation of copper / ferrous ions by spectrophotometry.		
10	Estimation of sodium and potassium in water by flame photometry.		
11	Determination of flash and fire point of lubricating oil		
12	Determination of cloud and pour point of lubricating oil		
13	Determination of phase change temperature of a solid.		
	Contact Hours		**30**
	Total Contact Hours		**75**

Course Outcomes: On completion of the course students will be able to	
●	Analyse type of corrosion and identify suitable corrosion control method
●	Construct electrochemical cells and measure its potential
●	Modify metal properties by alloying
●	Characterize various material systems
●	Appreciate the role of fuels in day-to-day applications

Text Books:	
1	P. C. Jain and Monika Jain, ―Engineering Chemistry‖,DhanpatRai Publishing Company (P) Ltd,New Delhi, 2015.
2	O.G.Palanna, ―Engineering Chemistry‖, McGraw Hill Education (India) PVT, Ltd,New Delhi, 2017.

Reference Books / Web links:	
1	Banwell.C.N and McCash,E.M. ―Fundamentals of Molecular Spectroscopy‖, 4th Edn, Tata Mc Graw-Hill Edition, 1995
2	Shashi Chawla, ―A Text Book of Engineering Chemistry‖, Dhanpat Rai & Co, New Delhi, 2017.
3	Sharma Y.R., ―Elementary Organic Spectroscopy‖, Sultan Chand & Sons, New Delhi, 2014.
4	Sharma B. K.,―Analytical Chemistry‖,Krishna Prakashan Media (P) Ltd., Meerut, 2005.

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

Course code	**Course Name (Lab oriented Theory Course)**	**Category**	**L**	**T**	**P**	**C**
GE19141	**PROGRAMMING USING C**	**ES**	**2**	**0**	**4**	**4**

Objectives:	
●	To develop simple algorithms for arithmetic and logical problems.
●	To develop C Programs using basic programming constructs
●	To develop C programs using arrays and strings
●	To develop applications in C using functions, pointers and structures
●	To do input/output and file handling in C

UNIT-I	**General Problem-Solving Concepts**	
Computer – components of a computer system-Algorithm and Flowchart for problem solving with Sequential Logic Structure, Decisions and Loops.		
UNIT-II	**C Language - Types Of Operator And Expressions**	
Introduction- C Structure- syntax and constructs of ANSI C - Variable Names, Data Type and Sizes, Constants, Declarations - Arithmetic Operators, Relational Operators, Logical Operators,		

Type Conversion, Increment and Decrement Operators, Bitwise Operators, Assignment Operators and Expressions, Precedence and Order of Evaluation, proper variable naming and Hungarian Notation.		
UNIT-III	**I/O And Control Flow**	
Standard I/O, Formatted Output – Printf, Variable-length argument lists- Formatted Input – Scanf, Statements and Blocks, If-Else-If, Switch, Loops – while, do, for, break and continue, GoTo Labels.		
UNIT-IV	**Functions And Program Structure**	
Basics of functions, parameter passing and returning type, External, Auto, Local, Static, Register Variables, Scope Rules, Block structure, Initialisation, Recursion, C Pre-processor, Standard Library Functions and return types.		
UNIT-V	**Pointers, Arrays And Structures**	
Pointers and addresses, Pointers and Function Arguments, Pointers and Arrays, Address Arithmetic, character Pointers and Functions, Pointer Arrays, Pointer to Pointer, Multi-dimensional arrays, Strings, Initialisation of Pointer Arrays, Command line arguments, Pointers to functions, complicated declarations. Basic Structures, Structures and Functions, Array of structures, Pointer of Structures, Self-referential Structures, Table look up, Typedef, Unions, Bit-fields, File Access - Error Handling, Line I/O, Miscellaneous Functions.		
	Contact Hours	**30**

List of Experiments			
1	Algorithm and flowcharts of small problems like GCD.		
Structured code writing with:			
2	Small but tricky codes		
3	Proper parameter passing		
4	Command line Arguments		
5	Variable parameter		
6	Pointer to functions		
7	User defined header		
8	Make file utility		
9	Multi file program and user defined libraries		
10	Interesting substring matching / searching programs		
11	Parsing related assignments		
	Contact Hours		**60**
	Total Contact Hours		**90**

Course Outcomes:	
●	To formulate simple algorithms for arithmetic and logical problems.
●	To implement conditional branching, iteration and recursion.
●	To decompose a problem into functions and synthesize a complete program using divide and conquer approach.
●	To use arrays, pointers and structures to formulate algorithms and programs.
●	To apply programming to solve matrix addition and multiplication problems and searching and sorting problems.
Text Books:	
1	Brian W. Kernighan and Dennis M. Ritchie, ―The C Programming Language‖, Pearson Education India; 2nd Edition, 2015.
2	Byron Gottfried, ―Programming with C‖, Second Edition, Schaum Outline Series, 1996.

Reference Books:	
1	Herbert Schildt, ―C: The Complete Reference‖, Fourth Edition, McGraw Hill, 2017.
2	Yashavant Kanetkar, ―Let Us C‖, BPB Publications, 15th Edition, 2016.

Web links for virtual lab:	
1	https://www.tutorialspoint.com/compile_c_online.php
2	https://www.codechef.com/ide
3	https://www.jdoodle.com/c-online-compiler
4	https://rextester.com/l/c_online_compiler_gcc

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

Course code	Course Name (Theory course)	Category	L	T	P	C
ME19201	MANUFACTURING PROCESSES	PC	3	0	0	3

Objectives:	
•	To understand the basic concepts of sand-casting technique and special casting technique.
•	To understand the principles, equipment‘s of different welding techniques.
•	To know the 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 – 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-II	**Metal Joining Processes**	9
Operating principle, basic equipment, 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. Adhesive bonding.		
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 – Test methods –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 Hour	**45**

Course Outcomes: At the end of this course, students can have the	
●	Ability to explain the requirements, process, application and defects of sand casting and special casting processes.
●	Ability to explain the working principles and applications of different arc welding processes, special welding process and defects associated with it.
●	Ability to select the suitable process for manufacturing of components among forging, rolling, drawing, extrusion and its types.
●	Ability to explain the principles and working of shearing, bending, drawing and forming in sheet metal.
●	Ability to appreciate various manufacturing methods of plastic components.

Text Books:	
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	Rao, P.N. "Manufacturing Technology Foundry, Forming and Welding", Vol 1, 4th Edition, McGraw Hill-2017.
5.	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	2	1	1	-	-	1	2	-	-	-	1	1	-	1	2
CO2	2	1	1	-	-	1	2	-	-	-	1	1	-	1	2
CO3	2	1	1	-	-	1	2	-	-	-	1	1	-	1	2
CO4	2	1	1	-	-	1	2	-	-	-	1	1	-	1	2
CO5	2	1	1	-	-	1	2	-	-	-	1	1	-	1	2

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

Course code	Course Name (Theory course)	Category	L	T	P	C
GE19201	ENGINEERING MECHANICS (Common to Mech, Aero, Auto, Civil and MCT)	ES	2	1	0	3

Objectives: Students will be able	
•	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 three dimensions – (Descriptive treatment only)		
UNIT-III	**Properties Of Surfaces And Solids**	12
Centroids and centre of mass – Centroids of lines and areas - Rectangular, circular, triangular areas by integration – T section, I section, - Angle section, Hollow section by using standard formula –Theorems of Pappus - Area moments of inertia of plane areas – Rectangular, circular, triangular areas by integration – T section, I section, Angle section, Hollow section by using standard formula – Parallel axis theorem and perpendicular axis theorem – Principal moments of inertia of plane areas – Principal axes of inertia-Mass moment of inertia –mass moment of inertia for prismatic, cylindrical and spherical solids from first principle – Relation to area moments of inertia.		
UNIT-IV	**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 – 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 Hour : 45	

Course Outcomes: On the successful completion of the course, students will be able to	
•	Analyze the forces in the system.
•	Analyze the problems in engineering systems using the concept of static equilibrium.

•	Determine the centroid and centre of gravity and moment of inertia of an object.
•	Solve problems involving kinematics and kinetics of rigid bodies in plane motion.
•	Solve problems involving frictional phenomena in machines.

Text Book (s):	
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

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

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

Course code	Course Name (Laboratory Course)	Categor	L	T	P	C
GE19211	**PROBLEM SOLVING AND PROGRAMMING IN PYTHON** (With effect from 2021 batch onwards) Common to all branches of B. E. / B.Tech programmes (Except – CSE, CSBS, CSD, IT, AI/ML)	ES	1	0	4	3

Course Objectives:

- To understand computers, programming languages and their generations and essential skills for a logical thinking for problem solving.
- To write, test, and debug simple Python programs with conditionals, and loops and functions
- To develop Python programs with defining functions and calling them
- To understand and write python programs with compound data- lists, tuples, dictionaries
- To search, sort, read and write data from/to files in Python.

List of Experiments

1. Study of algorithms, flowcharts and pseudocodes.
2. Introduction to Python Programming and Demo on Python IDLE / Anaconda distribution.
3. Experiments based on Variables, Datatypes and Operators in Python.
4. Coding Standards and Formatting Output.
5. Algorithmic Approach: Selection control structures.
6. Algorithmic Approach: Iteration control structures.
7. Experiments based on Strings and its operations.
8. Experiments based on Lists and its operations.
9. Experiments based on Tuples and its operations.
10. Experiments based on Sets and its operations.
11. Experiments based on Dictionary and its operations.
12. Functions: Built-in functions.
13. Functions: User-defined functions.
14. Functions: Recursive functions.
15. Searching techniques: Linear and Binary.
16. Sorting techniques: Bubble and Merge Sort.
17. Experiments based on files and its operations.

Contact Hours : 75

Course Outcomes:

On completion of the course, 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.

Text Books:	
1.	Allen B. Downey, Think Python: How to Think Like a Computer Scientist, Second edition, Updated for Python 3, 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 Python 3.2, NetworkTheory Ltd., 2011.
Reference Books:	
1.	John V Guttag, Introduction to Computation and Programming Using Python, Revised and expanded Edition, MIT Press , 2013.
2.	Robert Sedgewick, Kevin Wayne, Robert Dondero, Introduction to Programming inPython: An Inter-disciplinary Approach, Pearson India Education Services Pvt. Ltd., 2016.
3.	Timothy A. Budd, Exploring Python, Mc-Graw Hill Education (India) Private Ltd., 2015.
4.	Kenneth A. Lambert, Fundamentals of Python: First Programs, Cengage Learning, 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 Scienceusing Python 3, Second edition, Pragmatic Programmers, LLC, 2013.

Platform Needed:
Python 3 interpreter for Windows/Linux

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

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

Course code	**Course Name (Laboratory Course)**	**Categor**	**L**	**T**	**P**	**C**
GE19122	**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 impart hands on experience on various basic engineering practices in Electronics Engineering.
List of Experiments	
A. Electrical Engineering Practice	
1	Residential house wiring using switches, fuse, indicator, lamp and energy meter.
2	Fluorescent lamp wiring.
3	Stair case wiring.
4	Measurement of electrical quantities – voltage, current, power & power factor in RLC circuit.
5	Measurement of resistance to earth of an electrical equipment.
B. Electronics Engineering Practice	
1	Study of Electronic components and equipment's – Resistor, colour coding, measurement of A signal parameter (peak-peak, rms period, frequency) using CRO.
2	Study of logic gates AND, OR, EXOR and NOT.

3	Generation of Clock Signal.
4	Soldering practice – Components Devices and Circuits – Using general purpose PCB.
5	Measurement of ripple factor of HWR and FWR.
	Total Contact Hour **30**
Course Outcomes:	
On completion of the course, the students will be able to	
●	Fabricate electrical and electronic circuits
●	Frame the house wiring.
●	Design the AC-DC converter using diode and passive components
●	Understand the working of various electronic components and equipment‘s.
	Understand the behaviour of logic Gates and ripple factor.
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.

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

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

Course code	**Course Name (Mandatory Course)**	**Category**	**L**	**T**	**P**	**C**
MC19102	**INDIAN CONSTITUTION AND FREEDOM MOVEMENT (Common to Mech, Aero, Auto Civil and MCT)**	**MC**	**3**	**0**	**0**	**0**

Objectives:	
•	To inculcate the values enshrined in the Indian constitution
•	To create a sense of responsible and active citizenship
•	To know about Constitutional and Non- Constitutional bodies
•	To understand sacrifices made by the freedom fighters

UNIT-I	**Introduction**	9
Historical Background – 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. Constitution‘ meaning of the term, Indian Constitution: Sources and constitutional history, Features: Citizenship, Preamble, Fundamental Rights and Duties, Directive Principles of State Policy		
UNIT-II	**Structure And Function Of Central Government**	9
Union Government – Structures of the Union Government and Functions – President – Vice		

President – Prime Minister – Cabinet – Parliament – Supreme Court of India – Judicial Review.		
UNIT-III	**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, Panchayat Raj: Introduction, Elected officials and their roles,, Village level: Role of Elected and Appointed officials.		
UNIT-IV	**Constitutional Functions And Bodies**	**9**
Indian Federal System – Center – 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		
UNIT-V	**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-Indian 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		
	Total Contact Hour	**45**

Course Outcomes: On the successful completion of the course, students will be able to	
•	Appreciate the functions of the Indian government
•	Apply as abide the rules of the Indian constitution.
•	Follow the knowledge on functions of state Government and Local bodies
•	Adopt the Knowledge on constitution functions and role of constitutional bodies and no constitutional bodies
•	Appreciate the sacrifices made by freedom fighters during freedom movement

Text Book (s):	
•	Durga Das Basu, ―Introduction to the Constitution of India ―, Lexis Nexis, New Delhi., 21st 2013
•	Bipan Chandra, History of Modern India, Orient Black Swan, 2009
•	Bipan Chandra, India's Struggle for Independence, Penguin Books, 2016
•	Maciver and Page, ―Society: An Introduction Analysis ―, Mac Milan India Ltd., New Delhi.2 ed, 2014
•	P K Agarwal and K N Chaturvedi, Prabhat Prakashan, New Delhi, 1st ed, 2017

Reference Books(s) / Web links:	
•	Sharma, Brij Kishore, ―Introduction to the Constitution of India: Prentice Hall of India, Ne Delhi.
•	U.R.Gahai, ―Indian Political System ―, New Academic Publishing House, Jalaendhar.

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

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

SEMESTER –III

Course code	Course Name	Category	L	T	P	C
MA19355	**TRANSFORMS AND APPLICATIONS** Common to III sem. B.E. Mechanical Engineering, Mechatronics and Civil Engineering	BS	3	1	0	4

Objectives:

- To introduce Fourier series and to solve boundary value problems that arise in the field of Engineering.
- To acquaint the student with different transform techniques used in wide variety of situations.

UNIT-I	**Fourier Series**	**12**
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	**Boundary Value Problems – One Dimensional Equations**	**12**
Classification of second order quasi linear partial differential equations – Fourier series solutions of one-dimensional wave equation – One dimensional heat equation: Problems with temperature and temperature gradients.		
UNIT-III	**Boundary Value Problems – Two Dimensional Equations**	**12**
Steady state solution of two-dimensional heat equation in Cartesian coordinates: Infinite and finite plates – Steady state solution of two-dimensional heat equation in Polar coordinates: Circular and Semicircular disks.		
UNIT-IV	**Fourier Transforms**	**12**
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-V	**Z - Transforms And Difference Equations**	**12**
Z- transforms - Elementary properties – Inverse Z - transform (using partial fraction and residues) – Convolution theorem - Formation of difference equations – Solution of difference equations using Z- transform.		
	Total Contact Hour	**60**

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

- Develop skills to construct Fourier series for different periodic functions and to evaluate infinite series.
- Classify different types of PDE and solve one dimensional boundary value problems.
- Solve two-dimensional heat equations.
- Solve Engineering problems using Fourier transform techniques.
- Solve difference equations using Z – transforms that arise in discrete time systems.

Text Books:

1. Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, Wiley India, 2015.
2. Veerarajan. T., "Transforms and Partial Differential Equations", Tata McGraw Hill Education Pvt.Ltd.,New Delhi, Second reprint, 2016.

Reference Books / Web links:

1. Grewal B.S., "Higher Engineering Mathematics", 44rd Edition, Khanna Publishers, Delhi, 2016.
2. Ramana B.V., "Higher Engineering Mathematics", Tata McGraw Hill Publishing Compa Limited, New Delhi, 2017.

3	Glyn James, "Advanced Modern Engineering Mathematics", 4th Edition, Pearson Educatio 2016.
4	Ray Wylie C and Barrett.L.C, "Advanced Engineering Mathematics" Tata McGraw Hill Education Pvt Ltd, Sixth Edition, New Delhi, 2012.

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

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

Course code	**Course Name (Theory course)**	**Categor**	**L**	**T**	**P**	**C**
ME19301	**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, Zeroth And First Law**	**12**
Review of Basics – Thermodynamic systems, Properties and processes Thermodynamic Equilibrium - Displacement work - P-V diagram. Thermal equilibrium - Zeroth law – Concept of temperature and Temperature Scales. First law – application to closed and open systems – steady and unsteady flow processes.		
UNIT-II	**Second Law And Availability Analysis**	**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 - 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		
UNIT-III	**Properties Of Pure Substances**	**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. 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.		
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 Hour	**60**

Course Outcomes: At the end of this course the students will have the	
●	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.
●	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.
●	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.
●	Ability to appreciate the behavior of Ideal gas and the interrelationship between thermodynamic functions and solve practical problems.
●	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 Publication 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

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
CO2	3	2	2	-	-	1	2	-	-	1	-	3		-	1
CO3	3	2	2	-	-	1	2	-	-	1	-	3		-	1
CO4	3	2	2	-	-	1	2	-	-	1	-	3		-	1
CO5	3	2	2	-	-	1	2	-	-	1	-	3		-	1

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

Course code	Course Name (Theory course)	Categor	L	T	P	C
ME19302	METAL CUTTING AND MACHINE TOOLS	PC	3	0	0	3

Objectives: The main learning objectives of this course is to prepare the students	
●	To Understand the fundamental principles in material removal processes and importance of metal cutting parameters.
●	To Understand the Working principle of turning machines, Semi-automatic and automatic machine tools.
●	To study the working principles of reciprocating machines, milling process and gear manufacturing methods.
●	To impart the basic knowledge on grinding and broaching processes.
●	To understand basics of CNC machine tools and programming of 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–Bar Feeding Mechanism - tool layout – automatic lathes– single spindle: Swiss type, automatic screw type – multi spindle machines.		
UNIT-III	**Reciprocating, Milling And Gear Cutting Machines**	10
Reciprocating machine tools: Construction of shaper and its operation, Basics of Planer, slotter. - Hole making: Drilling, reaming, boring, tapping. 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, Manufacturing of grinding wheel - types of grinding process – cylindrical grinding, surface grinding, centreless grinding, internal grinding - micro finishing methods –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 Machine Tools**	7
Computer Numerical Control (CNC) machine tools –types, constructional details, special features, machining centre and part programming fundamentals – manual part programming and computer assisted part programming.		
	Total Contact Hour	**45**

Course Outcomes: At the end of this course students will have the	
●	Ability to apply the basic principles in material removal processes and importance of metal cutting parameters.
●	Ability to appreciate the working of various types of turning machines and can able to prepare the tool layout.
●	Ability to apply the working of various reciprocating, milling and gear cutting machines
●	Ability to implement the working of various abrasive processes and broaching processes
●	Ability to adopt the basics of CNC machine tools and to write simple part programme.

Text Books:	
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 book(s) / Web links:	
1	Geofrey Boothroyd, Winston A.Knight―Fundamentals of Machining and Machine Tools‖, Taylo & Francis, CRC press , 2006
2	P.N. Rao.―ManufacturingTechnology :Metal Cutting and Machine Tools, Volume 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
5.	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	1	-	-	-	1	2	-	-	-	-	3	-	-	2
CO2	3	1	-	-	-	1	1	-	-	-	-	3	-	-	2
CO3	3	1	-	-	-	1	1	-	-	-	-	3	-	-	2
CO4	3	1	-	-	-	1	1	-	-	-	-	3	-	-	2
CO5	3	1	-	-	1	1	1	-	-	-	-	3	-	-	2

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

Course code	Course Name (Theory course)	Categor	L	T	P	C
ME 19303	KINEMATICS OF MACHINERY	PC	2	1	0	3

Objectives:	
●	
●	To understand the basic concepts of cam mechanism, gears and gear trains
●	To have the basic knowledge on friction in machine elements
●	To create the basic concepts of toothed gearing and kinematics of gear trains
●	To Evaluate the effects of friction in motion transmission and in machine components.

UNIT-I	Basics Of Mechanisms	9

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

UNIT-II	**Kinematics Of Linkage Mechanisms**	**9**
Displacement, velocity and acceleration analysis of simple mechanisms – Graphical method– Velocity and acceleration polygons – Velocity analysis using instantaneous centres – kinematic analysis of simple mechanisms – Coincident points – Coriolis component of Acceleration – Introduction to linkage synthesis problem. Introduction to 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 Hou	**45**

Note: One assignment should be given to the students on simulation of mechanism.

Course Outcomes: At the end of this course students will have the	
●	Ability to analyze the mechanisms
●	Ability to construct the velocity and acceleration diagrams for a given mechanism
●	Ability to design and analyse the cam mechanisms.
●	Ability to analyze the given gear trains
●	Ability to analyze and predict the influence of friction in machine elements

Text Books:	
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	Amitabha Ghosh and Asok Kumar Mallik, ―Theory of Mechanisms and Machines‖, Affiliated East-West Pvt. Ltd.,3rd edition, 1988.
2	Rao.J.S. and Dukkipati.R.V. ―Mechanism and Machine Theory‖, New Age International Pvt. Lt 2nd Edition, 2014
3	Singh.V.P, ―Theory of Machine‖, Dhanpat Rai & Co., 6th Edition, 2017
4	Robert L. Norton, Kinematics and Dynamics of Machinery, McGraw-Hill Education, Special Indian Edition, Reprint-2017

5.	https://nptel.ac.in/courses/112/104/112104121/
6.	https://nptel.ac.in/courses/112105268/
7.	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 Name (Lab Integrated Theory Courses)	Categor	L	T	P	C
EE 19241	BASIC ELECTRICAL ENGINEERING (COMMON TO AUTO, ECE, MECH, AND MCT)	ES	3	0	2	4

Objectives:

- To introduce electric circuits and provide knowledge on the analysis of circuits using network theorems.
- To impart knowledge on the phenomenon of resonance in series and parallel circuits and also to obtain the transient response of RC, RL and RLC circuits.
- To provide knowledge on the principles of electrical machines.
- To learn the concepts of different types of power converter and batteries.
- To teach methods of experimentally analyzing electrical circuits and machines

UNIT-I	**DC Circuits**	**9**

Electrical circuit elements (R, L and C), voltage and current sources, Kirchhoff _s current and voltage laws, analysis of simple circuits with dc excitation. Superposition, Thevenin and Norton Theorems.

UNIT-II	**AC Circuits**	**9**

Representation of sinusoidal waveforms, peak and RMS values, phasor representation, real power, reactive power, apparent power, power factor. Analysis of single-phase ac circuits consisting of R, L, C, RL, RC, RLC combinations (series and parallel), resonance. Three phase balanced circuits, voltage and current relations in star and delta connections

UNIT-III	**DC Motors And Transformers**	**9**

Construction, working, torque-speed characteristic and speed control of DC motors Construction and principle of operation- EMF Equation- regulation, losses and efficiency of Single-Phase Transformers - Auto-transformer.

UNIT-IV	**AC Rotating Machines**	**9**

Construction and working of Synchronous Generators-EMF Equation - Construction and working-torque-slip characteristic- starting methods of three phase induction motors-Single-phase induction motors- Construction and Working of Permanent Magnet Brushless DC Motors and Stepper Motors.

UNIT-V	**Batteries And Power Converters**	**9**

Types of Batteries, Important Characteristics for Batteries -DC-DC buck and boost converters-duty ratio control -Single-phase and three-phase voltage source inverters – Sinusoidal modulation

Total Contact Hour	**45**

List of Experiments

1	Experimental verification of Kirchhoff‘s voltage and current laws.
2	Experimental verification of network theorems (Thevenin and, Norton Theorems).
3	Load test on DC shunt motor
4	Speed control of DC shunt motor.
5	Load test on single-phase transformer.
6	Open circuit and short circuit tests on single phase transformer.
7	Speed control of chopper fed DC motor.
8	Speed control of 3Φ Induction motor.

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

Course Outcomes:

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

- Analyse DC and AC circuits and apply circuit theorems.
- Realize series resonance, parallel resonance and three phase balanced circuits.

●	Adopt the principles of electrical machines.
●	Implement the principles of different types of power converter and batteries.
●	Experimentally analyze the electric circuits and machines.
Text Book (s):	
1	D. P. Kothari and I. J. Nagrath, ―Basic Electrical Engineering‖, Tata McGraw Hill, 2010.
2	M.H.Rashid, ―Power Electronics: Circuits, Devices and Applications‖, Pearson Education, PHI Third Edition, New Delhi, 2014.
3	David Linden and Thomas B. Reddy, ― Handbook of Batteries‖ McGraw-Hill Professional,2001
Reference Books(s) / Web links:	
1	D. C. Kulshreshtha, ―Basic Electrical Engineering‖, McGraw Hill, 2009.
2	E. Hughes, ―Electrical and Electronics Technology‖, Pearson, 2010.
3	D. Toro, ―Electrical Engineering Fundamentals‖, Prentice Hall India, 1989.
4	L. S. Bobrow, ―Fundamentals of Electrical Engineering‖, Oxford University Press, 2011.
5	P.S.Bimbra ―Power Electronics‖, Khanna Publishers, 4th Edition, 2007.

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	3	1	1	-	-	-	-	-	-	-	-
CO2	-	-	-	-	2	1	-	1	-	-	-	-	-	-	-
CO3	3	3	2	3	3	1	1	-	-	-	-	-	1	-	1
CO4	3	3	2	3	3	2	2	-	1	-	-	2	3	-	2
CO5	3	3	2	3	3	2	2	-	-	-	2	2	1	-	1

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

Course code	Course Name (Lab course)	Category	L	T	P	C
ME19311	**MACHINE DRAWING LAB**	**PC**	**0**	**0**	**3**	**1.5**

Objectives:	
●	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 make the students understand and interpret drawings of machine components so as to prepare assembly drawings either manually and using standard CAD packages
●	To impart knowledge on drawing principal views, two dimensional assembled views with suitable sections of different components with an emphasis by applying general projection principles using Computer Aided Drafting (CAD).
●	To impart practical experience in preparing 2D production drawings using CAD software.

Drawing Standards & Fits And Tolerances
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).

2-D Drafting & Cad Practice (Using Application Packages)			
Manual Preparation assembly drawings and production drawings. Using CAD packages- Drawing, Editing, Dimensioning, Plotting Commands, Layering Concepts, Hatching, Detailing of Part drawings and preparation of assembled view with suitable sections to the given part details. Suggested assembly drawings are Joints – Cotter joint (Manual Drawing), Knuckle joint, Universal joint Couplings – Muff coupling (Manual Drawing), Oldham's coupling, Flange coupling Bearings – Bushed bearing (Manual Drawing), Footstep bearing Engine parts – Piston, Connecting Rod, Stuffing box, multi-plate clutch. Machine Components – Screw Jack, Machine Vice, Lathe Tail Stock, Plummer Block (Manual Drawing) Valves – Safety valves Project **Note:** 25% of assembly drawings must be done manually and remaining 75% of assembly drawings must be done by using any CAD software. The above tasks can be performed manually and using standard commercial 2D CAD software.			
	Total Contact Hour		**4**

Course Outcomes: At the end of this course, the student able to	
1	Read the engineering drawings based on the standards of machine drawing practiced by Bureau Indian standards (B.I.S)
2	Draw the different types of thread forms, welding symbols, types of Keys, Riveted joints and fasteners.
3	Recognize the basic principles and applications of fits, tolerances and GD&T(Geometrical Dimensioning and Tolerance)
4	Draw 2D manual assembly and Production drawings of various components.
5	Draw different principal views, sectional views of the components or machine parts and their assemblies using CAD software.

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	Ajeet Singh, ―Machine Drawing includes AutoCAD‖ McGraw Hill, 2017
4	https://thesourcecad.com/autocad-tutorials/
5	https://all3dp.com/1/autocad-tutorial-for-beginners/
6	https://www.autodesk.in/campaigns/autocad-tutorials

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

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

Course code	Course Name (Theory course)	Categor	L	T	P	C
ME19312	MANUFACTURING TECHNOLOGY LAB	PC	0	0	3	1.5

Objectives: Enable the students	
●	To practice the moulding process using green sand.
●	To practice different types of sheet metal operatins
●	To perform various machining operations like facing, turning, knurling, thread cutting, shaping, grinding and milling.
●	To obtain the knowledge of different gear manufacturing processes.
●	To acquire knowledge on selection of appropriate processes, machines to complete a given job.

LIST OF EXPERIMENTS			
1	Preparation of sand mould using single piece pattern		
2	Preparation of sand mould using split piece pattern		
3	Fabrication of tray in sheet metal		
4	Fabrication of funnel in sheet metal		
5	Taper turning using lathe		
6	Knurling and external thread cutting using lathe		
7	Step turning and drilling using Capstan / Turret lathe		
8	Drilling and tapping		
9	Cube formation using shaper		
10	Study of Indexing mechanism in milling machine		
11	Hexagonal milling using vertical milling machine		
12	Spur gear cutting using milling machine		
13	Gear generation in gear hobbing machine		
14	Surface grinding		
15	Cylindrical grinding		
	Total Contact Hour		**45**

Course Outcomes: At the end of this course students will have the	
●	Ability to make a mould in green sand using different types of patterns.
●	Ability to create different objects using sheet metal.
●	Ability to perform different possible machining processes in lathe, shaper, grinders and milling machines.
●	Ability to select and perform different gear generating process based on requirements.
●	Ability to select suitable manufacturing method, machines, equipment and tools to make a job based on given requirements.

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 Name (Laboratory Course)	Category	L	T	P	C
CS19411	**PYTHON PROGRAMMING FOR MACHINE LEARNING** **(With effect from 2021 batch onwards)** Common to all branches of B.E / B.Tech programmes (Except – CSE, CSBS, CSD, IT, AI/ML)	ES	1	0	4	3

Course Objectives:

- To understand the relationship of the data collected for decision making.
- To know the concept of principle components, factor analysis and cluster analysis for profiling and interpreting the data collected.
- To lay the foundation of machine learning and its practical applications.
- To develop self-learning algorithms using training data to classify or predict the outcome of future datasets.
- To prepare for real-time problem-solving in data science and machine learning.

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
11	Representing Data and Engineering Features
12	Model Evaluation and Improvement

Contact Hou : 75

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

- Develop a sound understanding of current, modern computational statistical approaches and their application to a variety of datasets.
- Use appropriate packages for analysing and representing data.
- Analyze and perform an evaluation of learning algorithms and model selection.
- Compare the strengths and weaknesses of many popular machine learning approaches.
- Apply various machine learning algorithms in a range of real-world applications.

Text Books:

1. Wes McKinney, Python for Data Analysis - Data wrangling with pandas, Numpy, and ipython, Second Edition, O'ReillyMedia 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:

1. AurélienGéron, Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, 2nd Edition, O'Reilly Media Inc, 2019.

Platform Needed:
Python 3 interpreter for Windows/Linux

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

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

SEMESTER-IV

Course code	Course Name	Categor	L	T	P	C
MA19455	**STATISTICS AND NUMERICAL METHODS** Common to IV sem. B.E. Mechanical Engineering and Mechatronics	BS	3	1	0	4

Objectives:	
●	To provide the necessary basic concepts of a few statistical methods in designing and solving problems.
●	To provide various numerical methods in solving problems that occur in the field of Engineering and Technology.

UNIT-I	**Testing Of Hypothesis**	**12**
Statistical hypothesis - Large sample test based on Normal distribution for single mean and differenc of means -Tests based on t, F and Chi-square test for single sample standard deviation. Chi-square tests for independence of attributes and goodness of fit.		
UNIT-II	**Design Of Experiments**	**12**
One way and two-way classifications - Completely randomized design – Randomized block design Latin square design - 2^2factorial design.		
UNIT-III	**Solution Of Equations And Eigenvalue Problems**	**12**
Newton Raphson method – secant method – Gauss Jordan method – Iterative method of Gauss Seide –Eigen value of a matrix by power method and by Jacobi method for symmetric matrix.		
UNIT-IV	**Interpolation, Numerical Differentiation And Numerical Integration**	**12**
Curve fitting ($y= a+ bx$, $y = a+bx+cx^2$)-Lagrange‘s interpolations – Newton‘s forward and backward difference interpolation – Approximation of derivates using interpolation polynomials – Numerical integration using Trapezoidal and Simpson‘s 1/3 rules.		
UNIT-V	**Numerical Solution Of Differential Equations**	**12**
Taylor‘s series method – Modified Euler‘s method – Fourth order Runge - Kutta method for solving first order equations – Finite difference methods for solving second order equations- Finite differenc solution of one-dimensional heat equation by explicit and implicit methods - Two-dimensional Laplace equation.		
	Total Contact Hour	**60**

Course Outcomes: On completion of course, students will be able to	
●	Obtain statistical data from experiments and able to analyze the same using statistical test.
●	Design experiments using suitable ANOVA techniques and draw conclusions.
●	Solve algebraic equations and Eigen value problems that arise during the study of engineering problems.
●	Use interpolation methods to solve problems involving numerical differentiation and integration
●	Solve differential equations numerically that arise in course of solving engineering problems.

Text Books:	
1	Veerarajan T., _Statistics and Numerical methods‖ Mc Graw Hill, 2018
2	Kandasamy P., Thilagavathi and K. Gunavathi., —Statistics and Numerical Methods‖ , S. Chand Company Ltd. (2010).

Reference Books / Web links:	
1	Johnson R.A., and Gupta. C.B., "Miller and Freund‘s Probability and Statistics for Engineers",1 Edition, Pearson Education, , Asia, 2011.
2	Walpole R.E., Myers. R.H., Myers. S.L., and Ye. K., "Probability and Statistics for Engineers an Scientists", 9th Edition, Pearson Education, Asia, 2011.
3	Spiegel M.R., Schiller. J., and Srinivasan. R.A., "Schaum‘s Outlines on Probability and Statistics", Tata McGraw Hill Edition, 2004.
4	Grewal B.S., and Grewal. J.S., "Numerical Methods in Engineering and Science", 11th Edition, Khanna Publishers, New Delhi, 2013.
5	Gerald C.F., and Wheatley. P.O. "Applied Numerical Analysis" 7th EditionPearson Education, Asia, New Delhi, 2006.

PO-PSO / CO	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	3	3	2	-	-	-	-	-	2	2	2	-	2
CO2	3	3	3	3	2	-	-	-	-	-	2	2	2	-	2
CO3	3	3	3	3	1	-	-	-	-	-	1	2	2	-	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 Name	Categor	L	T	P	C
ME19401	THERMAL ENGINEERING	PC	3	0	0	3

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	8
UNIT-II	Internal Combustion Engines	10

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 Carburetor. 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.

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 an 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, Multistage air compressor and inter cooling –work of multistage air compressor		
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 Principl - Concept of RSHF, GSHF, ESHF- Cooling Load calculations.		
	Total Contact Hour	**45**

Course Outcomes: At the end the course, the students will be able to	
●	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
●	Evaluate the performance of the steam nozzles and steam turbines
●	Explain the working of air compressors and analyse their performance.
●	Analyse the performance of various refrigeration and air conditioning systems

Text Book (s):	
1	Rajput. R. K., ―Thermal Engineering‖, 10th Edition, Laxmi Publications, 2018.
2	Ballaney. P, ―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/
8	https://www.thermal-engineering.org

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

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

Course code	Course Name (Theory course)	Categor	L	T	P	C
ME19402	STRENGTH OF MATERIALS	PC	3	0	0	3

Objectives:	
●	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	12
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**	12
Beams – types transverse loading on beams – Shear force and bending moment in beams – Cantilevers – Simply supported beams and over hanging beams. Theory of simple bending– bending stress distribution – Load carrying capacity – Proportioning of sections – Flitched beams – Shear stresses in beams – Shear flow.		
UNIT-III	**Torsion On Shafts And Springs**	12
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.		
UNIT-V	**Thin Cylinders, Spheres And Thick Cylinders**	9
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 Hour	**45**

Course Outcomes: At the end of this course, students able to	
●	Determine the principal planes and stresses and draw Mohr's circle for the given stress conditions.
●	Draw the shear force diagram and bending moment diagram for beams subjected to different loading conditions.
●	Calculate the deformation of shafts subjected to torsional loads.
●	Calculate the deflection of beams through Macaulay's method, Moment area method and strain energy methods.
●	Determine stresses acting on thin cylinders and spheres and calculate the deformation.
Text Books:	
1	Bansal, R.K., "Strength of Materials", Laxmi Publications (P) Ltd., 2015.
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‖ Prentice Hall of India, New Delhi, 2001.
2	Ramamurtham S., "Strength of Materials", Dhanpat rai publishing company, 2011.
3	Hibbeler, R.C., "Mechanics of Materials", Pearson Education, 2018.
4	Ferdinand P. Been, Russell Johnson, J.r. and John J. Dewole "Mechanics of Materials", Tata McGraw Hill Publishing _co. Ltd., New Delhi, 2016.
5.	https://nptel.ac.in/courses/112107146/

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 Name (Theory course)	Categor	L	T	P	C
ME19403	Fluid Mechanics and Machinery	PC	3	0	0	3

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

- To introduce about properties of the fluids, behaviour of fluids under static and dynamic conditions
- To understand the difference between laminar and turbulent flow through circular conduits and losses in pipe flow
- To Gain the knowledge of dimensional and model analysis
- To understand the basic knowledge of types of turbines and its velocity triangle.
- To improve the knowledge on types of pumps and its application.

UNIT-I	Fluid Properties And Flow Characteristics	9

Properties of fluids- Pressure Measurements-Buoyancy and floatation-Flow characteristics- Eulerian and Lagrangian Principle of fluid flow– concept of control volume and system – Reynold‘s transportation theorem- continuity equation, energy equation and momentum equation- Applications.

UNIT-II	Flow Through Pipes And Boundary Layer	9

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

UNIT-III	Dimensional Analysis And Model Studies	9

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

UNIT-IV	Turbines	10

Impact of jets - Velocity triangles - 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	9
Classification of pumps- Centrifugal pumps– working principle - Heads and efficiencies– Velocity triangles- Work done by the impeller - performance curves - Reciprocating pump working principle – indicator diagram and it‘s variations – work saved by fitting air vessels.		
	Total Contact Hour	**45**

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

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
CO5	3	3	3	3	-	-	1	-	1	-	-	2		-	2

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

Course code	Course Name (Theory Courses)	Categor	L	T	P	C
ME19404	Engineering Materials and Metallurgy	PC	3	0	0	3

Objectives:	
●	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-1	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 microstructure, 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 stabilisers– 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.		
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.		
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), hardness tests, Nano Indentation test, Impact test- lzod and Charpy, fatigue and creep failure mechanisms.		
	Contact Hour	**45**

Course Outcomes: Upon completion of this course, the students will be able to:	
●	Construct the phase diagram and using of iron-iron carbide phase diagram for microstructure formation.
●	Select and applying various heat treatment process and its microstructure formation.
●	Apply the different types of ferrous and non-ferrous alloys and their uses in engineering field.
●	Apply the different polymer, ceramics and composites and their uses in engineering field.
●	Apply the various testing procedures and failure mechanism in engineering field.

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.WinowlinJappes, A Textbook 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.
5	https://nptel.ac.in/courses/113102080/
6	https://nptel.ac.in/courses/113107078/

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	2	-	3	2	3
CO3	3	-	3	-	-	-	3	-	2	1	2	-	3	-	3
CO4	3	-	3	-	-	-	3	-	2	1	2	-	3	-	3
CO5	3	-	3	2	-	-	3	-	2	1	2	-	3	-	3

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

Course code	Course Name (Theory course)	Categor	L	T	P	C
GE19303	ECONOMICS FOR ENGINEERS	HS	3	0	0	3

Objectives:	
●	The course will cover the determination of income, employment, the price level, interest rates and exchange rates in the economy. The economy will be analysed in the short run (e.g. business cycle and stabilization policy) and in the long run (e.g. economic growth). The insights of Keynesian and classical theories will be integrated. As macroeconomics is an empirical discipline the course will cover case studies and statistical data interpretation.

UNIT-I	MICROECONOMICS	9
Principles of Demand and Supply — Supply Curves of Firms — Elasticity of Supply; Demand Curves of Households — Elasticity of Demand; 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 — 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	**PRODUCTION FUNCTION AND COMPETITION**	**9**
Theory of Production — Production Function and Iso-quants — Cost Minimization; Cost Curves — Total, Average and Marginal Costs — Long Run and Short Run Costs; Equilibrium of a Firm Under Perfect Competition; Monopoly and Monopolistic Competition.		

UNIT-IV	NATIONAL INCOME AND KEYNESIAN MULTIPLIER	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 — Bank's Credit Creation Multiplier; Integrating Money and Commodity Markets.		
UNIT-V	**IS, LM MODEL, MONETARY, FISCAL POLICY AND TAXES:**	**9**
IS, LM Model; Business Cycles and Stabilization — Monetary and Fiscal Policy — Central Bank and the Government; The Classical Paradigm — Price and Wage Rigidities — Voluntary and Involuntary Unemployment- Introduction to individual Income Tax-and Corporate Income Tax- GST, GST Council.		
	Total Contact Hour	**45**

Course Outcomes:	
●	On completion of the course the students will be able to distinguish with both principles of micro and macroeconomics. They would also become familiar with application of these principles to appreciate the functioning of both product and input markets as well as the economy.
●	Students will be able to improve their economic vocabulary- the knowledge of the terms and concepts commonly used in discussions of economic issues.
●	Students will be able to demonstrate the ability to employ ‗the economic way of thinking'.
●	Students will learn to apply economic theories and concepts to contemporary social issues, as well as analysis of policies.
●	Students will be able to formulate informed opinions on policy issues and recognize the validity of opposing viewpoints.
Text Book (s):	
1	Paul A. Samuelson, William D. Nordhaus, Sudip Chaudhuri and Anindya Sen, Economics, 19th edition, Tata McGraw Hill, New Delhi, 2010.
2	D N Dwivedi, Managerial Economics, 8th Edition, Vikas Publishing House,2018.
3	N. Gregory Mankiw, Principles of Economics, 3rd edition, Thomson learning, New Delhi, 2007.
4	Richard Lipsey and Alec Charystal, Economics, 12th edition, Oxford, University Press, New Delhi, 2011.

Reference Books(s) / Web links:	
1	Karl E. Case and Ray C. fair, Principles of Economics, 6th edition, Pearson, Education Asia, New Delhi, 2002.
2	William Boyes and Michael Melvin, Textbook of economics, Biztantra, 2005.

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

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

Course code	Course Name (Laboratory Course)	Category	L	T	P	C
ME19411	STRENGTH OF MATERIALS AND FLUID MECHANICS AND MACHINERY LABORATORY	PC	0	0	3	1.5

Objectives:

- To supplement the theoretical knowledge gained in Mechanics of Solids with practical testing for determining the strength of materials under externally applied loads. This would enable the student to have a clear understanding of the design for strength and stiffness.

LIST OF EXPERIMENTS- Strength of Materials Lab

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

Total Contact Hours:

LIST OF EXPERIMENTS- Fluid Mechanics and Machinery Lab

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

Total Contact Hours:

OUTCOMES: At the end, the students have the

1. Ability to perform different destructive testing
2. Ability to characterize and compare different materials
3. Ability to measure the discharge of fluid using various measuring device
4. Ability to calculate various losses during the fluid flow.
5. Ability to Evaluate and estimate the characteristic study of pumps and turbines

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

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

Course code	Course Name (Laboratory Course)	Category	L	T	P	C
ME19412	THERMAL ENGINEERING LAB - I	PC	0	0	3	1.5

Objectives: The main learning objective of this lab course is to provide hands on training to the students in:	
●	Understanding the proper valve and port timing in IC engines
●	Testing the characteristics of fuels/Lubricates used in IC engines
●	Analysing the performance characteristics of various engines
●	Finding the frictional power of a diesel engine by retardation test
●	Understanding the boiler operation and conducting the performance test on a boiler and steam turbine
	List of Experiments
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 Test on 4 – stroke Diesel Engine
5	Heat Balance Test on 4 – stroke Diesel Engine
6	Morse Test on Multi-cylinder Petrol Engine
7	Retardation Test on a Diesel Engine
8	Study on Steam Generators and Turbines
9	Performance and Energy Balance Test on a Steam Generator
10	Performance and Energy Balance Test on Steam Turbine
	Total Contact Hour **45**

Course Outcomes: Upon completion of this lab course, the students will be able:	
●	To understand the proper valve and port timing in IC engines
●	To test the characteristics of fuels/Lubricates used in IC engines
●	To analyse the performance characteristics of various engines
●	To find the frictional power of a diesel engine by retardation test
●	To understand the boiler operation and conduct the performance test on a boiler and steam turbin

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

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

GE19421	SOFTSKILL LAB-I	Category	L	T	P	C
		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

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

Wee	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.

Total Hours:30

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 Name (Theory course)**	**Categor**	**L**	**T**	**P**	**C**
MC19301	**Essence of Indian Traditional Knowledge**	**MC**	**3**	**0**	**0**	**0**

Objectives:

●	This course aims at imparting basic principles of thought process, reasoning and inference. Sustainability is the core of Indian traditional knowledge system connecting society and nature. Holistic life style of yogic science and wisdom are important in modern society with rapid technological advancements and societal disruptions. The course mainly focuses on introduction to Indian knowledge system, Indian perspective of modern science, basic principles of Yoga and holistic healthcare system, Indian philosophical, linguistic and artistic traditions.

Pedagogy: Problem based learning, group discussions, collaborative mini projects.

UNIT-I Introduction to Indian Knowledge System Basic structure of the Indian Knowledge System –Veda – Upaveda - Ayurveda, Dhanurveda- Gandharvaveda, Sthapathyaveda and Arthasasthra. Vedanga (Six forms of Veda) – Shiksha, Kalpa, Nirukta, Vyakarana, Jyothisha and Chandas- Four Shasthras - Dharmashastra, Mimams Purana and Tharkashastra.	**9**
UNIT-II **Modern Science and Yoga:** Modern Science and the Indian Knowledge System – a comparison - Merits and demerits of Modern Science and the Indian Knowledge System - the science of Yoga-different styles of Yoga – types of Yogaasana, Pranayam, Mudras, Meditation techniques and their health benefits – Yoga and holistic healthcare – Case studies.	**9**
UNIT-III **Indian Philosophical Tradition:** Sarvadharshan/Sadhdharshan – Six systems (dharshans) of Indian philosophy - Nyaya, Vaisheshika, Sankhya, Yoga, Mimamsa, Vedanta-Other systems- Chavarka, Jain (Jainism), Boudh (Buddhism) – Case Studies.	**9**
UNIT-IV **Indian Linguistic Tradition:** Introduction to Linguistics in ancient India – history – Phonetics and Phonology – Morphology –Syntax and Semantics-Case Studies.	**9**

UNIT-V **Indian Artistic Tradition:** Introduction to traditional Indian art forms – Chitrakala (Painting), Murthikala / Shilpakala (Sculptures), Vaasthukala, Sthaapathya kala (Architecture), Sangeeth (Music), Nruthya (Dance) and Sahithya (Literature) – Case Studies.		**9**
	Total Contact Hour	**45**

Course Outcomes:	
●	At the end of the course, students will be able to appreciate the importance of traditional Indian knowledge system, Yoga and other Indian traditions that are important in a modern society with technological advancements and lifestyle changes.

Text Book (s):	
1	V. Sivaramakrishnan (Ed.), *Cultural Heritage of India-course material*, Bharatiya Vidya Bhavan, Mumbai. 5th Edition, 2014.
2	Swami Jitatmanand, *Modern Physics and Vedant*, Bharatiya Vidya Bhavan.
3	Swami Jitatmanand, *Holistic Science and Vedant*, Bharatiya Vidya Bhavan.
4	Fritzof Capra, Tao of Physics.
5	Fritzof Capra, The Wave of life.
Reference Books(s) / Web links:	
1	VN Jha (Eng. Trans.), *Tarkasangraha of Annam Bhatta*, International Chinmay Foundation, Velliarnad, Arnakulam.
2	Yoga Sutra of Patanjali, Ramakrishna Mission, Kolkata.
3	GN Jha (Eng. Trans.), Ed. RN Jha, Yoga-darshanam with Vyasa Bhashya,Vidyanidhi Prakashan, Delhi 2016.
4	RN Jha, Science of Consciousness Psychotherapy and Yoga Practices, Vidyanidhi Prakashan, Delhi 2016.

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

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

SEMESTER –V

Course code	Course Name (Theory course)	Categor	L	T	P	C
ME19501	DESIGN OF MACHINE ELEMENTS (Design Data Book is permitted to use in Exam)	PC	3	0	0	3

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

- To understand the methods of determining steady and variable stresses in machine members
- To understand the principle involved in the design of shaft and couplings
- To provide knowledge on design of Temporary and Permanent joints
- To know the design procedure in designing the Springs and Engine components
- To study the design steps and selection procedure involved in Bearings.

UNIT-I	**Steady Stresses And Variable Stresses In Machine Members**	**10**

Introduction to the design process - Factors influencing machine design, design consideration- Standards and codes - Selection of materials based on mechanical properties - Preferred numbers, fits and tolerances –Direct, Bending and torsional stress equations – Impact and shock loading – Calculation of principle 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.

UNIT-IV	**Energy Storing Elements And Engine Components**	**9**

Design of Helical Spring under Static and Variable Loads – Design of leaf spring, Optimization of helical, leaf Springs - Rubber springs – Design of Connecting Rods, Crank shafts and Piston.

UNIT-V	**Bearing**	**8**

Selection of Sliding contact and rolling contact bearings – Antifriction Bearing - Reliability Consideration - McKee's Eqn. - Sommerfield Number - Raimondi & Boyd - Design of hydrodynami journal bearings – Design of sliding Contact and rolling contact bearings.

	Total Contact Hour	**45**

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

- Use the codes in general practice and design the machine members under various loading conditions
- Design the Shaft and Couplings under various loading conditions
- Do the design of Temporary and Permanent joints.
- Perform the design of springs and engine components
- Design and select the standard bearing from the catalogue.

Text Book(s):	
1	Bhandari V, ―Design of Machine Elements‖, 4th Edition, McGraw-Hill Book Co, 2016.
2	Joseph Joseph Shigley, Charles Mischke, Richard Budynas and Keith Nisbett ―Mechanical Engineering Design‖, 10thEdition, McGraw-Hill, 2014.
Reference Books(s) / Web links:	
1	R.B. Patel, ―Design of Machine Elements‖, MacMillan Publishers India P Ltd., Tech-Max Educational resources, 2011.
2	Sundararajamoorthy 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.	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
CO1	2	2	3	1	1	1	1		2	1	2	1		2	3
CO2	2	2	3	1	1	1	1		2	1	2	1		2	2
CO3	2	2	3	1	1	1	1		2	1	2	1		2	2
CO4	2	2	3	2	1	1	1		2	1	2	1		2	2
CO5	2	2	3	1	1	1	1		2	1	2	1		2	1

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

Course code	Course Name (Theory course)	Categor	L	T	P	C
ME19502	HEAT AND MASS TRANSFER (Use of Data Book is permitted in Exam)	PC	3	0	0	3

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.		

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.		
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 Hour	**45**

Course Outcomes: On the successful completion of this course students will 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
●	Illustrate radiation shape factors for various geometries
●	Demonstrate the phenomenon of diffusion and convective mass transfer

Text Book (s):	
1	Yunus A. Cengel, "Heat Transfer A Practical Approach", Tata McGraw Hill, 2015
2	Holman, J.P., "Heat and Mass Transfer", Tata McGraw Hill, 2011

Reference Books(s) / Web links:	
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.	Sachdeva R C, ―Fundamentals of Engineering Heat and Mass Transfer‖ New Age International, 2010, 4th edition.
4.	https://nptel.ac.in/courses/112/101/112101097/
5.	https://nptel.ac.in/courses/112/108/112108149//

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

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

Course code	Course Name (Theory Integrated with Laboratory)	Categor	L	T	P	C
ME19541	DYNAMICS OF MACHINES	PC	3	0	2	4

Objectives: The main learning 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	**Single Degree 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- Selection of measuring instruments – accelerometer – dynamic properties and selection of structural materials for vibration control.

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 Hour	**45**

DYNAMICS LABORATORY

List of experiments:

1. Study of gear parameter.
2. Epicyclic Gear Train and Differential Gear Train.
3. Determination of Mass Moment of Inertia using bifilar suspension and compound pendulum.
4. Undamped free vibration of Equivalent Spring mass system.
5. Torsional Vibration (Undamped) of single rotor shaft system.
6. Dynamic analysis of cam mechanism.
7. Balancing of rotating masses.
8. Experiment of Hartnell Governor.

9. Experiment of motorized gyroscope.
10. Determination of critical speed of shaft.

Total contact Hours: 30

Course Outcomes: On successful completion of the course, the student will be able to	
•	Predict the force analysis in mechanical system/ engine.
•	Analyse unbalanced forces and bearing reactions for a system of rotating masses and reciprocating engines.
•	Determine natural frequency of mechanical systems represented in lumped form.
•	Select the critical speed of shaft with unbalanced rotors and basic working principle of measuring devices.
•	Identify the gyroscopic couple or effect for stabilization of ship, aeroplane, two-wheeler and four-wheeler vehicle.
Text Book:	
1	Uicker, J.J., Pennock G.R and Shigley, J.E., ―Theory of Machines and Mechanisms‖,3rd Edition, Oxford University Press, 2010.
2	Rattan, S.S, ―Theory of Machines‖, 3rd Edition, McGraw-Hill, 2014.
Reference Books(s) / Web links:	
1	Thomas Bevan, "Theory of Machines", 3rd Edition, CBS Publishers and Distributors, 2010.
2	Cleghorn. W. L, ―Mechanisms of Machines‖, Oxford University Press, 2015.
3	Robert L. Norton, "Kinematics and Dynamics of Machinery", Tata McGraw-Hill, 2009.
4.	Ghosh. A and Mallick, A.K., ―Theory of Mechanisms and Machines‖, 3rd Edition, Affiliated East-West Pvt. Ltd., New Delhi, 2006.
5.	Rao.J.S. and Dukkipati.R.V. "Mechanisms and Machine Theory‖, New Age International., New Delhi, 2006.
6.	https://nptel.ac.in./courses/112/104/112104114
7.	https://nptel.ac.in./courses/112/101/112101096

Course code	**Course Name (Theory Integrated with Laboratory)**	**Categor**	**L**	**T**	**P**	**C**
ME19542	**METROLOGY AND MEASUREMENTS**	**PC**	**3**	**0**	**2**	**4**

Objectives: The students can be able to	
•	Understand the importance of measurements in engineering and the factors affecting measurements and to familiar with standards in measurements.
•	Know the working principle and applications of various linear and angular measuring instruments, assembly and transmission elements.
•	Identify the various tolerance symbols given in engineering assembly drawings and collect critical information to choose the appropriate manufacturing process
•	Understand the working principles and methods of form and surface metrology.
•	Familiar with the advances in measurements for quality control in manufacturing Industries.

UNIT-I	**Basics Of Metrology**	**6**
Measurement – Need, Process, Role in quality control; Factors affecting measurement - SWIPE; Errors in Measurements – Types – Control – Measurement uncertainty – Types, Estimation, Problems on Estimation of Uncertainty, Statistical analysis of measurement data, Measurement system analysis, Calibration of measuring instruments, ISO standards.		

UNIT-II	Measurement Of Linear, Angular Dimensions And Assembly & Transmission Elements	12
Linear Measuring Instruments – Vernier caliper, Micrometer, Vernier height gauge, Depth Micrometer, bore gauge, telescoping gauge; Gauge blocks – Use and precautions, Comparators – Working and advantages; Opto-mechanical measurements using measuring microscope and Profile projector - Angular measuring instruments – Bevel protractor, Clinometer, Angle gauges, Precision level, Sine bar, Autocollimator, Angle dekkor, Alignment telescope. Measurement of Screw threads – Floating carriage micrometer - Single element measurements – Pitch Diameter, Lead, Pitch. Measurement of Gears – purpose – Analytical measurement – Runout, Pitch variation, Tooth profile, Tooth Thickness-Constant chord method and base tangent method, Lead – Functional checking – Rolling gear test		
UNIT-III	**Tolerance Analysis**	**9**
Tolerancing – Interchangeability, Selective assembly, Tolerance representation, Terminology, Limits and Fits, Problems (using tables); Fundamentals of GD & T- Conventional vs Geometric tolerance, Datums, Design of Limit gauges, Problems. Tolerance analysis in manufacturing, Process capability, tolerance stack up, tolerance charting.		
UNIT-IV	**Metrology Of Surfaces**	**8**
Inspection of geometric deviations like straightness, flatness, roundness deviations, etc. Simple problems – Measurement of Surface finish – Functionality of surfaces, Parameters, Comparative, Stylus based and Optical Measurement techniques, Filters, Introduction to 3D surface metrology-Parameters.		
UNIT-V	**Advances In Metrology**	**10**
Lasers in metrology - Advantages of lasers – Laser scan micrometers; Laser interferometers – Applications – Straightness, Alignment; Ball bar tests, Computer Aided Metrology - Basic concept of CMM – Types of CMM – Constructional features – Probes – Accessories – Software – Applications – Multi sensor CMMs. Machine Vision - Basic concepts of Machine Vision System – Elements – Applications - On-line and in-process monitoring in production - Computed tomography – White light Scanners.		
	Total Contact Hour	**45**

List of Experiments			
1	Calibration and use of linear measuring instruments – Vernier caliper /Micrometer / Vern height gauge / Comparators.		
2	Measurement of angles using bevel protractor and sine bar.		
3	Measurement of assembly and transmission elements - screw thread parameters – Screw thre Micrometer, Two wire method.		
4	Measurement of gear parameters – Gear Tooth Vernier caliper.		
5	Non-contact (Optical) measurement using Toolmaker‘s microscope / Profile projector.		
6	Measurement of Force and Torque.		
7	Measurement of Surface finish in components manufactured using various processes usi stylus-based instruments.		
	Lab Contact Hours	**:**	**30**
	Total Contact Hours	**:**	**75**

Course Outcomes: Upon completion of this course, the students will be able to:	
●	Explain the importance of measurements in engineering and the factors affecting measurements and to estimate measurement uncertainty.
●	Demonstrate the working principle and select the appropriate measuring instruments for linear, angular, assembly and transmission elements.
●	Interpret the various tolerance symbols given in engineering assembly drawings to choose the appropriate manufacturing process.
●	Demonstrate the importance and procedure of form and surface metrology.
●	Emphasize the importance and choose the recent advancements in measurements for quality control in manufacturing industries.

Text Books:	
1	Jain R.K. ―Engineering Metrology‖, Khanna Publishers, 25th Reprint 2019.
2	Raghavendra N.V. and Krishnamurthy. L., Engineering Metrology and Measurements, Oxford University Press, 2013.

Reference Books(s) / Web links:	
1	Gupta. I.C., ―Engineering Metrology‖, Dhanpatrai Publications, 2009.
2	Venkateshan, S. P., ―Mechanical Measurements‖, Second edition, John Wiley &Sons, 2015.
3	Ammar Grous, J ―Applied Metrology for Manufacturing Engineering‖, Wiley-ISTE, 2011.
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.
5.	Duraivelu, K and Karthikeyan. S, Engineering Metrology and Measurement, The Orient Blackswan Publisher, 2018.
6.	https://nptel.ac.in/courses/112/104/112104250/

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

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

Course code	Course Name (Theory course)	Categor	L	T	P	C
EC19351	Basic Electronics Engineering	ES	3	0	0	3

Objectives:	
●	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 a stable 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, flip-flops, shift registers, counters, Block diagram of 8086 microprocessor and 8051 microcontroller and their applications.		
UNIT-V	**ELECTRONIC 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 Hour	**45**

Course Outcomes: On completion of the course the 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):	
1	Floyd, ―Electronic Devices‖ Pearson Education, 9th edition, 2012.
2	R.P. Jain, ―Modern Digital Electronics‖, Tata McGraw Hill, 3rd Edition, 2007.

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
6.	Frenzel, ―Communication Electronics: Principles and Applications‖, Tata McGraw Hill, 3rd Edition, 2001

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

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

Course code	Course Name (Laboratory Course)	Category	L	T	P	C
ME19511	**CAD / CAM LABORATORY**	**PC**	**0**	**0**	**3**	**1.5**

Objectives: The students can be able to	
●	Learn various modelling technique in software.
●	Learn to model various machine components
●	Learn to assemble various machine components
●	To Generate of CNC part programs for various machining operations in CNC Lathe.
●	To Generate of CNC part programs for various machining operations in CNC Milling

LIST OF EXERCISES

Geometric Modelling	**30**
Introduction of 3D solid modelling and assembly using CAD packages - Extrude, Revolve, Sweeps, Loft - prepare assembly models like Flange Coupling, Plummer Block, Screw Jack, Universal Joint, Stuffing box, Lathe Tailstock, Safety Valves, Connecting rod, Piston etc. **Project- Student has to select a component and complete its part and assembly model.**	
Manual Part Programming	**15**
Part Programming - CNC Milling Machine Linear Cutting. Circular cutting. Cutter Radius Compensation. Canned Cycle Operations.	

Part Programming - CNC Turning Machine Straight, Taper and Radius Turning. Thread Cutting. Rough and Finish Turning Cycle. Drilling and Tapping Cycle.			
	Total Contact Hour		**45**

Course Outcomes: On successful completion of the course, the student will be able to	
1	Model any 3D machine component.
2	Assemble the 3D machine component
3	Generate the different views of the machine component.
4	Write CNC manual part program and simulate for CNC Lathe operations,
5	Write CNC manual part program and simulation for CNC Milling operations.

Reference Books(s) / Web links:	
1	Ken Evans, Programming of CNC Machines, Industrial Press Inc.,2016
2	SolidWorks 2019 for Engineers and Designers by Prof. Sham Tickoo- BPB Publications (2019)
3	https://www.solidworks.com/partner-product/solidworks-online-training-and-books

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

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

Course code	**Course Name (Laboratory Course)**	**Category**	**L**	**T**	**P**	**C**
ME19512	**THERMAL ENGINEERING LAB-II**	**PC**	0	0	**3**	**1.5**

Objectives: The main learning objective of this lab course is to provide hands on training to the students in	
●	Demonstrating the fundamentals of heat transfer including modes of heat transfer
●	Predicting the coefficient used in heat transfer application
●	Study the performance of the refrigeration and air-conditioning systems
●	Understanding the Performance of a reciprocating air compressor
●	Study the performance of a fluidized Bed Cooling Tower

List of Experiments	
1	Thermal conductivity measurement using guarded plate apparatus
2	Thermal conductivity measurement of pipe insulation using lagged pipe apparatus
3	Determination of heat transfer coefficient under natural convection from a vertical cylinder
4	Determination of heat transfer coefficient under forced convection from a tube

5	Determination of Thermal conductivity of composite wall
6	Determination of Thermal conductivity of insulating powder
7	Heat transfer from pin-fin apparatus (natural & forced convection modes)
8	Determination of Stefan – Boltzmann constant
9	Determination of emissivity of a grey surface
10	Effectiveness of Parallel / counter flow heat exchanger
11	Determination of COP of a refrigeration system
12	Determination of COP of an air-conditioning system
13	Performance test on a reciprocating air compressor
14	Performance test in a fluidized bed cooling tower
	Total Contact Hour **45**

Course Outcomes: On successful completion of this course, students will be able to
● Demonstrate the fundamentals of heat transfer including modes of heat transfer
● Predict the coefficient used in heat transfer application
● Analyze the performance of the refrigeration and air-conditioning systems
● Analyze the Performance of a reciprocating air compressor
● Analyze the performance of a fluidized bed cooling tower

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

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

Course code	Course Name (Laboratory Course)	Category	L	T	P	C
GE19521	SOFT SKILLS-II	EEC	0	0	2	1

Course Objectives: The major course objectives are:

a. To help students break out of shyness.
b. To build confidence
c. To enhance English communication skills.
d. 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 hav to find words and their meaning from the artic 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 weeken	The students design activities they are going t 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 oth 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 o 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 mor 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.	The aim of the lesson is designed to teach the art of questioning. It also helps to

		Post few trials the students are given same opportunity to do the same with the crowd.	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 challenging topic only using fictional characters.	The activity aims at developing 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 studen are selected at random and supported to prese 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.

Total Hours:30

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

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)

SEMESTER -VI

Course code	Course Name (Theory course)	Category	L	T	P	C
ME19601	FINITE ELEMENT ANALYSIS	PC	3	0	0	3

Objectives: To introduce the students about the	
•	Mathematical formulation and solution for engineering problem.
•	Fundamentals of 1D Finite elements for structural analysis
•	Application of 1D finite element to Heat transfer and Vibration domain
•	Fundamentals of 2D Finite elements for structural analysis.
•	Need for Isoparametric formulation and numerical integration.

UNIT-I	**Introduction**	**9**
Historical Background – Mathematical Modeling of field problems in Engineering –Governing Equations – Discrete and continuous models – Boundary, Initial and Eigen Value problems– Weighted Residual Methods – Variational Formulation of Boundary Value Problems – Ritz Technique – Basic concepts of the Finite Element Method.		
Unit-II	**One Dimensional Analysis**	**9**
One Dimensional Second Order Equations – Discretization – Element types- Linear and Higher order Elements – Derivation of Shape functions and Stiffness matrices and force vectors-Assembly of Matrices - Solution of problems from solid mechanics. Fourth Order Beam Equation- Problems on it.		
UNIT-III	**Application Of One-Dimensional Element To Heat Transfer And Vibration**	**9**
Derivation of matrices and vector for heat transfer. Problems on Heat transfer. Natural frequencies of longitudinal vibration and mode shapes. Transverse Natural frequencies of beams.		
UNIT-IV	**Two-Dimensional Analysis**	
Second Order 2D Equations involving Scalar Variable Functions – Variational formulation –Finite Element formulation – Triangular elements and Quadrilateral elements- Shape functions and element matrices and vectors. Application to Field Problems. Equations of elasticity – Plane stress, plane strain and axisymmetric problems – Constitutive matrices and Strain displacement matrices – Stiffness matrix – Stress calculations.		
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-linearity.		
	Total Contact Hour	**45**

Course Outcomes: On successful completion of the course, the student will be able to	
•	Develop mathematical models for Boundary Value Problems and their numerical solution
•	Apply the concepts of Finite Element Analysis to solve one dimensional problem in structural analysis
•	Apply the concepts of Finite Element Analysis to solve one dimensional problem in Heat transfer and Dynamics
•	Apply the concepts of Finite Element Analysis to solve two dimensional problems in structural analysis
•	Apply the Isoparametric transformation and the use of numerical integration for various analysis

Text Books:	
1	Rao, S.S., —The Finite Element Method in Engineering‖, 6th Edition, ButterworthHeinemann,2018.
2	Tirupathi R.Chandrupatla and Ashok D.Belegundu, —Introduction to Finite Elements in Engineering‖, International Edition, Pearson Education Limited, 2014.

Reference Books(s) / Web links:	
1	David Hutton, —Fundamentals of Finite Element Analysis‖, Tata McGrawHill, 2017
2	Reddy,J.N. —Introduction to the Finite Element Method‖, 4thEdition, Tata McGrawHill,2018.
3	Robert D. Cook, David S. Malkus, Michael E. Plesha, Robert J. Witt, —Concepts and Applications of Finite Element Analysis‖, 4th Edition, Wiley Student Edition, 2007.
4	Seshu.P, —Text Book of Finite Element Analysis‖, PHI Learning Pvt. Ltd., NewDelhi, 2013.
6	https://nptel.ac.in/content/storage2/courses/112104116/ui/Course_mod_1.htm

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

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

Course code	Course Name (Theory course)	Categor	L	T	P	C
ME19602	GAS DYNAMICS AND JET PROPULSION	PC	3	0	0	3

Objectives: The main learning objective of this course is to prepare the students	
●	To understand the concept of compressible flow and isentropic flow through nozzles and diffusers
●	To understand the flow through constant area ducts with heat transfer and friction and variation of fluid properties
●	To understand the phenomenon of shock waves, its effect on flow and applications
●	To gain knowledge of theory and analysis of jet propulsion and operating principles of various types of aircraft engines
●	To understand theory of rocket propulsion, rocket engines, propellant feeding systems, equations and applications

UNIT-I	Basic Concepts And Isentropic Flows	9
Energy and momentum equations of compressible fluid flows – Stagnation states, Mach waves and Mach cone – Effect of Mach number on compressibility – Isentropic flow through variable ducts – Nozzle and Diffusers		
UNIT-II	**Flow Through Ducts**	**9**
Flows through constant area ducts with heat transfer (Rayleigh flow) and Friction (Fanno flow) – variation of flow properties.		
UNIT-III	**Normal And Oblique Shocks**	**9**
Governing equations – Variation of flow parameters across the normal and oblique shocks – Prandtl – Meyer relations – Applications.		

UNIT-IV	Jet Propulsion	9
Theory of jet propulsion – Thrust equation – Thrust power and propulsive efficiency – Operati principle, cycle analysis and use of stagnation state performance of ram jet, turbojet, turbofan a turbo prop engines.		
UNIT-V	**Space Propulsion**	**9**
Types of rocket engines – Propellants-feeding systems – Ignition and combustion – Theory of rocket propulsion – Performance study – Staging – Terminal and characteristic velocity – Applications – space flights.		
	Total Contact Hour	**45**

Course Outcomes: Upon completion of this course the student will be able to	
●	Explain basic concepts of gas dynamics and analyze the compressible flow in ducts with area changes
●	Analyse the simple flows such as Fanno flow and Rayleigh flow with applications to nozzle
●	Derive the conditions for the change in pressure, density, temperature and strength of shock for flow through a normal and oblique shock
●	Describe the jet propulsion engines
●	Explain about propellants and concepts of rocket propulsion system

Text Book (s):	
1	Anderson, J.D., Modern Compressible flow, ISBN-10: 1259027422, 3rdEdition, McGraw Hill, 2017
2	Yahya, S.M. Fundamentals of Compressible Flow with Aircraft and Rocket Propulsion, New Age International (P) Limited, New Delhi, Fifth edition, 2016

Reference Books(s) / Web links:	
1	Hill. P. and C. Peterson, Mechanics and Thermodynamics of Propulsion, Addison –Wesley Publishing company, Second Edition, 2016
2	Zucrow. N.J., Aircraft and Missile Propulsion, Vol.1 & II, John Wiley, 2013
3	Ganesan. V., Gas Turbines, Tata McGraw Hill Publishing Co., New Delhi, 3rdEdition, 2017
4	Babu. V., Fundamentals of Gas Dynamics, ANE Books India, Second Edition, 2014
5	Cohen. H., G.E.C. Rogers and Saravanamutto, Gas Turbine Theory, Longman Group Ltd., Seventh Edition, 2017
6	Somasundaram. PR.S.L., Gas Dynamics and Jet Propulsions, New Age International Publishers, 2008

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

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

Course code	Course Name (Theory course)	Categor	L	T	P	C
ME19603	TOTAL QUALITY MANAGEMENT	PC	3	0	0	3

Objectives:	
●	To facilitate the understanding of basic quality management in engineering.
●	To facilitate the understanding of various principles of TQM.
●	To be acquainted with management tools, six sigma and benchmarking.
●	To be acquainted with quality functions, TPM concepts &continuous improvement tools.
●	To learn various quality systems and TQM implementation in manufacturing and service sectors.

UNIT-I	Introduction	9
Introduction - Need for quality - Evolution of quality - Definitions of quality - Dimensions of product and service quality - Basic concepts of TQM - TQM Framework - Contributions of Deming, Juran and Crosby - Barriers to TQM - Quality statements - Customer focus - Customer orientation, Customer satisfaction, Customer complaints, Customer retention.		
UNIT-II	**TQM Principles**	9
Leadership - Strategic quality planning, Quality Councils - Employee involvement - Motivation, Empowerment, Team and Teamwork, Recognition and Reward, Performance appraisal - Continuous process improvement - PDCA cycle, 5S, Kaizen, 8D methodology - Supplier partnership - Partnering, Supplier selection, Supplier Rating.		
UNIT-III	**TQM Tools And Techniques I**	9
The seven traditional tools of quality - New management tools - Six sigma, Lean Six Sigma: Concepts, Methodology, applications to manufacturing, service sector including IT - Bench marking - Reason to bench mark, Bench marking process - FMEA - Stages, Types.		
UNIT-IV	**TQM Tools And Techniques Ii**	9
Quality Circles – Cost of Quality – Quality Function Deployment (QFD) – Taguchi quality loss function – TPM – Concepts, improvement needs – Performance measures, 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—Benefits of EMS.		
	Total Contact Hour	**45**

Course Outcomes: At the end of this course, students can have the	
●	Ability to explain the importance of quality in engineering.
●	Ability to explain various principles in TQM.
●	Explore the knowledge of implementing various TQM tools.
●	Ability to create rapport among workers to form a quality team.
●	Ability to explain the benefits of implementing ISO-9000 & ISO-14000 in manufacturing and service sectors.

Text Book:	
1	Dale H.Besterfield, Carol Besterfield- Michna, Glen H. Besterfield, Mary Besterfield - Sacre, Hemant Urdhwareshe and Rashmi Urdhwareshe ―Total Quality Management, Pearson Education Asia, Revised Third Edition, Indian Reprint, Sixth Impression, 2013.

Reference Books(s) / Web links:	
1	James R. Evans and William M. Lindsay, "The Management and Control of Quality", 8th Edition, First Indian Edition, Cengage Learning, 2012.
2	Suganthi.L and Anand Samuel, "Total Quality Management", Prentice Hall (India) Pvt. Ltd., 2006.
3	Janakiraman. B and Gopal .R.K., "Total Quality Management - Text and Cases", Prentice Hall (India) Pvt. Ltd., 2006.
4.	ISO9001-2015 standards-A Complete Guide to Quality Management Systems by ItayAbuhav.
5.	Poka - Yoke, "Improving Product Quality by Preventing Defects", Productivity Press, 2004.

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

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

Course code	Course Name (Theory course)	Categor	L	T	P	C
ME19604	DESIGN OF TRANSMISSION SYSTEMS (Use of Design Data Book is Permitted)	PC	3	0	0	3

COURSE OBJECTIVES: The main learning 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**

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

UNIT-II Spur And Helical Gears **9**

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

UNIT-III Bevel And Worm Gears **9**

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

UNIT-IV	**Gear Boxes**	9
Need - Design of sliding and constant mesh gear boxes: Speed selection - Geometric progression - Standard step ratio - Ray diagram, kinematic layout – Determination of number of teeth. Design of multi speed gear box for machine tool applications, Variable speed gear box, Fluid Couplings, Torque Converters for automotive applications - Continuous variable transmission system.		
UNIT-V	**Clutches And Brakes**	9
Design of single and multi-plate clutches, cone clutches, internal expanding rim clutches and Electromagnetic clutches. Design of brakes: External shoe brakes - Single and Double Shoe, Internal expanding shoe brakes and Band brakes.		
	Total Contact Hour	**45**

Note: (**Use of standard Design Data Book is permitted in the End Semester Examination**)

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.

TEXT BOOKS:	
1	Shigley. J., Mischke. C., Budynas, R., and Nisbett. K., ―Mechanical Engineering Design‖,10thEdition, Tata McGraw-Hill, 2014.
2	Sundararajamoorthy. T. V. and Shanmugam. N., ―Machine Design‖, 9th Edition, AnuradhaPublications, Chennai, 2003.
REFERENCES/WEBLINKS	
1	Bernard Hamrock, Steven Schmid, Bo Jacobson, ―Fundamentals of Machine Elements‖,2nd Edition, Tata McGraw Hill, 2006.
2	Sundararajamoorthy. T. V. and Shanmugam. N., ―Machine Design‖, 9th Edition, AnuradhaPublications, Chennai, 2003. x
3	Sen and Bhattacharya, ―Principles of Machine Tools‖, New Central Book Agencies, 1975.
4.	https://nptel.ac.in/courses/112/106/112106137/

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

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

Course code	Course Name (Laboratory Course)	Category	L	T	P	C
GE19621	PROBLEM-SOLVING TECHNIQUES	EEC	0	0	2	1

Course Objectives:

- To improve the numerical ability
- To improve problem-solving skills.

Course topics:

S.No.	Topics
1	Number‘s 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

Total Hours:30

Course Outcomes: On successful completion of the course, the students will be able to	
•	Recognize proportional relationships from verbal, graphical, symbolic or numerical scenarios.
•	Use proportionality to solve and analyze a variety of multi-step contextual problems
•	Solve quantitative aptitude problems with more confident.
•	Distinguish relevant from non-relevant data, fact from opinion.
•	Appropriate use mathematical results to guide decision-making

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

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

Course code	Course Name (Lab course)	Category	L	T	P	C
ME19611	SIMULATION AND ANALYSIS LABORATORY	PC	0	0	3	1.5

Course Objectives: The main learning objective of this course is to provide hands on training to the students in:	
●	Simulating various mechanisms and robot configuration
●	Analyzing the force, stress, deflection in mechanical components.
●	Analyzing thermal stress and heat transfer in mechanical components.
●	Analyzing the vibration of mechanical components.
●	Analyzing the modal, harmonic, transient and spectrum concepts in mechanical components.

LIST OF EXPERIMENTS	
1	Stress analysis of Trusses.
2	Stress and deflection analysis in beams with different support conditions.
3	Stress analysis of rectangular plate and rectangular plate with hole
4	Stress analysis of axis–symmetric components.
5	Thermal Analysis of Fin and chip.
6	Unsteady Thermal analysis of fin.
7	Modal analysis of Beams.
8	Stress analysis in pressure vessel
9	Linear Column Buckling Analysis
10	Project Work – Analysis of any one mechanical component
	Total contact periods:

Course Outcomes: On successful completion of the course, the students will be able to	
●	Perform Stress analysis of beam.
●	Stress analysis of Axisymmetric component
●	Do heat transfer analysis of mechanical components.
●	Perform modal analysis of mechanical components.
●	Analyse the buckling in column.

Reference Books/Weblink	
1	ANSYS for Designer by Prof. Shyam Tickoo and Vivek Singh, CADCIM Technologies, USA,
2	www.confluence.cornell.edu

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

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

Course code	Course Name (Practical course)	Category	L	T	P	C
ME19612	INNOVATION and DESIGN THINKING FOR MECHANICAL ENGINEER	EEC	0	0	3	1.5

Objectives:	The main learning objectives of this course is to provide exposure to the students
●	Work in a group and to identify the potential areas in the field of mechanical Engineering.
●	Recognize the creative thinking skills to compare and contrast the several existing solutions for the identified problem.
●	Understand the project plan for creating a solution for the work identified.
●	Acquire fundamental principles of planning and carrying out the work plan of the project through observations, discussions and decision-making processes.
●	Understand on preparing the project report and present the findings of the work conducted.

Design thinking is a comprehensive approach to solutions, which stimulates creativity in working groups of participants. It is an innovating process, which allows the development of new solutions for any given problem. Concepts are created and then revised in various cycles and tested using prototypes. This holistic approach with creative solutions enables companies to develop innovations.

GUIDELINE FOR REVIEW AND EVALUATION

The students may be grouped into 2 or 3 should select an existing mechanical component/ assembly and they should identify, define, ideate, fabricate and test. The device/ system/component(s) to be fabricated may be decided in consultation with the supervisor.

A project report to be submitted by the group and the fabricated model, which will be reviewed and evaluated for internal assessment by a committee constituted by the Head of the Department. At the end semester examination, 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.

COURSE OUTCOMES:

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

1. Work in a group and identify the potential research areas in the field of Mechanical Engineering.
2. Apply their creative thinking skills to Compare and contrast the several existing solutions for the problems identified.
3. Formulate and propose a plan for creating a solution for the work identified.
4. Apply fundamental principles of planning and carrying out the work plan of the project through observations, discussions and decision-making process
5. Prepare the project report and present the findings of the work conducted.

Scheme for Internal Evaluation:

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

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

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

SEMESTER-VII

Course code	Course Name (Theory course)	Categor	L	T	P	C
ME19701	AUTOMOBILE ENGINEERING	PC	3	0	0	3

Objectives: The main learning objective of this course is to prepare the students	
●	To understand the various types of automobiles, their power packs, and types of vehicle bodies.
●	To understand the various types of power train and fuel supply and management systems.
●	To know the various types of transmission systems for a vehicle.
●	To understand the working parameters of various braking and suspension system in a vehicle.
●	To understand the working parameters of various electrical and electronic devices in a vehicle.

UNIT-I	Introducton To Automobile And Types	9
An overview of different types of automobiles and their power sources. Specifications, Performance Parameters, Types of power delivery, Safety standards, Trends in automobile design. Two and Types, Regulations, Car body construction. Bus Body Details, General consideration relating to chassis layout. Introduction to MV Act, Pollution Norms.		
UNIT-II	**Powertrain And Fuel Management Systems**	**9**
Reciprocating Engine systems, Hybrid systems. Pollutant emissions and their control; Catalytic converter systems, Electronic Engine Management systems for SI and CI engines. Liquid and gaseous alternate fuels - Alcohol, LPG, CNG, and Hydrogen.		
UNIT-III	**Clutch And Transmission Systems**	**9**
Clutch system and types, Gear box and types - manual, automatic, and AMT, propeller shafting, Differential, Axles - function, and types, Wheels, Tyres - types, construction and specification, suspension system - types and functioning.		
UNIT-IV	**Braking And Suspension Systems**	**9**
Braking system - requirements and types, Steering system - working, types and steering geometry parameters. Wheel balancing & Alignment Wind Tunnel testing, Servicing of Vehicles,		
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, ABS, Modern electronic features in vehicles like tyre pressure monitoring, ESP, EBD, Automatic headlamp ON, Rain sensing wipers, speed sensing auto locking, OBD. HVAC system.		
	Total Contact Hour	**45**

Course Outcomes: On successful completion of this course, students will be able to	
●	Explain the various types of automobiles, their power packs, and types of vehicle bodies.
●	Explain the various types of power train and fuel supply and management systems.
●	Select the various types of transmission systems for a vehicle.
●	Explain the working parameters of various braking and suspension system in a vehicle
●	Explain the working parameters of various electrical and electronic devices in a vehicle.

Text Books:	
1	Jack Erjavek, ―Automotive Technology – A Systems Approach‖, Thomson Learning, 3rdEdition, 1999
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	Kirpal Singh, Automobile Engineering Volume I and II, Standard Publishers &Distributors, 14th Edition, 2017.
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
CO1	2	1	1	1	-	-	1	-	-	-	-	1	-	-	2
CO2	2	1	1	1	-	-	1	-	-	-	-	1	-	-	2
CO3	2	1	1	1	-	-	1	-	-	-	-	1	-	-	2
CO4	2	1	1	1	-	-	1	-	-	-	-	1	-	-	2
CO5	2	1	1	1	-	-	1	-	-	-	-	1	-	-	2

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

Course code	Course Name (Theory course)	Categor	L	T	P	C
ME19702	AUTOMATION IN MANUFACTURING	PC	3	0	0	3

Objectives:	
●	To understand the basics of Manufacturing and Automation concepts.
●	To understand about the design, analysis and implementation of manufacturing support systems.
●	To understand the needs and application of various material and tool handling systems.
●	To understand group technology concepts, coding systems and implementation of flexible manufacturing systems.
●	To understand the anatomy, configuration and application of Industrial robots and basics of smart manufacturing.

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 Hour	**45**

Course Outcomes: At the end of this course, students can have the	
●	Ability to understand the basics of Manufacturing, its fundamentals, types and Automation principles used in Manufacturing Industries.
●	Ability to convert customer requirements into product related data and its subsequent plan for manufacturing it effectively and to improve productivity.
●	Ability to understand the use and application of modern material handling, tool handling systems and storage systems.
●	Ability to group the work parts, identify and design the proper layout for manufacturing them.
●	Ability to identify and implement a proper robotic system for any application and understand the significance of smart manufacturing.

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.

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	-	-	-	1	2	-	-	2
CO2	2	2	2	-	1	1	1	-	-	-	1	2	-	-	2
CO3	2	2	2	-	-	1	1	-	-	-	1	2	-	-	2
CO4	2	1	1	-	-	1	1	-	-	-	1	2	-	-	2
CO5	2	1	1	-	-	1	1	-	-	-	1	2	-	-	2

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

Course code	Course Name (Theory course)	Categor	L	T	P	C
ME19741	MECHATRONICS	PCC	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 – 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.

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.

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 –IoT based Case studies

Total Contact Hour	**45**

Course Outcomes: At the end of this course, students can have the

- Ability to select sensors to develop mechatronics systems based on the applications.
- Ability to explain the architecture and timing diagram of microprocessor, Arduino, Raspberry and also interpret and develop programs.
- Ability to design appropriate interfacing circuits to connect I/O devices with microprocessor.
- Ability to apply PLC and SCADA system as a controller in mechatronics system.
- Ability to Design and develop the apt mechatronics system for an application

Text Book:

1. Bolton W., ―Mechatronics‖, Pearson Education, 6th Edition, 2015.
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.	Frank Lamb, Industrial Automation: Hands On, McGraw-Hill Professional, 2013
6.	Krishna Kant, ―Microprocessor & Microcontrollers‖, Prentice Hall of India, 2007

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

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

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

Course code	Course Name (Laboratory course)	Category	L	T	P	C
ME19711	PROJECT PHASE-I	EEC	0	0	2	1

OBJECTIVES

- Discovering potential research areas in the field of Mechanical Engineering.
- Comparing and contrast the several existing solutions for the problem identified through literatures.
- Formulate and propose a plan for the identified work.
- 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.

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TOTAL:30 PERIODS

Scheme for Internal Evaluation

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

COURSE OUTCOMES: The students can able to:

- Formulate the objectives of the project work
- Know the recent developments in their project area through Literature survey
- Identify the research Gap from the literature survey
- Formulate the methodology of the project work.
- Prepare the time line for each stage of their project Work.

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

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

Course code	Course Name (Laboratory course)	Categor	L	T	P	C
ME19712	COMPREHENSION	EEC	0	0	2	1

Objectives:	
●	To encourage the students to comprehend the knowledge acquired from the first Semester to Sixth Semester of B.E Degree Course through periodic exercise.

METHOD OF EVALUATION

The students will be assessed 100% internally through weekly test and an end semester examination with objective type questions in Mechanical Engineering domain.

TOTAL: 30 PERIODS

OUTCOMES: At the end of this course, students are:

- Collect critical information required to solve engineering problems
- Interpret the knowledge acquired to take decision making in various fields of mechanical engineering
- Able to apply the fundamental knowledge gained for solving the engineering problems.
- Able to apply the knowledge gained to write the competitive exams
- Able to apply the knowledge gained to face technical interviews.

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	-	1	2	1	-	2	1	1	-	2	2
CO2	3	2	2	1	-	1	2	1	-	2	1	1	-	2	2
CO3	3	2	2	1	-	1	2	1	-	2	1	1	-	2	2
CO4	3	2	2	1	-	1	2	1	-	2	1	1	-	2	2
CO5	3	2	2	1	-	1	2	1	-	2	1	1	-	2	2

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

Course code	Course Name (Laboratory Course)	Categor	L	T	P	C
ME19713	ARTIFICIAL INTELLIGENCE FOR MECHANICAL ENGINEERS	PC	0	0	6	3

Objectives:
To provide exposure to the students with real time experience on Artificial Intelligence in Mechanical Engineering Domain.

Note:
Any 3 problem can be choosen from list of sample exercises given below.
The titles are not restricted to the sample exercises listed.
The final report need to be submitted for all the problems chosen.

List of Sample Exercises	
1.	Soldering defect identification in PCB using AI/ Machine Learning Techniques
2.	Defect identification in welded joints using ultrasonic images and AI/ML Technique.
3.	Welding process parameters decision using AI/ML technique.
4.	Machining time calculation using AI/ML Technique.
5.	AI/ML technique to predict the surface roughness of the machined part.
6.	Estimating the duration for solidification in Metal forming using AI/ML technique.
7.	Prediction of power generated in Kaplan/Francis / Pelton turbine based on head/discharge using AIML Technique
8.	Prediction of deflection in Cantilever/simply supported beam using AI/ML
9.	Prediction of heat transfer coefficient for free/forced convection of air using AIML
10.	Prediction of efficiency/emission of four stroke compression Ignition Engine under various loading conditions using AIML.
11.	Machine Learning models to predict the natural frequency in a bea
12.	Identifying and matching the nut for bolt using image processing and AI/ML Technique.
	Total Contact Hour **30+45=7**

Course Outcomes: At the end of the course students have

- Learned the various AIML techniques.
- Learned how to work with a variety of mechanical engineering application development frameworks.
- Acquire the basic and important design concepts and issues of development of machine learning language
- Deploy applications of ML to the various core mechanical engineering specializations.
- Develop the Machine learning program using Internal and External databases.

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

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

SEMESTER-VIII

Course code	Course Name (Laboratory course)	Category	L	T	P	C
ME19812	PROJECT PHASE-II	EEC	0	0	18	9

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: 270 PERIODS

Scheme for Internal Evaluation

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

COURSE OUTCOMES:

- On completion the students can able to execute the proposed plan and identify and overcome the bottlenecks during each stage.
- On Completion of the project work students will be in a position to take up any challenging practical problems and find solution by formulating proper methodology.
- 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.
- Students will be able to 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.

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

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

PROFESSIONAL ELECTIVES / VERTICALS FOR

B.E. MECHANICAL ENGINEERING

VERTICAL 1 : COMPUTATIONAL ENGINEERING

(Common to Mechanical, Aero, Mechatronics, Robotics and Automation)

Course code	Course Name (Theory course)	Categor	L	T	P	C
ME19A11	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 fuzzy logic, Fuzzification and Defuzzification
- To learn about basics of neural networks and neuro fuzzy networks.
- To learn about recurrent neural networks and Reinforcement learning.

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.

TEXT BOOKS:	
1	Micheal Negnevitsky, Artificial Intelligence: A Guide to Intelligent Systems, 3rd Edition,
2.	Machine Learning. Tom Mitchell. First Edition, McGraw- Hill, 1997

REFERENCES:	
1.	Bruno Siciliano, Oussama Khatib, ―Handbook of Robotics‖, 2016 2nd Edition, Springer
2.	Simon Haykin, ―Neural Networks and Learning Machines: A Comprehensive Foundation‖ Third Edition, Pearson, Delhi 2016.
3.	Timothy J Ross, ―Fuzzy Logic with Engineering Applications‖, 4th Edition, Chichester,
4.	https://nptel.ac.in/courses/106106202
5.	https://nptel.ac.in/courses/108104049

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

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

Course code	Course Name (Theory course)	Category	L	T	P	C
ME19A12	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 imagesOpen 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.

PO-PSO / CO	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	1	1	1	1	2	1	3	2	2	1	2	2	1	1
CO2	2	1	1	1	1	2	1	3	2	2	1	2	2	1	1
CO3	1	1	1	1	2	1	3	2	3	1	1	2	2	1	1
CO4	3	3	2	2	2	1	3	2	3	1	1	1	2	1	1
CO5	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 Name (Theory course)	Category	L	T	P	C
ME19A13	NUMERICAL HEAT TRANSFER	PE	3	0	0	3

Objectives:

- To analyse mathematical and computational methods for fluid flow and heat transfer simulations
- To use the Nature of Numerical Methods and Methods of Deriving the Discretization Equations
- To assess the Conduction flow analysis
- To assess the flow of Convection and Diffusion flow analysis
- 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, 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 one-Dimensional 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.

Total Contact Hours : 45

Course Outcomes: Upon completion of the course students should be able to:

- Derive and apply the governing equations and boundary conditions for Fluid dynamics
- Analyze Discretization concept and Discretization Equations
- Analyze Finite difference and Finite volume method for Conduction problems
- Analyze Finite difference and Finite volume method for Convection and Diffusion problems
- Analyze 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.

4	Varsteeg, Malalasekera, An introduction to Computational Fluid Dynamics The finite volume method, Pearson Prentice hall.

Reference Books(s) / Web links:	
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

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

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

Course code	**Course Name (Theory course)**	**Category**	**L**	**T**	**P**	**C**
ME19A14	**THEORY OF 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 vario 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_s 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 – LineBased Techniques - Region-Based Techniques - Combinations of Techniques – Trees Displaying Hierarchical Structures – Graphics and Networks- Displaying Arbitrary Graphs/Networks.		
		Total Contact Hours: 45

Course Outcomes: At end of this course,
CO1: Analyze a given language and design an appropriate finite automaton
CO2: Formulate regular expressions for specific languages and prove the equivalence between finite automata and regular expressions.
CO3: classify grammars based on Chomsky's hierarchy, generate languages using context-free grammars
CO4: capable of designing effective visualizations and appreciating the historical development of visualization techniques.
CO5: Apply appropriate visualization techniques to represent different types of data effectively

Text Book(s):
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.

Reference Books(s) / Web links:
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.

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

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

Course code	Course Name (Theory course)	Category	L	T	P	C
ME19A15	COMPUTATIONAL BIOMECHANICS	PE	3	0	0	3

Objectives:	
•	To Introduce principles and concepts of bio-mechanics
•	Focuses on the studies of tissues and structure of musculoskeletal system.
•	To study the mechanics of joints and human motion.
•	To explain the computational approaches in biomechanics
•	To learn the quantification of forces and motion.

UNIT-I	**Introduction To Biomechanics**	**9**
Perspective of biomechanics, Terminologies, Kinematic and kinetic concepts for analyzing human motion, Kinetic concepts for analyzing human motion, Linear kinetics of human movement, Equilibrium, Angular kinetics of human Movement, Mechanical properties of soft tissues, bones, and muscles.		
UNIT-II	**Biomechanics Of Tissues And Structures Of The Musculoskeletal System**	**9**
Biomechanics of Bone, Biomechanics of Articular Cartilage, Tendons and Ligaments, Peripheral Nerves and Spinal Nerve Roots, Skeletal Muscle.		
UNIT-III	**Biomechanics Of Joints And Human Motion**	**9**
Knee, Hip, Foot and Ankle, Lumbar Spine, Cervical Spine, Shoulder, Elbow Wrist, and Hand, Linear kinematic and kinetic aspects of human movement, angular kinematic and kinetic aspects of human movement, equilibrium and human moment.		
UNIT-IV	**Computational Approaches In Biomechanics**	**9**
Finite Element Analysis in Biomechanics, Computational modelling of Vancouver Periprosthetic Fracture in Femur, Scaffolds, artificial hip and knee joints, Aortic Valve.		
UNIT-V	**Gait Analysis**	**9**
Exoskeleton design, Ergonomics, Sports mechanics, Performance Analysis, Biomechanical analysis, 3D printing.		
	Total Contact Hours : 45	

Course Outcomes: Upon completion of the course students should be able to:	
•	Discuss the principles of mechanics.
•	Elaborate the tissues and structures of the musculoskeletal system
•	Discuss of joint mechanics and human motion.
•	Create Examples of computational mathematical modelling applied in biomechanics.
•	Describe the analysis of human motion.

Text Books:	
1	Susan J Hall, ―Basic Biomechanics, 6th Edition, The McGraw-Hill Companies Inc., 2011
2	Jay D Humphrey and Sherry L Delange, ―An Introduction to Biomechanics: Solids and Fluids, Analysis and Design, 1st edition, Springer-Verlag, 2010
Reference Books(s) / Web links:	
1	Jay D. Humphrey, Sherry De Lange, ―An Introduction to Biomechanics: Solids and Fluids, Analysis and Design‖, Springer Science Business Media, 2004
2	Shrawan Kumar, ―Biomechanics in Ergonomics‖, Second Edition, CRC Press2007
3	Sheraz S. Malik et. al. ―Orthopaedic Biomechanics Made Easy‖, Cambridge University Press, 2015.

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

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

Course code	Course Name (Theory course)	Category	L	T	P	C
ME19A16	ADVANCED STATISTICS AND DATA ANALYTICS	PE	3	0	0	3

Objectives:	
•	To introduce the basic concepts of linear regression and multiple regression
•	To introduce exploratory data analysis
•	To study logistic regression models for classification
•	To develop the forecasting techniques for the predictions
•	To introduce the time series analysis for the prediction of future behavior

UNIT-I	Regression	9
Introduction – Linear regression - Correlation analysis -Limitations, errors, and caveats of using regression and correlation analyses - Multiple regression and correlation analysis - Inferences about population parameters – Modeling techniques. - Coefficient of determination, Interpretation of regression coefficients, Categorical variables, heteroscedasticity, Multi-co linearity outliers, Ridge regression.		
UNIT-II	**Exploratory Data Analysis**	**9**
Rise of statistics, Data Wrangling, Data Quality. Visual encoding – Mapping Data to Visual Variables, Encoding Effectiveness, Scales & Axes, Aspect Ratio, Regression Lines, Multidimensional Data, Parallel Coordinates, Dimensionality Reduction.		
UNIT-III	**Logistic And Multinomial Regression**	**9**
Logistic function, Estimation of probability using Logistic regression, Variance, Wald Test, Hosmer		

Lemshow Test, Classification Table, Gini Co-efficient.		
UNIT-IV	**FORECASTING AND CAUSAL MODELS**	**9**
Forecasting – Basics, Methods of forecasting, Quantitative Methods, Delphi method, Qualitative methods , Moving average, Exponential Smoothing, Casual Models.		
UNIT-V	**TIME SERIES ANALYSIS**	**9**
Time series analysis- Types- Auto regression (AR), Moving Average(MA) Models, ARMA, ARIMA models , Multivariate Model,		
	Total Contact Hours	**45**

Course Outcomes: Upon completion of the course students should be able to:	
•	Apply regression analysis techniques to fit a mathematical model to given data,
•	Analyze and interpret data through the application of explanatory data analysis techniques
•	Integrate knowledge and skills to create a novel solution for data classification.
•	Analyzing forecasting techniques and causal inferences.
•	Assess and apply advanced time series analysis techniques to forecast future data behavior.

	Text Books:
1	Douglas C Montgomery and George C Runges, ―Applied Statistics and Probability for Engineer John Wiley &Sons, 2014
2	Douglas C. Montgomery, Cheryl L. Jennings, Murat Kulachi, ―Introduction to Time Series Analysis and Forecasting‖ ,Wiley,2015

Reference Books(s) / Web links:	
1	David Forsyth, _Probability and Statistics for Computer Science‘, Springer; 2018
2	Michael J. Evans, Jeffrey S. Rosenthal, _Probability and Statistics - The Science of Uncertainty‘. W H Freeman & Co, 2010
3	Max Kuhn, Kjell Johnson, ―Applied Predictive Modeling‖, Springer, 2014.
4	Ronald E. Walpole, Raymond H. Meyers, Sharon L. Meyers, ―Probability and Statistics for Engineers and Scientists‖, Pearson Education, 2014.
5	Daniel T. Larose, Chantal D. Larose ―Data Mining and Predictive Analytics‖, Wiley,2015
6	Thomas W.Miller, ―Modeling Techniques in Predictive Analytics with Python and R: A guide to Data Science‖, Pearson Education, 2014.

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

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

Course code	Course Name (Theory course)	Category	L	T	P	C
ME19A17	NOISE ACOUSTICS AND VIBRATION	PE	3	0	0	3

Course Objectives	
•	To introduce the concept of noise and its analysis methods
•	To impart knowledge about the source of noise and its control techniques
•	To introduce the concepts of Acoustics and measuring devices
•	To familiarize the students with knowledge about various types of vibrations
•	To enlighten the students with vibration measuring devices and control it.

UNIT-I	Basics Of Noise	9
Introduction, amplitude, frequency, wavelength and sound pressure level, addition, subtraction and averaging decibel levels, noise dose level, legislation, measurement and analysis of noise, measurement environment, equipment, frequency analysis, tracking analysis, sound quality analysis.		
UNIT-II	**Source Of Noise And Its Control**	**9**
Methods for control of engine noise, combustion noise, mechanical noise, predictive analysis, palliative treatments and enclosures, automotive noise control principles, sound in enclosures, sound energy absorption, sound transmission through barriers		
UNIT-III	**Introduction To Acoustics And Its Measurements**	**9**
Theory of Sound—Predictions and Measurement, Sound Sources, Sound Propagation in the Atmosphere, Sound Radiation from Structures and Their Response to Sound. Signal Acquisition, and Processing, Acoustical Transducer Principles and Types of Microphones, Sound Level Meters, Noise Dosimeter, and Impedance tube		
UNIT-IV	**Fundamentals Of Vibration**	**9**
Basic definitions and concepts - Free vibration of single-degree-of-freedom systems Harmonic Motion and Harmonically Excited Vibration, Damping in Vibrating Systems, Introduction and response to forced vibration system.		
UNIT-V	**Vibration Measurement And Control**	**9**
Specification of Vibration Limits –Vibration severity standards- Vibration analysis in structural health monitoring – Vibration based fault detection in mechanical systems - Vibration Absorbers.		
	Total Contact Hours	**45**

Course Outcomes: At the end of the course the students would be able to:	
•	Comprehend the foundational principles of noise and differentiate between various methods for analyzing its diverse types
•	Apply methods for controlling noise and comprehend the principles of noise control techniques.
•	Utilize various measuring techniques to demonstrate a comprehensive understanding of the fundamental principles of sound.
•	Classify among various types of vibration, showcasing a comprehensive understanding of the fundamental principles of vibration.
•	Evaluate vibration severity using standards and perform **diagnosis** of structural health and fault detection in mechanical systems

Text Books:	
1	S.S Rao, ―Mechanical Vibration,‖ Sixth Edition, **Pearson Education**, 2018.
2	C. Sujatha, Vibrations and Acoustics, Measurement and Signal Analysis, McGraw-Hill Education (India) Pvt Limited, 2017.

Reference Books(s) / Web links:	
1	Debasish Chattopadhyay and Phatik Chandra Rakshit, Vibrations, Waves, and Acoustics, Books and Allied (P) Ltd, Kolkatta, 2010.
2	Malcolm J. Crocker (Author), Jorge P. Arenas (Author), Engineering Acoustics: Noise and Vibration Control (Wiley Series in Acoustics Noise and Vibration), Wiley Publication, 2021.
3	https://www.digimat.in/nptel/courses/video/112107087/
4	https://www.digimat.in/nptel/courses/video/112106225/

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
CO2	2	1	1	-	-	1	-	-	-	-	-	-	-	-	1
CO3	2	1	1	-	-	1	-	-	-	-	-	-	-	-	1
CO4	2	1	1	-	-	1	-	-	-	-	-	-	-	-	1
CO5	2	1	1	-	-	1	-	-	-	-	-	-	-	-	1

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

Course code	Course Name (Theory course)	Category	L	T	P	C
ME19A18	COMPUTATIONAL SOLID MECHANICS	PE	2	0	2	3

Objectives:	
I	To study the definition and basics on theory of elasticity
I	To learn finite element method and procedure for static linear elasticity
I	To study the Non Linear and History depend problems
I	To study time dependent and dynamic problems of Small and large strain visco-plasticity
I	To study Structural Elements & Interfaces and contact using penalty method.

UNIT-I	Basic On Theory Of Elasticity	9
Definitions- notations and sign conventions for stress and strain, Equations of equilibrium. Strain – displacement relations, Stress – strain relations, Lame's constant –cubical dilation, Compressibility of material, bulk modulus, Shear modulus, Compatibility equations for stresses and strains, Principal stresses and principal strains, Mohr's circle, Saint Venant's principle.		
UNIT-II	**Finite Element Method For Static Linear Elasticity**	**9**
Derivation and implementation of a basic 2D FE code with triangular constant strain elements. Generalization of finite element procedures for linear elasticity: interpolation and numerical integration in 1D, 2D and 3D. Deriving finite element equations - constructing variation forms; mixed methods. Accuracy and convergence; the Patch test.		
UNIT-III	**Non Linear And History Depend Problems**	**9**
Small strain hypo-elastic materials - Small strain visco-plasticity - Large strain elasticity -Large strain visco-plasticity.		
UNIT-IV	**Time Dependent And Dynamic Problems**	**9**
First-order systems - the diffusion equation - Explicit time integration – the Newmark method - Implicit time integration - Modal analysis and modal time integration.		
UNIT-V	**Structural Elements & Interfaces And Contact**	**9**
Continuum Beams – Shells – Cohesive Zones - Enforcing constraints using penalty methods and Lagrange Multipliers - Contact elements (in two dimensions)		
	Total Contact Hours	**: 45**

Course Outcomes: Upon completion of the course students should be able to:	
•	Deliberate the definition and basics on theory of elasticity
•	Develop the finite element method for static linear elasticity, solve problems.
•	Examine non-linear and history-dependent problems, and apply problem-solving techniques to address them.
•	Examine time-dependent and dynamic problems, applying problem-solving skills to resolve the
•	Examine structural elements, interfaces, and contact in the context of problem-solving.

List of Exercises
1. Importing 3d model to FEA software and patch work
2. Mesh Convergence study
3. Nonlinear FEA- Geometry and material
4. Modal Analysis of rotor blade
5. Crushing analysis of can
6. Drop weight impact analysis
7. Composite stress analysis

Text Books:	
1	L.S.Srinath, Advanced Mechanics of Solids, 3rd Edition, Mcgraw Hill Publication, 2017.
2	R.D.Cook, Concepts and Applications of Finite Element Analysis, 4th Edition 2007

Reference Books(s) / Web links:	
1	S.Timoshenko, Theory of Elasticity, McGraw-Hill Education (India) Pvt Limited, 2010.
2	The Finite Element Analysis of Shells - Fundamentals (Computational Fluid and Solid Mechanics) by Dominique Chapelle and Klaus-Jurgen Bathe | 27 January 2013.
3	Inelastic Analysis of Solids and Structures (Computational Fluid and Solid Mechanics) by M. Kojic and Klaus-Jurgen Bathe | 22 October 2010.
4	https://archive.nptel.ac.in/courses/112/104/112104193/.
5	https://nptel.ac.in/courses/112106135

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	-	-	1	3	1	1
CO2	3	3	2	1	-	-	-	-	1	-	-	1	3	1	1
CO3	3	3	2	1	-	-	-	-	1	-	-	1	3	1	1
CO4	3	3	2	1	-	-	-	-	1	-	-	1	3	1	1
CO5	3	3	2	1	-	-	-	-	1	-	-	1	3	1	1

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

Course code	Course Name (Theory course)	Category	L	T	P	C
ME19A19	COMPUTATIONAL FLUID DYANAMICS	PE	3	0	0	3

Objectives:	
•	To analyze mathematical and computational methods for fluid flow and heat transfer simulations
•	To use the Finite difference and volume method for solving diffusion problems
•	Differentiate between datums, datum features, and the parts of datum systems
•	Understand various forms and orientation
•	Understand various tolerances and its application

UNIT-I	Governing Equations And Boundary Conditions	9
Basics of computational fluid dynamics – Governing equations of fluid dynamics – Continuity, Momentum and Energy equations – Chemical species transport – Physical boundary conditions – Time-averaged equations for Turbulent Flow – Turbulent–Kinetic Energy Equations – Mathematical behavior of PDEs on CFD - Elliptic, Parabolic and Hyperbolic equations		
UNIT-II	**Finite Difference And Finite Volume Methods For Diffusion**	**9**
Derivation of finite difference equations – Simple Methods – General Methods for first and second order accuracy – Finite volume formulation for steady state One, Two and Three - dimensional diffusion problems – Parabolic equations – Explicit and Implicit schemes – Example problems on elliptic and parabolic equations – Use of Finite Difference and Finite Volume methods.		
UNIT-III	**Finite Volume Method For Convection Diffusion**	**9**
Steady one-dimensional convection and diffusion – Central, upwind differencing schemes properties of discretization schemes – Conservativeness, Boundedness, Transportive, Hybrid, Power-law, QUICK Schemes		
UNIT-IV	**Flow Field Analysis**	**9**
Finite volume methods -Representation of the pressure gradient term and continuity equation – Staggered grid – Momentum equations – Pressure and Velocity corrections – Pressure Correction equation, SIMPLE algorithm and its variants – PISO Algorithms		
UNIT-V	**Turbulence Models And Mesh Generation**	**9**
Turbulence models, mixing length model, Two equation (k- Є) models – High and low Reynolds number models – Structured Grid generation – Unstructured Grid generation – Mesh refinement – Adaptive mesh – Software tools.		
	Total Contact Hours : 45	

Course Outcomes: Upon completion of the course students should be able to:	
•	Derive and apply the governing equations and boundary conditions for Fluid dynamics
•	Analyze Finite difference and Finite volume method for Diffusion problems
•	Examine and assess the Finite Volume Method applied to convective diffusion problems.
•	Apply Finite Volume Methods, executing pressure gradient representation, continuity, and advanced algorithms for fluid flow.
•	Interpret the Turbulence models and Mesh generation techniques

Text Books:	
1	Versteeg, H.K., and Malalasekera, W., ―An Introduction to Computational Fluid Dynamics: The finite volume Method‖, Pearson Education Ltd., 2007
2	Ghoshdastidar, P.S., ―Computer Simulation of flow and heat transfer‖, Tata McGraw Hill Publishing Company Ltd., 1998.

Reference Books(s) / Web links:	
1	Patankar, S.V. ―Numerical Heat Transfer and Fluid Flow‖, Hemisphere Publishing Corporation, 2004
2	Chung, T.J. ―Computational Fluid Dynamics‖, Cambridge University, Press, 2002
3	Fletcher, C. A. J., ―Computational Techniques for Fluid Dynamics‖, Springer Verlag, 2011
4	Hyoung Woo Oh, ―Applied Computational Fluid Dynamics‖, InTech Publishers, 2012
5	John F Wendt ―Computational Fluid Dynamics‖ Springer, 2012
6	Jiyuan TL, Guan Heng Yeoh, ―Computational Fluid Dynamics a Practical Approach‖ Butterworth-Heinemann, 1st Edition 2008.
7	Anderson, Jr., John D.., ―Computational fluid Mechanics the Basics with Applications‖ McGraw Hill Education, 2012.
8	https://nptel.ac.in/courses/112105045
9	https://archive.nptel.ac.in/courses/112/105/112105254/

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

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

VERTICAL – 2 : LOGISTICS AND SUPPLY CHAIN MANAGEMENT
(Common to Mechanical, Aero, Mechatronics, Robotics and Automation)

Course code	Course Name (Theory course)	Category	L	T	P	C
ME19B11	RELIABILITY AND MAINTENANCE ENGINEERING	PE	3	0	0	3

Objectives: The main learning objective of this course is

- To inculcate the fundamentals of the reliability concepts
- To inculcate the fundamentals of the reliability concepts
- To describe basic maintenance concepts
- To extract optimum maintenance decisions
- To Illustrate the root cause for maintenance problems

UNIT-I	**Reliability Concepts**	**9**

Reliability engineering - fundamentals – failure data analysis, Mean failure rate, Mortality curves concept of burn –in period, useful life and wear out phase of a system, mean time to failure, meantime between failure, hazard rate – failure density and conditional reliability- Maintainability and availability – simple problems

UNIT-II	**Reliablity 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**

Proactive/reactive maintenance - Maintenance policies – Imperfect maintenance Preventive / breakdown maintenance – Optimal PM schedule and product characteristics – Inspection decisions - Maximizing profit - Minimizing downtime – Replacement decisions.

UNIT-IV	**Maintenance Models**	**9**

Proactive/reactive maintenance - Maintenance policies – Imperfect maintenance Preventive / breakdown maintenance – Optimal PM schedule and product characteristics – Inspection decisions - Maximizing profit - Minimizing downtime – Replacement decisions.

UNIT-V	**Maintenance Quality**	**9**

Five zero concept – FMEA- 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 the course students should be able to:

- Evaluate the different reliability measurements while applying the reliability concepts
- Select the suitable method of improving the reliability and integrate reliability concepts in ne product design and development.
- Describe basic maintenance concepts
- Extract maintenance policies for maximizing the profit
- Make a diagnosis of maintenance problems

Text Books:	
1	Srinath. L.S., —Reliability Engineering‖, 4th edition Affiliated East west press, 2011
2	Andrew K.S.Jardine & Albert H.C. Tsang, —Maintenance, Replacement and Reliability‖ , Tay and Francis, 2006.
Reference Books:	
1	Sharma S.C., —Inspection Quality Control and Reliability‖, Khanna Publishers, 1998.
2	Bikas Badhury & Basu S K, —Tero Technology: Reliability Engineering and Maintenance Management‖, Asian Books, 2003.
3	Mishra R C and Pathak K., —Maintenance Engineering and Management‖, PHI,2012
4	Venkataraman. K —Maintancence Engineering and Management‖, PHI Learning, Pvt. Ltd., 20

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

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

Course code	Course Name (Theory course)	Category	L	T	P	C
ME19B12	WAREHOUSING AUTOMATION	PE	3	0	0	3

Objectives: The main learning objective of this course is

- To learn the basics of warehousing automation
- To describe the warehousing decisions
- To describe inventory management
- To solve the transportation network models
- To illustrate about MCDM models

UNIT-I	**Introduction**	**9**
Descriptive, predictive and prescriptive analytics, Data Driven Supply Chains – Basics, transform supply chains.		
UNIT-II	**Warehousing Decisions**	**9**
P-Median Methods - Guided LP Approach, Greedy Drop Heuristics, Dynamic Location Models, Sp Determination and Layout Methods. Decision Making without Probabilities		
UNIT-III	**Inventory Management**	**9**
Dynamic Lot sizing Methods, Inventory Models: Deterministic Demand -Economic Order Quantity (EOQ) Model,- Quantity Discounts for the EOQ Model - Economic Production Lot Size Model - Aggregate Inventory system and LIMIT, Risk Analysis in Supply Chain, Risk pooling strategies.		
UNIT-IV	**Transportation Network Models**	**9**

Minimal Spanning Tree, Shortest Path Algorithms, Maximal Flow Problems, Transportation Proble Set covering and Set Partitioning Problems, Travelling Salesman Problem, Scheduling Algorithms.			
UNIT-V	**MCDM Models**		**9**
Analytic Hierarchy Process (AHP), Data Envelopment Analysis (DEA), Fuzzy Logic an Techniques, t analytical network process (ANP), TOPSIS.			
	Total Contact Hours	**:**	**45**
Course Outcomes: Upon completion of the course students should be able to:			
	To enable quantitative solutions in business decision making under conditions of certainty, risk a uncertainty.		
Text Books:			
1	Nada R. Sanders, Big data driven supply chain management: A framework for implementing analytics and turning information into intelligence, Pearson Education, 2014.		
2	Michael Watson, Sara Lewis, Peter Cacioppi, Jay Jayaraman, Supply Chain Network Design: Applying Optimization and Analytics to the Global Supply Chain, Pearson Education, 2013.		
Reference Books:			
1	Anna Nagurney, Min Yu, Amir H. Masoumi, Ladimer S. Nagurney, Networks Against Time: Supply Chain Analytics for Perishable Products, Springer, 2013.		
2	Muthu Mathirajan, Chandrasekharan Rajendran, Sowmyanarayanan Sadagopan,Arunachalam Ravindran, Parasuram Balasubramanian, Analytics in Operations/Supply Chain Management , I.K. International Publishing House Pvt. Ltd., 2016.		
3	Gerhard J. Plenert, Supply Chain Optimization through Segmentation and Analytics, CRC Press, Taylor & Francis Group, 2014		

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

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

Course code	Course Name	Categor	L	T	P	C
ME19B13	OPERATIONS MANAGEMENT	PE	3	0	0	3

Objectives: The students can be able to

- To understand the basics of production and operations management and its role in product design and development .
- To understand the various aspects of process planning and other controlling operations .
- To learn about the plant location and its layout
- To learn the activities of Materials and inventory management
- To learn about the quality concept 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, The 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-

	Total Contact Hour	45

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

- Understand the concept of production and operations management and its role in product design and development.
- Analyze the various aspects of process planning and other controlling operations .
- Understand the plant location and its layout
- Understand the activities of Materials and inventory management
- Learn about the quality concept and various quality control techniques

Text Books:	
1	Jay Heizer, Barry Render (2014), Operations Management, 11th Edition, Pearson Education
2	Robert S.Russell, Bernard W.Taylor, (2013), Operations Management, 8th edition, Wiley.
3	Collier, Evans, Ganguly(2016), OM-Operations Management , Cengage Learning
Reference Books(s) :	
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, 201
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, th edition, 2015

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	1	-	1	2	1	1	2	3	2	3
CO2	3	3	2	1	1	1	1	1	2	1	1	2	3	2	3
CO3	3	3	2	1	1	1	1	1	2	1	1	2	3	2	3
CO4	3	3	2	1	1	1	-	1	2	1	1	2	3	2	3
CO5	3	3	2	1	1	1	-	1	2	1	1	2	3	2	3

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

Course code	Course Name	Categor	L	T	P	C
ME19B14	MATERIAL HANDLING EQUIPMENT, REPAIR AND MAINTENANCE	PE				

Objectives: The students can able

- To study the fundamental concept and principles of materials handling equipment.
- To learn the principles of Industrial Vehicles.
- To analyse the functional requirements of conveyor equipment.
- To impart the knowledge on 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 handli equipment - selection of material handling equipments - guidelines for effective utilization of mater handling equipments -unit load concept

UNIT-II	Industrial Vehicles	9

Introduction and types - Hand trucks - Two wheel Hand Trucks - Multiple wheel Hand Trucks - Ha Lift Trucks - Power Trucks - Fixed Platform Truck - Platform Lift Truck - Pallet Lift Truck - Walk 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 b Conveyors - Roller conveyors - Haulage Conveyors - Screw Conveyors - Bucket Conveyors – Cha Conveyors - Cable Conveyors - Pneumatic and Hydraulic conveyors – Vibrating and actuati conveyors. Computer controlled conveyor system.

UNIT-IV	**Auxiliary Equipmentand Hoisting Equipment**	9
Hoppers - Gates- Feeders- Chutes-positioners- Ball Table- Weighing and Control Equipment- Pa loaders and un loaders -applications and advancements. - Hoisting Equipment - parts of hois equipment - Description and uses of hoists - Description and uses of ropes - description and purpo 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 t workplace - Robots and their classification - Major components of a robot - classification of Robo manipulators - Robotic handling applications – Maintenance and safety of material handli equipment.		
	Total Contact Hour	**45**

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

- Demonstrate the basic concepts of material handling equipment.
- Explain the basic working principles of various industrial Vehicles.
- Develop the basic working principles of various conveyors.
- 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, 1987.
2. Siddharta Ray, Introduction to Materials Handling, New Age International Publishers

Reference Books:

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

WEBLINKS:

1. https://onlinecourses.nptel.ac.in/noc23_mg71/preview
2. https://www.oxfordhomestudy.com/courses/supply-chain-courses-online/free-online-courses-in-logistics-and-supply-chain
3. https://www.coursera.org/learn/supply-chain-logistics
4. https://www.shiksha.com/online-courses/logistics-and-supply-chain-management-course-grlel96
5. https://www.linkedin.com/learning/supply-chain-foundations-2014

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	-	-	-	-	-	-	1	-	1	2
CO2	2	1	1	1	1	-	-	-	-	-	-	1	-	1	2
CO3	2	1	1	1	1	-	-	-	-	-	-	1	-	1	2
CO4	2	1	1	1	1	-	-	-	-	-	-	1	-	1	2
CO5	2	1	1	1	1	-	-	-	-	-	-	1	-	1	2

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

Course code	Course Name	Categor	L	T	P	C
ME19B15	CONTAINER LOGISTICS	PE	3	0	0	3

Objectives: The students can able

- To learn about the basics of containerization and its types and globalization
- To understand the container freights load management and estimation of fleet size
- To study the characteristics and operation of containers at nation and international level
- To design the container packing, maintenance & service and security
- To design and model the container for multimodal and Information technology in Container logistics

UNIT-I	**Basic Concept Of Containerization**	9

Malcolm Mclean and the birth of containerization - Basic concepts of Containerization - Maj Container Trades - Container Operators - Container Ships- Liner shipping Industry- Termin Consideration of Container Terminal Planning - Container Distribution – Container types and specification - features - ISO Container Dimension by types - Non- Containerisable cargo Equipment for non-containerisable cargo.

UNIT-II	**Freighting And Size Of Container**	9

Container shipping business - Container terminology – Full Container Load (FCL) and Less th Container Load (LCL) sea freight products - Freighting of FCL and LCL cargo - Slot utilizati strategies - Estimation of optimum container fleet size - Multiport LCL consolidation. Generations container ships and their specification - and cargoes carried in them. Trade routes ◦Globalizati ◦Supply and demand ◦Principal arterial routes ◦Principal container ports

UNIT-III	**Characteristics And Physical Operations Of Containers**	9

Containerization: Concept, Classification, Benefits and Constraints, Container terminal busines World‘s leading container terminals and location characteristics - container terminal infrastructur container terminal productivity and profitability-Inland Container Depots (ICD) Roles and function Container Freight Stations(CFS),Clearance at ICD, CONCOD(Container corporation of India) ,ICD under CONCOD, Charting: Kinds of Charter, Charter Party and Arbitration. Landside contain logistics

UNIT-IV	**Container Types And Business**	9

Container manufacturing trends - Container leasing business - Types of container leasing and th terms - maintenance and repair of containers - tracking of container movements - Contain interchange. - Container management - Container packing and securing -Container security a integrity - Container Shipping Business, Regulations and Documentation

UNIT-V	**Multimodal Transport**	**9**

Design and Modeling of Container Logistics - Container Terminal optimization -Alternate use containers -marketing of used containers -carriage of shipper own containers - multimodal transp options for containers -Insurance for containers -strategies for managing container imbalance Container Shipping Costs, Revenue and Freight Rates – Cooperation and Collaboration in contain logistics – Benchmarking – IoT Solutions – Block chain technology -Power BI

	Total Contact Hour	**45**

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

- Illustrate about a basics of containerization and its types and globalization
- Determine the container freights load management and estimation of fleet size
- Explain about Characteristics and operation of containers at nation and international level
- Design the container packing, maintenance & service and security
- Design and Model the container for multimodal and Information technology in Contain logistics

Text Books:	
1	Rolf Neise Container Logistics: The Role of the Container in the Supply Chain, Kogan Pa 2018
2	Marc Levinson, The Box: How the Shipping Container Made the World Smaller and the World Economy Bigger, Princeton University Press, 2008.
Reference Books:	
1	Dr. K. V. Hariharan, Containerisation, Multimodal Transport & Infrastructure Development India, Sixth Edition, Shroff Publishers and Distributors, 2015.
2	Lee, C.-Y., Meng, Q. (Eds.), Handbook of Ocean Container Transport Logistics Making Glob Supply Chains Effective, Springer, 2015
3	John J. Coyle, Brian J. Gibson, Edward J. Bardi& Novack, Management Of Transportation, 7 Edition, Cengage Learning, 2011
4	Pierre David, International Logistics, R, Publishing Company, 2013
5	Immer J. R., Material Handling, Tata McGraw Hill Publication.

WEBLINKS:

1. https://iimm.org/wp-content/uploads/2019/12/Logistics-and-Warehousing-Management.pdf
2. https://baou.edu.in/assets/pdf/BBAATR_206_slm.pdf
3. https://iritm.indianrailways.gov.in/uploads/files/1366964675894-Container.pdf
4. https://www.logisticsmgmt.com/images/site/LM1109_EuroSiteSelSUP.pdf
5. https://www.youtube.com/watch?v=uQeoe8ZpJa0

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	1	2	-	-	-	1	2	1	2	1
CO2	2	2	2	2	1	1	2	-	-	-	1	2	1	2	1
CO3	2	2	2	2	2	1	2	-	-	-	1	2	1	2	1
CO4	3	3	3	3	1	1	2	-	-	-	1	2	1	2	1
CO5	3	3	3	3	1	1	2	-	-	-	1	2	1	2	1

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

Course code	Course Name (Theory course)	Category	L	T	P	C
ME19B16	PRODUCTION PLANNING AND CONTROL	PE	3	0	0	3

Objectives: The students can able	
●	To familiarize with various types of production and aspects of new product development.
●	To understand the concepts and steps involved in work study.
●	To identify various steps involved in product and process planning.
●	To understand various components and functions of production scheduling.
●	To understand inventory control and recent trends like JIT, MRPII and ERP.

UNIT-I	Introduction To Production Planning And Control	9
Objectives and benefits of production planning -Functions of production control-Types of productions–job shop, batch and continuous, Product Analysis – Marketing aspects, Product characteristics – Functional aspects –Operational aspects–Durability, dependability and aesthetic aspects, Production aspects-General approach to DFM–Guidelines for the selection of production processes-Guidelines for specific processes like casting, forming, machining and assembly.		
UNIT-II	**Workstudy**	**9**
Method study, basic procedure –Selection-Recording of process - Critical analysis, Development - Implementation -Micro motion and memo motion study – work measurement - Techniques of work measurement - Time study -Production study – Work sampling- Synthesis from standard data–pre-determined motion time standards.		
UNIT-III	**Product Planning And Process Planning**	**9**
Product planning and information-Value Analysis-Problems in lack of product planning-Process planning and routing-Information needed for process planning- Steps in process planning-Quantity determination in batch production-Machine capacity, balancing-Analysis of process capabilities in a multi-product system.		
UNIT-IV	**Production Scheduling**	**9**
Production Control Systems-Loading and scheduling- Master Scheduling-Scheduling rules-Gantt charts-Perpetual Loading-Basic scheduling problems - Line of balance – Flow production scheduling- Batch production scheduling-Product sequencing–Production Control systems-Periodic batch control-MRPI-Kanban–Dispatching-Progress reporting and expediting-Manufacturing lead time-Techniques for aligning completion times and due dates.		
UNIT-V	**Inventory Control And Recent Trends In PPC**	**9**
Inventory control-Purpose of holding stock-Effect of demand on inventories-Ordering procedures, Two bin system-Ordering cycle system-Determination of Economic order quantity and economic lot size-ABC analysis-Recorder Procedure-Introduction to computer integrated production planning systems, Elements of JIT, Fundamentals of MRPII and ERP.		
	Total Contact Hours	**45**

Course Outcomes: At the end of this course, students can have the	
•	Ability to distinguish the types of production and aspects of new product development.
•	Ability to construct the various charts / diagrams and eliminate unnecessary movements and delays, also to calculate standard time to complete the assigned job.
•	Ability to carry out value analysis of a product, prepare routing chart, also analyze process capabilities in a multi-product system.
•	Ability to generate a better scheduling and line balancing, also to apply techniques for aligning completion times and due dates.
•	AbilitytoadoptdifferentmethodsofplanningtocontrolInventoryinmanufacturingorganizationandto plementrecenttrendslike JIT,MRPII and ERP systems.

Text Books:	
1	Mart and Telsang, ―Industrial Engineering and Production Management‖, First edition, S.Chand Company, 2000.
2	James .B. Dilworth, ―Operations management–Design, Planning and Control for manufacturing a services‖, Mc-graw Hill International Edition, 1992.

Reference Books(s)/ Web links:	
1	Elwood S. Buffa, and Rakesh K. Sarin, ―Modern Production/ Operations Management‖, 8th Editio John Wiley and Sons, 2000.
2	Kanishka Bedi, ―Production and Operations management‖, 2nd Edition, Oxford University Press, 2007.
3	Norman Gaither, G. Frazier, ―Operations Management‖, 9th edition, Thomson learning IE, 2007.
4	Upendra Kachru, ―Production and Operations Management– Text and cases‖, 1st Edition, Excel books, 2007.
5.	Chary.S.N., ―Theory and Problems in Production & Operations Management‖, Tata McGraw Hil 1995.

WEBLINKS:

1. https://www.slideshare.net/sudhirpawar12/production-planning-control-ppt
2. https://www.youtube.com/watch?v=eHCfgC5rqW8
3. https://www.youtube.com/watch?v=JExh2DhqCG0
4. https://www.techtarget.com/searcherp/definition/production-planning
5. https://www.ddegjust.ac.in/2017/Uploads/11/POM-326.pdf

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

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

Course code	Course Name (Theory course)	Categor	L	T	P	C
ME19B17	OPERATIONS RESEARCH	PE	3	0	0	3

Objectives: The students can able

- To create awareness about optimization techniques in utilization of resources and to formulate the linear programming model for industrial applications based on the constraints and availability of the resources.
- To provide knowledge and training in Transportation and other production models and to obtain the optimal solution to maximize the profit.
- To provide knowledge about the Network models and to furnish the solution for the failure of item.
- To understand the deterministic and stochastic inventory models and to plan, manage the stocks to meet the customer demands.
- To understand the Queuing models, queue discipline and to explore the ways to give better customer service.

UNIT-I Linear Programming Models **9**

Introduction to Operations Research-Scope, objectives, phases, models and limitations. Linear programming–formulation of LPP-Graphical method–Simplex algorithm–Artificial variables–Big M method–Two phase method
–Duality formulation.

UNIT-II Transportation Models **9**

Transportation Models-Finding basic feasible solution–LCM, NWC and VAM methods–Optimal solution using MODI method–Unbalanced model and Degeneracy.
Assignment Models – Hungarian method for optimal solution - Unbalanced problem - Traveling Salesman problem. Sequencing Models-Processing Jobs through Machines, Jobs through Machines, and Jobs through Machines using Johnson algorithm.

UNIT-III Network And Replacement Models **9**

Networks models: Network logic – Ford - Fulkerson's rule – Shortest route – Project network – CPM and PERT networks–Critical path scheduling– Types of Floats and calculations. Replacement models: Types of failures-Present value factor-Replacement of items that deteriorate with time, Items that fail suddenly –Individual and Group replacement policies.

UNIT-IV Inventory Models **9**

Need for Inventory–Types of Inventories–Inventory costs-Economic order quantity–Deterministic Inventory models
–with and without shortages-Quantity discount models–Stochastic inventory models–Multi product models–Inventory control – P and Q systems – Determination of Buffer stock and Reorder level.

UNIT-V Queueingmodels **9**

Queueing models - Queueing systems and structures – Notation parameter – Poisson input – Exponential service – Single server and multi-server models—Constant rate service–Infinite population–Simulation–Monte Carlo technique–Inventory and Queuing problems.

Total Contact Hours : 45

Course Outcomes: At the end of this course, the students will be able to

- Formulate are al-world mathematical linear programming model, select the constraints based on the availability of the resources and determine the optimal solution.
- Build and solve specialized Transportation, Assignment and Sequencing problems with optimum results.
- Investigate the nature of the project/failure and give suggestions towards decision making.
- Know about the maintenance of inventory level, Plan the manufacturing policies and manage the stocks according to the customer demands.
- Model a dynamic system as a queuing model and compute important performance measures for better customer service.

Text Books:	
1	Hamdy A Taha, ―Operations Research: An Introduction‖, 10th edition, PHI/Pearson education, 2017.
2	Wayne L. Winston, Jeffrey B. Goldberg, ―Operations Research Applications and Algorithms‖, Thomson Brooks/Cole, 2004.

Reference Books(s)/ Web links:	
1	Prem kumar Gupta and D.S. Hira, ―Problems in Operations Research‖, S.Chand, 2009.
2	Sharma JK, ―Operations Research: Theory and Applications‖, 5th edition, Macmillan India, 2013.
3	Pannerselvam R, ―Operations Research‖, 2nd edition, PHI, 2009.
4	Srinivasan G, ―Operations Research: Principles and Applications‖, 3rd edition EEEPHI, 2017.
5.	Tulsian and Pasdey V., ―Quantitative Techniques‖, Pearson Asia, 2002.

WEBLINKS:

1. https://www.coursera.org/courses?query=operations%20research
2. https://onlinecourses.nptel.ac.in/noc22_ma48/preview
3. https://www.classcentral.com/course/swayam-operations-research-14219
4. https://unacademy.com/course/introduction-to-operation-research/1V3SWDSO
5. https://www.theorsociety.com/training/

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

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

Course code	Course Name(Theory course)	Categor	L	T	P	C
ME19B18	SUPPLY CHAIN AND LOGISTICS MANAGEMENT	PE	3	0	0	3

Objectives: The students can able to

- Describe the role and drivers of supply chain management in achieving competitiveness.
- Understand about Supply Chain Network Design.
- Illustrate the issues related to Logistics in Supply Chain.
- Appraise about Sourcing and Coordination in Supply Chain.
- Understand the application of Information Technology and Emerging Concepts in Supply Chain.

UNIT-I	Introduction To Supply Chain And Logistics Management	9

Supply Chain and Logistics Management: Scope and Importance - Evolution of Supply Chain – Examples of supply Chains - Decision Phases in Supply Chain - Competitive and Supply chain Strategies – Drivers of Supply Chain Performance and Obstacles–Relationship of Logistics to Supply Chain Management.

UNIT-II	Supply Chain Network Design	9

Role of Distribution in Supply Chain – Factors influencing Distribution network design – Design options for Distribution Network- Distribution Network in Practice - Role of network Design in Supply Chain – Framework for networkDecisions–ImpactofuncertaintyonNetworkDesign–Networkdesigndecisions–Networkdesigndecisionsusing
Decision Trees.

UNIT-III	Logistics In Supply Chain	9

Role of transportation in supply chain – Factors affecting transportations decision – Design option for transportation network – Tailored transportation – Routing and scheduling in transportation - 3PL- 4PL- Global Logistics – Reverse Logistics: Reasons, Activities and issues.

UNIT-IV	Sourcing And Coordination In Supply Chain	9

Role of Sourcing in supply chain - Supplier selection, assessment and contracts - Design Collaboration – Sourcing, Planning and Analysis - Supply chain co-ordination - Bull whip effect – Effect of lack of coordination in supply chain and obstacles –Building strategic partnerships and trust within a supply chain.

UNIT-V	IT And Emerging Concepts In Supplychain	9

The role IT in supply chain-The supply chain IT framework-Customer Relationship Management-Internal Supply Chain Management –Supplier Relationship Management –Future of IT in supply chain–E-Business in supply chain
-Risks in Supply Chain- Lean supply Chains- Sustainable supply Chains.

Total Contact Hours	:	45

Course Outcomes: Upon completion of this course, students will acquire the

- Ability to understand the scope of Supply Chain & Logistics Management and the drivers of Supply Chain performance.
- Ability to design suitable Supply Chain network for a given situation.
- Ability to analyze and solve the issues related to Logistics in SCM.
- Ability to understand Sourcing, Coordination and current issues in SCM.
- Ability to appraise about the applications of IT in SCM and apply SCM concepts in selected enterprises.

Text Books:	
1	Sunil Chopra, Peter Meindl and D.V. Kalra, ―Supply Chain Management: Strategy, Planning and Operation", Pearson Education, 2016.
2	Dr. Shila Bootwala, Raisa Shaikh, Mohd Fazil Shareef ,‖Supply Chain and Logistics Management‖ Nirali Prakashan Publications, 2018 edition.

Reference Books(s)/ Web links:	
1	Ravi Ravindran A, Donald P. Warsing, Jr, ―Supply Chain Engineering: Models and Applications‖, CRC Press, 2012.
2	Srinivasan G.S, ―Quantitative models in Operations and Supply Chain Management‖, PHI, 2010.
3	Janat Shah, ―Supply Chain Management: Text and Cases‖, Pearson Education India, 2016.
4	Ashley McDonough, ―Operations and Supply Chain Management‖ Vibrant Publishers-2019 Edition
5	Khalid Zidan ,‖ Supply Chain Management‖ Create space Independent Publication, 2016 Edition

WEBLINKS:

1. https://onlinecourses.nptel.ac.in/noc23_mg71/preview
2. https://www.oxfordhomestudy.com/courses/supply-chain-courses-online/free-online-courses-in-logistics-and-supply-chain
3. https://www.coursera.org/learn/supply-chain-logistics
4. https://www.shiksha.com/online-courses/logistics-and-supply-chain-management-course-grlel96
5. https://www.linkedin.com/learning/supply-chain-foundations-2014

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	1	-	-	1	-	-	2	-	-	2
CO2	2	1	1	1	1	1	-	-	1	-	-	2	-	-	2
CO3	2	1	1	1	1	1	-	-	1	-	-	2	-	-	2
CO4	2	1	1	1	1	1	-	-	1	-	-	2	-	-	2
CO5	2	1	1	1	1	1	-	-	1	-	-	2	-	-	2

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

Course code	Course Name (Theory course)	Categor	L	T	P	C
ME19B19	DATA SCIENCE	PE	3	0	0	3

Objectives: The students can able

- To understand the techniques and processes of data science.
- To apply descriptive data analytics.
- To visualize data for various applications.
- To understand inferential data analytics.
- To analysis and build predictive models from data.

UNIT-I	**Introduction**	**9**
Data Science: Benefits and uses – facets of data - Data Science Process: Overview – Defining research goals – Retrieving data – Data preparation - Exploratory Data analysis – build the model– presenting findings and building applications - Data Mining - Data Warehousing – Basic Statistical descriptions of Data		
UNIT-II	**Describing Data**	**9**
Types of Data - Types of Variables -Describing Data with Tables and Graphs –Describing Data with Averages - Describing Variability - Normal Distributions and Standard (z) Scores		
UNIT-III	**Describing Relationships**	**9**
Correlation –Scatter plots –correlation coefficient for quantitative data –computational formula for correlation coefficient – Regression –regression line –least squares regression line – Standard error of estimate – interpretation of r2 –multiple regression equations –regression towards the mean		
UNIT-IV	**Python Libraries For Data Wrangling**	**9**
Basics of Numpy arrays –aggregations –computations on arrays –comparisons, masks, boolean logic – fancy indexing – structured arrays – Data manipulation with Pandas – data indexing and selection – operating on data – missing data – Hierarchical indexing – combining datasets – aggregation and grouping – pivot tables		
UNIT-V	**Data Visualization**	**9**
Importing Mat plot lib – Line plots – Scatter plots – visualizing errors – density and contour plots – Histograms – legends – colors – subplots – text and annotation – customization – three dimensional plotting - Geographic Data with Base map - Visualization with Sea born.		
	Total Contact Hours	**45**

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

CO1	Define the data science process
CO2	Express the different types of data description for data science process
CO3	Attain the knowledge on relationships between data
CO4	Utilize the Python Libraries for Data Wrangling
CO5	Apply visualization Libraries in Python to interpret and explore data

Text Books:

1. David Cielen, Arno D. B. Meysman, and Mohamed Ali, ―Introducing Data Science‖, Mann Publications, 2016. (Unit I)
2. Robert S. Witte and John S. Witte, ―Statistics‖, Eleventh Edition, Wiley Publications, 2017. (U II and III)
3. Jake Vander Plas, ―Python Data Science Handbook‖, O'Reilly, 2016. (Units IV and V)

Reference Books(s)/Web links:	
1	Allen B. Downey, —Think Stats: Exploratory Data Analysis in Python‖, Green Tea Press,2014.
2	Sanjeev J. Wagh, Manisha S. Bhende, Anuradha D. Thakare, —Fundamentals of Data Science‖, C Press, 2022.
3	Chirag Shah, —A Hands-On Introduction to Data Science‖, Cambridge University Press,2020.
4	Vineet Raina, Srinath Krishnamurthy, —Building an Effective Data Science Practice: A Framewor to Bootstrap and Manage a Successful Data Science Practice‖, Apress, 2021.
5	Larry L. Peterson, Bruce S. Davie, Computer Networks: A Systems Approach, Fifth Edition, Morgan Kaufmann Publishers Inc., 2012.

WEBLINKS:

1. https://onlinecourses.nptel.ac.in/noc21_cs69/preview
2. https://onlinecourses.nptel.ac.in/noc21_cs69/preview
3. https://www.youtube.com/watch?v=GYRz3RAu4Bk
4. https://www.linkedin.com/pulse/top-10-data-science-certifications-from-beginner-enamul-haque
5. https://www.learndatasci.com/best-data-science-online-courses/

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

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

VERTICAL 3 : ROBOTICS AND AUTOMATION

Course code	Course Name (Theory course)	Category	L	T	P	C
ME19C11	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- History of drone - Types of current generation of drones based on their method of propulsion- Drone technology impact on the businesses- Drone business through entrepreneurship- Opportunities/applications for entrepreneurship and employability

UNIT-II	**DRONE DESIGN, FABRICATION AND PROGRAMMING**	**9**

Classifications of the UAV -Overview of the main drone parts- Technical characteristics of the parts - Function of the component parts -Assembling a drone- Payload - The energy sources- Level of autonomy- Drones configurations - Drone Programming and Simulation – Multi rotor stabilization.

UNIT-III	**DRONE FLYING AND OPERATION**	**9**

Concept of operation for drone -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 - Onboard storage capacity - Removable storage devices- Linked mobile devices and applications – Drone Computing

UNIT-IV	**DESIGN OF DRONE MECHANISM FOR COMMERCIAL APPLICATIONS**	**9**

Choosing a drone based on the application -Drones in the insurance sector- Drones in delivering mail, parcels and other cargo- Drones in agriculture- Drones in defence – 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- 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: Upon completion of the course students should 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
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
CO1	1	2	3	1	3	2	-	-	-	-	-	1	2	1	3
CO2	1	2	3	1	3	2	-	-	-	-	-	1	2	1	3
CO3	1	2	3	1	3	2	-	-	-	-	-	1	2	1	3
CO4	1	2	3	1	3	2	-	-	-	-	-	1	2	1	3
CO5	1	2	3	1	3	2	-	-	-	-	-	1	2	1	3

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

Course code	Course Name (Theory course)	Category	L	T	P	C
ME19C12	ELECTRICAL DRIVES AND ACTUATOR	PE	3	0	0	3

Objectives:

- To understand steady state operation and transient dynamics of a motor load system.
- To study and understand the operation and performance of AC Induction motor drives.
- To study and understand the operation and performance of AC Synchronous motor drives.
- To analyze and design the current and speed controllers for a closed loop solid state DC motor drives.
- To know about the knowledge of the Hydraulic systems and its components.

UNIT-I	DRIVE CHARACTERISTICS	9

Electric drive – Equations governing motor load dynamics – steady state stability – multi quadr Dynamics: acceleration, deceleration, starting & stopping – typical load torque characteristics – Select of motor.

UNIT-II	INDUCTION MOTOR DRIVES	9

Stator voltage control – energy efficient drive – v/f control – constant air gap flux – field weakening m – voltage / current fed inverter – closed loop control.

UNIT-III	SYNCHRONOUS MOTOR DRIVES	9

Regular expression – Regular Languages- Equivalence of Finite Automata and regular expression Proving languages to be not regular (Pumping Lemma) – Closure properties of regular languages.

UNIT-IV	**DESIGN OF CONTROLLERS FOR DRIVES**	**9**
Transfer function for DC motor / load and converter – closed loop control with current and speed feedb – armature voltage control and field weakening mode – design of controllers; current controller and sp controller-converter selection and characteristics.		
UNIT-V	**ACTUATORS**	**7**
Hydraulic Actuators: Cylinders – Types and construction, Hydraulic motors -Types and constructio Control Components: Direction control, Flow control and Pressure control valves-Types, Construction Operation Applications – Types of actuations. Accessories: Reservoirs, Accumulators, Intensifi Pressure Switches Classification and functions- Applications- Fluid Power ANSI Symbol.		
	Total Contact Hours : 45	

Course Outcomes: Upon completion of the course students should be able to:

- design steady state operation and transient dynamics of a motor load system.
- To do operation and performance of AC Induction motor drives.
- To do operation and performance of AC Synchronous motor drives.
- Able to analyze and design the current and speed controllers for a closed loop solid state DC mo drives.
- Understand the knowledge of the Hydraulic systems and its components.

Text Books:

1	Gopal K.Dubey, Fundamentals of Electrical Drives, Narosa Publishing House.
2	Bimal K.Bose. Modern Power Electronics and AC Drives, Pearson Education.

Reference Books(s) / Web links:

1	S.K.Pillai, A First course on Electrical Drives, Wiley Eastern Limited, 1993.
2	Murphy J.M.D and Turnbull, Thyristor Control of AC Motor, Pergamon Press, Oxford 1988.
3	Gopal K.Dubey, Power semiconductor controlled Drives, Prentice Hall Inc., New Jersey, 1989.
4	R.Krishnan, Electric Motor & Drives: Modeling, Analysis and Control, Prentice hall of India, 2001

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

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

Course code	Course Name (Theory course)	Category	L	T	P	C
ME19C13	ROBOTICS	PE	3	0	0	3

Objectives:

- To understand the Robot types
- To introduce the concept of robot kinematics
- To impart knowledge on dynamics of robots
- To understand the methods in trajectory and motion planning
- To know about the various applications of robots

UNIT-I	**Fundamentals of Robotics**	**8**

Introduction- Basic components of robot-Laws of robotics- classification of robot- robot architecture, work space-accuracy-resolution –repeatability of robot.

UNIT-II	**Robot Kinematics**	**11**

Robot kinematics: Introduction- Matrix representation- rigid motion & homogeneous transformation- D-H, forward & inverse kinematics of 2DOF and 3 DOF planar and spatial mechanisms

UNIT-III	**Robot Dynamics**	**9**

/introduction to inverse and forward dynamics, determination of inertia tensor, Larange-Euler formation for joint torque

UNIT-IV	**Trajectory, Path Planning And Programming**	**8**

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

UNIT-V	**Robot And Robot Applications**	**9**

Sensors and Actuators for Robots, Power transmission systems, Rotary to rotary motion, Rotary to linear motion, Harmonics drives – gear system - belt drives. Robot end effectors & Grippers: Introduction- types & classification- Mechanical gripper- gripper force analysis- other types & special purpose grippers. Robot Applications: pick and place, manufacturing, automotive, medical, space and underwater.

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

Course Outcomes: Upon completion of the course students should be able to:

- State the basic concept and terminologies of robot
- Know the procedures for forward and inverse kinematics, dynamics for various robots
- Derive the forward and inverse kinematics, dynamics for various robots
- Apply the various programming techniques in industrial applications
- Analyze the use of various types of robots in different applications

Text Books:

1	John.J.Craig, " Introduction to Robotics: Mechanics & control", Pearson Publication, Fourth edition, 2018.
2	K.S.Fu, R.C.Gonzalez, C.S.G.Lee, "Robotics: Sensing, Vision & Intelligence", Tata McGraw-Hill Publication, First Edition, 1987.

Reference Books(s) / Web links:

1	M.P.Groover, M.Weiss ,R.N. Nagal, N.G.Odrey, "Industrial Robotics - Technology, programming and Applications" Tata , McGraw-Hill Education Pvt Limited 2ndEdition, 2012.
2	Jazar, "Theory of Applied Robotics: Kinematics, Dynamics and Control", Springer, 2ndEdition, 2010

3	S K Saha, Introduction to Robotics, Tata McGraw-Hill, ISBN: 9789332902800, Second Edition, 9789332902800
4	Sathya Ranjan Deb, "Robotics Technology & flexible Automation" Second edition, Tata McGraw-Hill Publication, 2009.

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

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

Course code	Course Name (Theory course)	Categ	L	T	P	C
ME19C14	EMBEDDED SYSTEMS AND PROGRAMMING	PE	2	0	2	3

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

UNIT-I	Introduction To Microcontroller	6
Fundamentals Functions of ALU - Microprocessor - Microcontrollers – CISC and RISC – Types Microcontroller - 8051 Family - Architecture - Features and Specifications - Memory Organization - Instruction Sets – Addressing Modes.		
UNIT-II	**Programming And Communication**	**6**
Fundamentals of Assembly Language Programming – Instruction to Assembler – Compiler and IDE - C Programming for 8051 Microcontroller – Basic Arithmetic and Logical Programming - Timer and Counter - Interrupts – Interfacing and Programming of Serial Communication, I2C, SPI and CAN of 8051 Microcontroller – Bluetooth and WI-FI interfacing of 8051 Microcontroller.		
UNIT-III	**Peripheral Interfacing**	**6**
I/O Programming – Interfacing of Memory, Key Board and Displays – Alphanumeric and Graphic, RTC, interfacing of ADC and DAC, Sensors - Relays - Solenoid Valve and Heater - Stepper Motors, DC Motors - PWM Programming – Closed Loop Control Programming of Servomotor – Traffic Light .		
UNIT-IV	**Arm Processor**	**6**
Introduction ARM 7 Processor - Internal Architecture – Modes of Operations – Register Set – Instruction Sets – ARM Thumb - Thumb State Registers – Pipelining – basic programming of ARM 7 - Applications		
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**

EMBEDDED SYSTEMS LAB- List of Experiments
1. Assembly Language Programming and Simulation of 8051. 2. Alphanumeric and Graphic LCD Interfacing using 8051 Microcontroller. 3. Input switches and keyboard interfacing of 8051. 4. Sensor Interfacing with ADC to 8051 and DAC & RTC Interfacing with 8051. 5. Timer, Counter and Interrupt Program Application for 8051. 6. Step Motor (Unipolar & Bipolar Motor) and PWM Servo Motor Control to Interfacing with 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. (any 7 experiments) **Total Contact Hours: 30**

Course Outcomes: Upon completion of the course students should be able to:	
•	Know the various functional units of microcontroller, processors and system-on-chip based the features and specifications.
•	Recognize the role of each functional units in microcontroller, processors and system on-ch based on the features and specifications.
•	Interface the sensors, actuators and other I/O‘s with microcontroller, processors and system chip based interfacing
•	Design the circuit and write the programming microcontroller, processors and system on ch
•	Develop the applications using Embedded system.

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

Reference Books(s) / Web links:	
1	Muhammad Ali Mazidi and Janice GillispicMazdi, ―The 8051 Microcontroller and Embedded Systems‖, Pearson Education, 2006.
2	Simon Monk, Programming the Raspberry Pi, Second Edition: Getting Started with Python McGraw Hill TAB; 2nd edition,2015
3	James W. Stewart, ―The 8051 Microcontroller Hardware, Software and Interfacing‖, Regents Prentice Hall, 2003.
4	https://nptel.ac.in/courses/108102045
5	https://archive.nptel.ac.in/courses/106/105/106105193/

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

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

Course code	Course Name (Theory course)	Category	L	T	P	C
ME19C15	SENSORS AND INSTRUMENTATION	PE	3	0	0	3

Objectives:	
●	To understand the concepts of measurement technology.
●	To learn the various sensors used to measure various physical parameters.
●	To learn the fundamentals of signal conditioning, data acquisition and communication
●	To learn the systems used in mechatronics system development
●	To learn about the optical, pressure and temperature sensor

UNIT-I	**Introduction**	9
Basics of Measurement – Classification of errors – Error analysis – Static and dynamic characteristics of transducers – Performance measures of sensors – Classification of sensors – Sensor calibration techniques – Sensor Output Signal Types.		
UNIT-II	**Motion, Proximity And Range Sensors**	9
Motion Sensors – Potentiometers, Resolver, Encoders – Optical, Magnetic, Inductive, Capacitive, LVDT – RVDT – Synchro – Microsyn, Accelerometer – GPS, Bluetooth, Range Sensors – RF beacons, Ultrasonic Ranging, Reflective beacons, Laser Range Sensor (LIDAR).		
UNIT-III	**Force, Magnetic And Heading Sensors**	9
Strain Gage, Load Cell, Magnetic Sensors –types, principle, requirement and advantages: Magneto resistive – Hall Effect – Current sensor Heading Sensors – Compass, Gyroscope, Inclinometers		
UNIT-IV	**Optical, Pressure And Temperature Sensors**	9
Photo conductive cell, photo voltaic, Photo resistive, LDR – Fiber optic sensors – Pressure – Diaphragm, Bellows, Piezoelectric – Tactile sensors, Temperature – IC, Thermistor, RTD, Thermocouple. Acoustic Sensors – flow and level measurement, Radiation Sensors - Smart Sensors - Film sensor, MEMS & Nano Sensors, LASER sensors		
UNIT-V	**Signal Conditioning And Daq Systems**	9
Amplification – Filtering – Sample and Hold circuits – Data Acquisition: Single channel and multi-channel data acquisition – Data logging - applications - Automobile, Aerospace, Home appliances, Manufacturing, Environmental monitoring.		
	Total Contact Hour	**45**

Course Outcomes: Upon successful completion of the course, students should be able to	
•	Recognize with various calibration techniques and signal types for sensors.
•	Outline the working principle and characteristics of force, magnetic, heading,
•	Analyze and apply knowledge force, magnetic and head sensors to real world application.
•	Apply the various optical, pressure and temperature sensors in various applications
•	Evaluate and apply principles of amplification, filtering, sample and hold circuits, and data acquisition for designing systems in various applications.

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

Reference Books(s) / Web links:	
1	C. Sujatha , Dyer, S.A., Survey of Instrumentation and Measurement, John Wiley & Sons, Canada, 2001.
2	Hans Kurt Tönshoff (Editor), Ichiro, ―Sensors in Manufacturing‖ Volume 1, Wiley-VCH April 2001
3	John Turner and Martyn Hill, ―Instrumentation for Engineers and Scientists‖, Oxford Science Publications, 1999.
4	Patranabis D, ―Sensors and Transducers‖, 2nd Edition, PHI, New Delhi, 2011.

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	2	1	-	-	-	-	-	2	1	-	2
CO2	3	2	1	2	2	1	-	-	-	-	-	2	2	-	2
CO3	3	2	1	1	2	1	-	-	-	-	-	2	2	-	2
CO4	3	2	1	3	2	1	-	-	-	-	-	2	2	-	2
CO5	3	2	1	3	2	1	-	-	-	-	-	2	2	-	2

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

Course code	Course Name (Theory course)	Category		T	P	C
ME19C16	HYDRAULICS AND PNEUMATICS	PE	3	0	0	3

Objectives:	
●	To understand the basics of fluid power system and its applications.
●	To know about the knowledge of the Hydraulic systems and its components.
●	To know about the Hydraulic circuits and Hydro static transmission.
●	To understand the basic concepts of pneumatic system and its logic circuits.
●	To understand the design of Hydraulic and pneumatic circuits with causes of trouble shooting/remedies

UNIT-I	Fluid Power Principles And Hydraulic Pumps	9
Introduction to Fluid power- Advantages and Applications- Fluid power systems – Types of fluids- Properties of fluids Basics of Hydraulics – Pascal‘s Law- Principles of flow – Work, Power and Torque. Properties of air– Perfect Gas Laws. Sources of Hydraulic power: Pumping Theory – Pump Classification- Construction, Working, Design, Advantages, Disadvantages, Performance, Selection criterion of Linear, Rotary- Fixed and Variable displacement pumps.		
UNIT-II	Hydraulic Actuators And Components	9
Hydraulic Actuators: Cylinders – Types and construction, Hydraulic motors -Types and construction - Control Components: Direction control, Flow control and Pressure control valves-Types, Construction and Operation-Applications – Types of actuations. Accessories: Reservoirs, Accumulators, Intensifiers, Pressure Switches-Classification and functions- Applications- Fluid Power ANSI Symbol.		

UNIT-III	**Hydraulic Circuits And Hydro Static Transmission**	**9**
Industrial hydraulic circuits- Regenerative, Pump Unloading, Double-pump, Pressure Intensifier, Air-over oil, Sequence, Reciprocation, Synchronization, Fail-safe, Speed control, Accumulators application circuits, Hydrostatic transmission, Electro hydraulic circuits, Mechanical Hydraulic servo systems		
UNIT-IV	**Pneumatic System**	**9**
Compressors- Filter, Regulator, Lubricator, Muffler, Air control Valves, Quick Exhaust valves, Pneumatic actuators, Servo systems. Design of Pneumatic circuit –classification-single cylinder and multi cylinder circuits-Cascade method- Introduction to Fluidics, Pneumatic logic circuits.		
UNIT-V	**Design Of Hydralic And Pneumatic Circuits**	**9**
Design of circuits using the components of hydraulic system for Drilling, Planning, Shaping, Punching, Press. – Selection, fault finding and maintenance of hydraulic components- Sequential circuit design for simple application using cascade method, Electro pneumatic circuits. Selection criteria of pneumatic components – Installation fault finding and maintenance of pneumatic components. Microprocessor and PLC- Applications in Hydraulic and Pneumatics- Low-cost Automation – Hydraulic and Pneumatic power packs		
	Total Contact Hours	**45**

Course Outcomes: Upon completion of the course students should be able to:	
●	Apply the basics of fluid power system and its applications in industry
●	Analyze the Hydraulic systems and its components
●	Design the Hydraulic circuits and Hydro static transmission
●	Analyze, design, and apply principles of compressors, filters, regulators, and pneumatic circuits f various engineering applications.
●	Analyse and design of Hydraulic and pneumatic circuits with causes of trouble shooting/remedies

Text Books:	
1	Anthony Esposito,‖ Fluid Power with Applications‖, PHI / Pearson Education, 2014
2	Majumdar, S.R., ―Oil Hydraulics Systems- Principles and Maintenance‖, Tata McGraw Hill, 201

Reference Books(s) / Web links:	
1	Shanmugasundaram.K, ―Hydraulic and Pneumatic controls‖, Chand & Co, 2011.
2	Srinivasan. R, "Hydraulic and Pneumatic Control", III Edition, Tata McGraw - Hill Education,20
3	https://nptel.ac.in/courses/112/105/112105046/

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

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

Course code	Course Name (Theory course)	Category	L	T	P	C
ME19C17	SMART MOBILITY AND INTELLIGENT VEHICLES	PE	3	0	0	3

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

UNIT-I	Introduction To Automated, Connected, And Intelligent Vehicles	9
Concept of Automotive Electronics, Electronics Overview, History & Evolution, Infotainment, Body, Chassis, and Powertrain Electronics, Introduction to Automated, Connected, and Intelligent Vehicles. Case studies: Automated, Connected, and Intelligent Vehicle.		
UNIT-II	**Sensor Technology For Smart Mobility**	**9**
Basics of Radar Technology and Systems, Ultrasonic Sonar Systems, Lidar Sensor Technology and Systems, Camera Technology, Night Vision Technology, Other Sensors, Use of Sensor Data Fusion, Integration of Sensor Data to On-Board Control Systems		
UNIT-III	**Connected Autonomous Vehicle**	**9**
Basic Control System Theory applied to Automobiles, Overview of the Operation of ECUs, Basic Cyber-Physical System Theory and Autonomous Vehicles, Role of Surroundings Sensing Systems and Autonomy, Role of Wireless Data Networks and Autonomy.		
UNIT-IV	**Vehicle Wireless Technology & Networking**	**9**
Wireless System Block Diagram and Overview of Components, Transmission Systems – Modulation/Encoding, Receiver System Concepts– Demodulation/Decoding, Wireless Networking and Applications to Vehicle Autonomy, Basics of Computer Networking – the Internet of Things, Wireless Networking Fundamentals, Integration of Wireless Networking and On-Board Vehicle Networks.		
UNIT-V	**Connected Car & Autonomous Vehicle Technology**	**9**
Connectivity Fundamentals, Navigation and Other Applications, Vehicle-to-Vehicle Technology and Applications, Vehicle-to-Roadside and Vehicle-to-Infrastructure Applications, Autonomous Vehicles - Driverless Car Technology, Moral, Legal, Roadblock Issues, Technical Issues, Security Issues.		
	Total Contact Hours :	**45**

Course Outcomes: Upon completion of the course students should be able to:	
•	Recognize the concept of cyber-physical control systems and their application to collision avoidance and autonomous vehicles
•	Assess the concept of remote sensing and the required sensor technologies essential for its implementation.
•	Acquainted with the concept of fully autonomous vehicles
•	Apply the basic concepts of wireless communications and wireless data networks
•	Analyze the concept of the connected vehicle and its role in automated vehicles

Text Books:	
1	Intelligent Transportation Systems and Connected and Automated Vehicles‖, 2016, Transportation Research Board.
2	Radovan Miucic, ―Connected Vehicles: Intelligent Transportation Systems‖, 2019, Springer.

Reference Books(s) / Web links:	
1	Tom Denton, ―Automobile Electrical and Electronic systems, Roultedge‖, Taylor & Francis Group,5th Edition,2018.
2	https://professional.mit.edu/course-catalog/transportation-networks-and-smart-mobility-methods-and-solutions.
3	https://engineering.purdue.edu/CE/Academics/Graduate/Online/smart-mobility

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

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

Course code	**Course Name (Theory course)**	**Category**	**L**	**T**	**P**	**C**
ME19C18	**HAPTICS AND IMMERSIVE TECHNOLOGIES**	**PE**	**3**	**0**	**0**	**3**

Objectives:	
•	To learn the various immersive technologies of VR, AR and MR.
•	To understand the software related to immersive technologies.
•	To study the haptic perception and extended reality
•	To learn the concepts of developing VR and unreal engine.
•	To familiarize on various immersive technologies of VR, AR and MR and allied softwares.

UNIT-I	**Introduction To Immersive Technologies**	**9**
Introduction on Virtual reality – Augmented reality – Mixed reality – Extended reality – VR Devic – AR Devices – Applications in Training and Education, Healthcare, Marketing and Retail		

UNIT-II	**Software Tools**	**9**
Intro to Unity – Unity editor workspace – Intro to C# and visual studio - Programming in Unity –In to Unreal Engine – UE4 Editor workspace – Intro to Blueprint programming – Programming in Ue		
UNIT-III	**Building Ar Application With Unity**	**9**
AR SDKs for unity and unreal engine – Working with SDKs for unity – Developing AR applicatio in unity - Building AR application-VR Architectural Visualization-AR Interior Design Apps		
UNIT-IV	**Building Vr Application With Unreal Engine**	**9**
VR SDKs for unity and unreal engine – Developing VR application in Ue4 – Building VR Application- Implementing basic lighting and effects for VR.		
UNIT-V	**Haptic Perception And Extended Reality**	**9**
Extended Reality - Introduction to Haptics – Devices and possibilities – Custom Device development – Device Integration.		
	Total Contact Hours : 45	

Course Outcomes: Upon completion of the course students should be able to:	
•	Apply detailed knowledge about immersive technology.
•	Acquire the knowledge of different types of Software Tools and Devices in Immersive Technologies.
•	Acquire the knowledge about AR Unity and VR Unreal Engine.
•	Advance the applications in immersive technologies.
•	Explore about haptics in immersive technologies.

Text Books:	
1	Immersive Multimodal Interactive Presence, by Angelika Peer (Editor), Christos D. Giachritsis (Editor), Springer;2014
2	XR Haptics, Implementation & Design Guidelines, by Eric Vezzoli , Chris Ullrich , Gijs den Butter , Rafal Pijewski, 2022

Reference Books(s) / Web links:	
1	Practical Augmented Reality, by Steve Aukstakalnis, Addison-Wesley Professional; edition.2019
2	Augmented Reality - Theory, Design and Development, by Chetankumar G Shetty,2020
3	https://archive.nptel.ac.in/courses/121/106/121106013/
4	https://www.coursera.org/learn/introduction-virtual-reality
5	https://www.target3d.co.uk/

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

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

Course code	Course Name (Theory course)	Categor	L	T	P	C
ME19C19	ROBOT DYNAMICS APPLICATIONS	PE	3	0	0	3

Course Objectives:	
	To introduce the basics concept of Mobile robot.
	To understand the Kinematics of a robot system.
	To understand the Dynamic behavior of a robot system.
	To familiarize the dynamic modeling and simulation of a robot system.
	To introduce the robot control system.

UNIT-I	**Mobile Robot**	9
Introduction to mobile robots and manipulators- Principle of locomotion and types of locomotion- Types of mobile robots: ground robots aerial robots, underwater robots and water surface robots.		
UNIT-II	**Robot Kinematics**	9
Direct kinematics- Inverse kinematics- Co-ordinate frames-Rotations-Homogeneous Coordinates- Link coordinates, DH Representation, Arm equation -Two axis, three axis, four axis, five axis and six axis robots		
UNIT-III	**Robot Dynamics**	9
Forward Dynamics and Inverse Dynamics – Importance – Spatial description and transformations – Different types of dynamic formulation schemes – Lagrangian formulation for equation of motion for robots and manipulators. Properties of the dynamic model, Dynamic model of simple manipulator structures, Dynamic parameters identification, Operational space dynamics model, Differential kinematics.		
UNIT-IV	**Dynamic Modeling And Simulation**	9
Modeling of motion of robots and manipulators using Newton – Euler equations – State space representation of equation of motion and system properties – Importance of Simulation and its types – Numeric Integration solvers and their role in numeric simulation - Numeric simulation of robots and manipulators using MATLAB / Simulink module.		
UNIT-V	**Introduction To Robot Control**	9
Introduction – Need & types of control schemes for robots – joint space control schemes and task space control schemes with examples.		
	Total Contact Hours	**45**

Course Outcomes: Upon completion of this course, students will acquire	
•	Grasp the fundamental concepts of mobile robots, demonstrating a foundational understanding of the subject.
•	Develop the kinematics of a robot system, showcasing the ability to design and formulate robotic motion
•	Assess the dynamic behavior of a system, demonstrating the ability to analyze and interpret its complex interactions.
•	Comprehend the dynamic modeling and simulation of robot systems, showcasing an understanding of their complex interactions.
•	Apply the acquired knowledge to analyze and implement suitable control schemes for diverse robotic applications

Text Books:	
1	Dudek, M Jenkin, Computational Principles of Mobile Robotics, Cambridge University Press, USA, 2010.

Reference Books(s) / Web links:	
1	Kelly, A ―Mobile Robotics: Mathematics, Models, and Methods‖, Cambridge University Press, USA, 2013.
2	Choset, Lynch, S. Hutchinson, G. Kantor, W. Burgard, L. E. Kavraki, and S. Thrun, ―Principles of Robot Motion:Theory, Algorithms, and Implementations‖, MIT Press, 2005
3	Tzafestas, ―Introduction to Mobile Robot Control, Elsevier‖, USA, 2014

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

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

VERTICAL 4 : PRODUCT DESIGN

Course code	Course Name	Categor	L	T	P	C
ME19D11	DESIGN FOR X	PE	3	0	0	3

Objectives:

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

UNIT-I Introduction **9**

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

UNIT-II Factors Influencing Form Design **9**

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

UNIT-III Component Design - Machining Consideration **9**

Design features to facilitate machining - drills - milling cutters - keyways - Doweling procedures, counter sunk screws - Reduction of machined area- simplification by separation - simplification by amalgamation - Design for machinability - Design for economy - Design for clampability – Design for accessibility - Design for assembly – Product design for manual assembly - Product design for automatic assembly – Robotic assembly.

UNIT-IV Component Design – Casting Consideration **9**

Redesign of castings based on Parting line considerations - Minimizing core requirements, machined holes, redesign of cast members to obviate cores. Identification of uneconomical design - Modifying the design - group technology - Computer Applications for DFMA

UNIT-V Design For Additive Manufacturing **9**

Introduction to AM, DFMA concepts and objectives, AM unique capabilities, exploring design freedoms, Design tools for AM, Part Orientation, Removal of Supports, Hollowing out parts, Inclusion of Undercuts and Other Manufacturing Constraining Features, Interlocking Features, Reduction of Part Count in an Assembly, Identification of markings/ numbers.

Total Contact Hour **45**

Course Outcomes: At the end of this course, students can have the

- Ability to Elaborate the design principles for manufacturability
- Ability to discuss the factors influencing in form design.
- Ability to apply the component design features of various machine
- Ability to discuss the design consideration principles of welding in the design of welded products.
- Ability to discuss the design consideration principles of additive manufacturing.

Text Books:	
1	James G. Bralla, ―Design for Manufacturability Handbook‖, McGraw Hill Professional, 1998.
2	O. Molloy, E. A. Warman, S. Tilley, Design for Manufacturing and Assembly: Concepts, Architectures and Implementation, Springer, 1998.
Reference Books(s) / Web links:	
1	CorradoPoli, Design for Manufacturing: A Structured Approach, Elsevier, 2001.
2	David M. Anderson, Design for Manufacturability & Concurrent Engineering: How to Design for Low Cost, Design in High Quality, Design for Lean Manufacture, and Design Quickly for Fast Production, CIM Press, 2004.
3	Erik Tempelman, Hugh Shercliff, Bruno Ninaber van Eyben, Manufacturing and Design: Understanding the Principles of How Things Are Made, Elsevier, 2014.
4	Graedel T. Allen By. B, Design for the Environment Angle Wood Cliff, Prentice Hall. Reason Pub., 1996.
5	Boothroyd, G, Heartz and Nike, Product Design for Manufacture, Marcel Dekker, 1994

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

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

Course code	Course Name	Categor	L	T	P	C
ME19D12	COMPUTER AIDED DESIGN	PE				

Objectives:

- To Introduce and understand the Basic of Design.
- To study the two dimensional drafting and bill of material creation. .
- To learn three dimensional modelling and its advantages.
- To study the basic and purpose of assembling modeling.
- To study the basics of CAD standards

UNIT-I	Basics Of Designs	9

Understanding of Projections, Scales, units, GD & T; its 14 symbols, Special characteristics & Title Block readings. Revision / ECN status of drawings – Customer Specific requirements – Drawing Grid reading

UNIT-II	2D Drafting	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

UNIT-III	3D Modeling	9

Conversion of Views – 2D to 3D & 3D to 2D – Parametric and Non-Parametric Modeling – Tree features of 3D Modeling and its advantages – Surface Modeling – BIW (Body In White) – Solid Modeling, Boolean operations like Unite, Subtraction, Intersect, etc.

UNIT-IV	**Assembly Modeling**	**9**
Basics of Assembly modeling, Purpose of Assembly modeling & amp; its advantages – Top to Down & BottomUp modeling approaches – Analysis of Clearances – Undercuts – Interferences – Stack up analysis –Cumulative effect of Tolerances in after assembly conditions.- motion 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, STEP, CALS etc.		
	Total Contact Hour	**45**

Course Outcomes: At the end of this course, students would beable to

- Discuss the basics of the design and concepts. .
- Develop the two dimensional drafting and projection views.
- Discuss the three dimensional modeling, parametric and Non-parametric modeling
- Discuss the assembly modeling and top down, bottom up approaches.
- Discuss the various CAD standards

Text Books:

1	Computer Aided Design & Manufacturing - Jacob Moses & Ruchi Agarwal, Technic Publications, 2020.
2	J. Srinivas, CAD / CAM Principles & Application, Oxford Press, 2016.

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	Rao PN, ―CAD / CAM Principles and Applications ―- Mc Graw Hill Publisher, 2017

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

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

Course code	Course Name (Theory course)	Category	L	T	P	C
ME19D13	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.

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.

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. N D Bhatt and VM Panchal, Machine Drawing, Charotar Publishing, 2014.

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. 2nd edition, 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
CO1	2	1	-	1	-	-	-	-	-	-	-	2	1	-	2
CO2	2	1	-	1	-	-	-	-	-	-	-	2	1	-	2
CO3	2	1	-	1	-	-	-	-	-	-	-	2	1	-	2
CO4	2	1	-	1	-	-	-	-	-	-	-	2	1	-	2
CO5	2	1	-	1	-	-	-	-	-	-	-	2	1	-	2

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

Course code	Course Name (Theory course)	Categor	L	T	P	C
ME19D14	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 2K 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. 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. Basics of Shainin DOE - Problem Solving Algorithm - Problem Identification Tools- Shainin DOE Tools - Case studies- Illustrations using software packages.		
	Total Contact Hour	**45**

Course Outcomes: At the end of this course, students can have the	
●	Ability to appreciate the fundamental principles of Classical Design of Experiments.
●	Ability to apply single factor experiment for process parameter understanding and optimization.
●	Ability to relate Factorial Design principles for understanding of process parameters and its optimization.
●	Ability to advance knowledge on Taguchi's approach to experimental design for attaining robustness.
●	Ability to 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.
	https://onlinecourses.nptel.ac.in/noc21_mg48/preview
	https://www.youtube.com/watch?v=KhjM8YI3agk
	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**
CO1	3	3	3	3	2	-	-	1	-	-	-	2	-	2	3
CO2	3	3	3	3	3	-	-	1	-	-	-	2	-	2	3
CO3	3	3	3	3	3	-	-	1	-	-	-	2	-	2	3
CO4	3	3	3	2	3	-	-	1	-	-	-	2	-	2	3
CO5	3	3	3	2	3	-	-	1	-	-	-	2	-	2	3

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

Course code	Course Name	Category	L	T	P	C
ME19D15	DESIGN WITH ADVANCED MATERIALS	PE	3	0	0	3

Objectives:	
●	Understanding of Engineering materials.
●	To understand material selection for various applications
●	To study different plastics and Polymer composites materials
●	To understand high temperature material and its application
●	To understand fundamentals of ceramics and surface modifications in material.

UNIT-I	Design And Materials	9
Engineering Design process and the role of materials; materials classification and their properties; material propertycharts; selection of materials based on function, objective, constraints, and free variables.		
UNIT-II	**Materials Selection**	**9**
Computer aided materials selection. Selection of process based on material classification; pencil curve approach;material selection for multiple constraints and multiple objective cases; multiple constraints and conflicting objectives. Co-selection of material and shape; concept of macroscopic and microscopic shape factors; Four-quadrant method ofmaterial selection.		
UNIT-III	**Polymers And Polymer Composites**	**9**
Properties of plastics- polymers and elastomers- visco-elastic properties- mathematical modeling plastic properties; Maxwell, Kelvin-Voigt Models; fatigue and fracture of plastics- Fundamentals fiber- reinforced plastics; Stress, strain analysis of continuous fiber composites, rule of mixtures, gen deformation behavior of laminates.		
UNIT-IV	**High Temperature Materials**	**9**
Introduction to high temperature materials; families of super alloys and their characteristics; creep and fatigue resistanceof super alloys; role of precipitates in strengthening of super alloys; repair of super alloys after creep damage.		
UNIT-V	**Surface Engineering**	**9**
Fundamentals of ceramics, general properties, applications of ceramics for critical applications. Desig considerations. Surface treatment of materials using coatings; type of coatings; PVD and CVD coatings. Basics of electro-plating andelectro-less plating.		
	Total Contact Hours	**45**

Course Outcomes: On completion of this course, the students will be able to	
●	Describe the properties of various materials.
●	Select the material for the product suitably.
●	Explain the behaviour of polymers and FRP‘s under various conditions.
●	Describe the behaviour of materials under creep.
●	Apply the various methods of coating over the surface.

Text Books:	
1	Ashby, M.F., ―Materials Selection in Design‖, Butterworth-Heinemann, 4/e, 2019.
2	Crawford, R. J., ―Plastics Engineering‖, Butterworth-Heinemann, 3/e, 2018.

Reference Books(s) / Web links:	
1	Donachie, M. J. and Donachie, S. J., ―Super alloys: A technical guide‖, ASM International, 2002.
2	Carter, C.B., and Grant, N. M., ―Ceramic Materials: Science and Engineering‖, Springer, 2013.
3	Bralla, J. C., ―Design for Manufacturability Handbook‖, McGraw-Hill Professional; 2/e, 1998.
4	https://onlinecourses.nptel.ac.in/noc19_mm13/preview
5	https://www.digimat.in/nptel/courses/video/112104228/L25.html

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

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

Course code	Course Name (Theory course)	Categor	L	T	P	C
ME19D16	PROCESS PLANNING AND COST ESTIMATION	PE	3	0	0	3

Objectives:

- To create a process plan for a given Product.
- To understand the purpose, functions and procedure for Estimating.
- To determine cost elements, overheads and depreciation for a given Product.
- To estimate cost for the casting, forging and welding processes.
- To calculate the machining times and costs for various machining processes.

UNIT-I	Introduction To Process Planning	10

Outlining to process planning - Drawing interpretation –Material selection process and methods, Selection of Production Processes – standardization, simplification –Break even analysis –Factors to be considered in selecting: Process Sequencing; Operation Sequencing; Process parameters Equipment & Tool Selection; Tool Material evaluation -Selection of jigs and fixtures –Computer Aided Process Planning – Manual, Retrieval CAPP and Generative CAPP - Case Study in Process Planning.

UNIT-II	Fundamental Of Estimating	7

Concept and Purpose of Estimating, Functions of Estimating department, Costing versus Estimating, Types of Estimates, Importance of Estimates, Estimating Procedure, Case Study in Estimating.

UNIT-III	Fundamental Of Costing	10

Aims, Functions and Importance of costing–methods of costing-elements of cost estimation – Cost Estimators and their Qualifications, Principal Constituents in a Cost Estimate – Allocation of Cost Elements –Material Cost, Labour Cost, Expenses and Cost of Product (Ladder Cost), Distribution of Overhead Cost and Methods to Calculate the Depreciation.

UNIT-IV	Cost Estimation Of Casting, Forging & Welding Costs	9
Estimation of cost for various production processes - Estimation of Forging Shop– Losses in forging –Forging cost, Estimation of Welding Shop– Electric welding cost – Gas Welding cost, Estimation of Foundry Shop– Pattern cost - Casting cost.		
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 this course, students can have the	
●	Dexterity to make a standard and detailed process plan for a given product.
●	Ability to differentiate estimation and costing.
●	Capacity to allocate cost elements, distribute over heads and calculate depreciation for a given Product.
●	Agility to estimate cost for various production processes like casting, forging and weldi processes for a given product.
●	Ability to calculate the machining times and costs for various conventional machining processes

Text Books:	
1	Adithan, M, ―Process Planning and Cost Estimation‖, New Age International Publishers, 2020.
2	Peter Scallan, ―Process Planning, The Design/Manufacture Interface‖, Butterworth Heinemann, 2018.

Reference Books(s) / Web links:	
1	Chitale A. K., and Gupta R. C., ―Product Design and manufacturing‖, Prentice Hall of India, Ne Delhi, 2016.
2	Gideon Halevi, ―Process and operation planning‖, Kluwer academic publishers (Printed ebook), 2015.
3	Narang G.B.S. & Kumar. V, ―Production and Costing‖, Khanna Publishers, 2017.
4	Phillip F. Ostwald & Jairo Munoz, ―Manufacturing Processes and Systems‖, 9th Edition, Wiley student edition, 2016.
5.	Robert Creese, Adithan M. &Pabla B. S., ―Estimating and Costing for the Metal Manufacturing Industries‖, Marcel Dekker, 2015.
6	https://onlinecourses.nptel.ac.in/noc23_ce59/preview
7	https://www.youtube.com/watch?v=11ShbDNcqhI&list=PLFQ4-HFt2IjT8oFa7xpMioJPofxfU1ux

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

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

Course code	Course Name (Theory course)	Categor	L	T	P	C
ME19D17	PRODUCT LIFECYCLE MANAGEMENT	PE	3	0	0	3

Objectives: The main learning objective of this course is to prepare the students to:
• To study about the history, concepts and terminology in PLM
• To assess the and conceptualize the PLM environment
• To study about Product Data Management and its workflow
• To emphasize on Collaborative Product Development and its validation
• To demonstrate and justify PLM approaches for industrial applications

UNIT-I	**Introduction**	**9**
Overview, Need, Benefits, Concept of Product Life Cycle, Emergence Views, Components, Phases Significance of PLM, Feasibility study, PLM visioning, PLM implementation cases in various indu verticals.		
UNIT-II	**Plm Concepts, Processes And Workflow**	**9**
Characteristics of PLM, Environment driving PLM, Drivers of PLM, Conceptualization, Design, Development, Validation, Production, Support of PLM.		
UNIT- III	**Product Data Management (Pdm) Process And Workflow**	**9**
PDM systems and importance, reason for implementing a PDM system, financial justification of PDM implementation. Versioning, check-in and checkout, views, Metadata, Lifecycle, and workflow. Applied problems and solution on PDM processes and workflow.		
UNIT-IV	**Collaborative Product Development**	**9**
Engineering vaulting, product reuse, smart parts, engineering change management, Bill of materia and process consistency, Digital mock-up and prototype development, design for environment, virt testing and validation, marketing collateral.		
UNIT-V	**Plm Assesment And Role Of Plm In Industries**	**9**
Strategy, Impact of strategy, PLM initiatives to support corporate objectives. Infrastructure assessment of current system and applications. PLM strategy, change management for PLM, financia justification of PLM, barriers to PLM implementation, ten step approach to PLM, benefits of PLM for–business, organization, users, produc or service, process performance		
	Total Contact Hours	**45**

Course Outcomes : On completion of this course, the students will be able to
• Evaluate the advantages, elements, and execution of Product Lifecycle Management
• Analyze the procedures involved in designing, developing, and validating a Product Lifecy Management (PLM) environment.
• Analyze the lifecycle of a product and its data management and workflow throughout.
• Evaluate the Collaborative Product Development and validate its implementation.
• Illustrate the integration of PLM across diverse industrial sectors..

Text Books:	
1	Product Lifecycle Management: Grieves, Michael, McGraw-Hil, Edition 2018.ISBN0071452303
2	PDM: Product Data Management: Burden, Rodger, Resource Pub, 2015. ISBN0970035225.

Reference Books(s) / Web links:	
1	Fabio Guidice, Guido La Rosa, Product Design for the environment A life cycle approach, Tayl and Francis 2019.
2	Robert J. Thomas, ―NDP: Managing and forecasting for strategicprocesses‖.
3	Hartman, ―Product life cycle management with SAP‖,2015
4	Stark, John,‖Product Life cycle Management: Paradigm for 21st Century Product Realization ―, Springer-Verlag, 2017. ISBN18523381055.
5	https://nptel.ac.in/courses/112107217
6	https://www.youtube.com/watch?v=qgVs8vskWl0

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

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

Course code	Course Name (Theory course)	Category	L	T	P	C
ME19D18	NEW PRODUCT DEVELOPMENT	PE	3	0	0	3

Objectives: The main learning objective of this course is to prepare the students to:	
•	After the completion of this course, students will be able to understand the basic principles and concepts of new product development strategies, the product life cycles.
•	Students will be able to design and development of new products according to the application needed.
•	Students will be able to analysis the product economics in the commercial world.
•	Students will be able to set potential innovation triggers and strategically select those opportunities that fit with the organizational resources and strategies.
•	Students will be able to design the product development through case studies, and the ability to address costs issues through better design decisions.

UNIT-I	Introduction To Product Development	9
Introduction-product strategy-analysing product opportunities-agile product development-prod to market- understanding customer needs-design thinking for new products- New Prod Development Process: idea generation, evaluation of product ideas, conducting business analy product development, market testing, launching new products-product life cycle		
UNIT-II	**Materials And Product Architecture**	**9**
Materials selection and development-Organizing product development-design for manufactu and prototyping-concept selection, development and testing-innovations and types-implicatio product architecture-product planning		
UNIT- III	**Product Design**	**9**
New product design and development-factors affecting-product innovation and types-Design fo approaches-concept design-robust design-design for manufacturing: Design for machinabilit Design for economy - Design for clampability – Design for accessibility – Design for assemb design for environment-industrial design.		

UNIT-IV	**Product Development**	**9**
Characteristics of successful product development-challenges-product service systems-prototyp and testing-opportunity identifications-product specifications-standardization-customizati Ergonomics and aesthetic development-tools for digital product development-Addi manufacturing.		
UNIT-V	**Case Studies And Commercialization**	**9**
Product development economics-Case studies: New Product Development in Goods and Service Industries- New Product Development and Growth Strategies-marketing strategy-patent and intellectual rights-New product commercialization-sustainability.		
	Total Contact Hour	**45**

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

- Understand and discuss the key concepts and principles concerning the role of product strat and services.
- Understand the competencies and product architecture involved in new product development.
- Understand the range of tools and methods that are used to manage new product design.
- Analyze the set of potential innovation triggers and strategically select those opportunities t fit with the organizational resources and strategies.
- Critically evaluate the role of design in product development through case studies, and ability to address costs issues through better design decisions.

Text Books:	
1	Karl T.Ulrich and Steven D.Eppinger, ―Product design and development‖, McGraw Hill, 6th Edition, 2019.
Reference Books(s) / Web links:	
1	Boothroyd, G, Heartz and Nike, Product Design for Manufacture, Marcel Dekker, 2018
2	O. Molloy, E.A. Warman, S. Tilley, Design for Manufacturing and Assembly: Concepts, Architectures and Implementation, Springer, 2014.
3	James G. Bralla, ―Design for Manufacturability Handbook‖, McGraw Hill Professional, 201
4	Revolutionizing Product Development – Steven C Wheelwright & Kim B. Clark.
5	https://onlinecourses.nptel.ac.in/noc21_me83/preview
6	https://www.youtube.com/watch?v=sWBkRd6dmdu

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

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

Course code	Course Name (Theory course)	Categor	L	T	P	C
ME19D19	DESIGN OF JIGS, FIXTURES AND PRESS TOOLS	PE	3	0	0	3

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

- To understand the locating and clamping principles.
- To design and develop jigs and fixtures for a given component.
- To understand press working terminologies and elements of cutting dies.
- To design and develop bending and forming dies.
- To develop knowledge in other forming techniques.

UNIT-I	**Locating And Clamping Principles**	**8**

Objectives of tool design- Function and advantages of Jigs and fixtures – Basic element principles of location – Locating methods and devices – Redundant Location – Principles clamping – Types of clamps - Mechanical actuation – pneumatic and hydraulic actuation Stand parts – Drill bushes and Jig buttons – Tolerances and materials used.

UNIT-II	**Jigs And Fixtures**	**10**

Design and development of jigs and fixtures for given component- Types of Jigs – Post, Turno Channel, latch, box, pot, angular post jigs – Indexing jigs – General principles of milling, La boring, broaching and grinding fixtures – Assembly, Inspection and Welding fixtures – Mod fixturing systems- Quick change fixtures.
Application of CAD software packages in design of Jigs and Fixtures – Case Study

UNIT- III	**Press Working Terminologies And Elements Of Cutting Dies**	**10**

Press Working Terminologies - operations – Types of presses – press accessories – Computatio press capacity – Strip layout – Material Utilization – Shearing action – Clearances – Press W Materials – Center of pressure- Design of various elements of dies – Die Block – Punch holder, set, guide plates – Stops – Strippers – Pilots – Selection of Standard parts – Design and preparat of standard views of simple blanking, piercing, notching, compound and progressive dies.

UNIT-IV	**Bending And Drawing Dies**	**10**

Difference between bending and drawing – Blank development for above operations – Types Bending dies – Press capacity – Spring back – knockouts – direct and indirect – pressure pad Ejectors – Variables affecting Metal flow in drawing operations – draw die inserts – drawbe ironing – Design and development of bending, forming, drawing, reverse redrawing combination dies – Blank development for axisymmetric, rectangular and elliptic parts – Sin and double action dies.

UNIT-V	**Other Forming Techniques**	**7**

Bulging, Swaging, Embossing, coining, curling, hole flanging, shaving and sizing, assembly, f Blanking dies – recent trends in tool design- computer Aids for sheet metal forming Analysi basic introduction - tooling for numerically controlled machines- setup reduction for work hold – Single minute exchange of dies – Poka Yoke.

	Total Contact Hour	**45**

Note: (Use of P S G Design Data Book is permitted in the End Semester examination)

Course Outcomes : On completion of this course, the students will be able	
●	To understand the locating and clamping principles.
●	To design and develop jigs and fixtures for a given component.
●	To understand press working terminologies and elements of cutting dies.
●	To design and develop bending and forming dies.
●	To develop knowledge in other forming techniques.

Text Books:	
1	Joshi, P.H. —Jigs and Fixtures‖, Second Edition, Tata McGraw Hill Publishing Co., Ltd., New Delhi, 2020.
2	Joshi P.H —Press tools - Design and Construction‖, wheels publishing, 2018

Reference Books(s) / Web links:	
1	Venkataraman. K., —Design of Jigs Fixtures & Press Tools‖, Tata McGraw Hill, New Delhi, 2015
2	Donaldson, Lecain and Goold —Tool Design‖, 3rd Edition, Tata McGraw Hill, 2018.
3	Kempster, —Jigs and Fixture Design‖, Third Edition, Hoddes and Stoughton, 2010.
4	Hoffman —Jigs and Fixture Design‖, Thomson Delmar Learning, Singapore, 2014.
5	ASTME Fundamentals of Tool Design Prentice Hall of India.
6	Design Data Hand Book, PSG College of Technology, Coimbatore.
7	V.Balachandran, —Design of Jigs Fixtures & Press Tools‖, Notion Press, 2019.
8	https://www.youtube.com/watch?v=7yzvno4AvKw
9	https://courseware.cutm.ac.in/courses/design-of-jigs-fixtures-and-dies/

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

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

VERTICAL 5 : DIGITAL MANUFACTURING

Course code	Course Name (Theory course)	Categor	L	T	P	C
ME19E11	DIGITAL MANUFACTURING AND IoT	PE	3	0	0	3

Objectives:

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

UNIT-I **Introduction** **9**

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

UNIT-II **Digital Life Cycle & Supply Chain Management** **9**

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

UNIT-III **Smart Factory** **9**

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

UNIT-IV **Industry 4.0** **9**

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

UNIT-V **Study Of Digital Twin** **9**

Basic Concepts – Features and Implementation – Digital Twin: Digital Thread and Digital Shadow- Building Blocks – Types – Characteristics of a Good Digital Twin Platform – Benefits, Impact & Challenges – Future of Digital Twins.

Total Contact Hours : 45

Course Outcomes: Upon completion of the course students should be able to:

- Impart knowledge to use various elements in the digital manufacturing.
- Differentiate the concepts involved in digital product development life cycle process and supply chain management in digital environment.
- Select the proper procedure of validating practical work through digital validation in Factories.
- Implementation the concepts of IoT and its role in digital manufacturing.
- Analyse and optimize various practical manufacturing process through digital twin

Text Books:

1 Zude Zhou, Shane (Shengquan) Xie and Dejun Chen, Fundamentals of Digital Manufacturing Science, Springer-Verlag London Limited, 2012.

2 Alasdair Gilchrist, ―Industry 4.0: The Industrial Internet of Things‖, A press, 2016.

Reference Books(s) / Web links:

1 Lihui Wang and Andrew YehChing Nee, Collaborative Design and Planning for Digital Manufacturing, Springer-Verlag London Limited, 2009.

2	Andrew Yeh Chris Nee, Fei Tao, and Meng Zhang, ―Digital Twin Driven Smart Manufacturing‖, Elsevier Science., United States, 2019.
3	Alp Ustundag and Emre Cevikcan, ―Industry 4.0: Managing The Digital Transformation‖, Springer Series in Advanced Manufacturing., Switzerland, 2017
4	Ronald R. Yager and Jordan Pascual Espada, ―New Advances in the Internet of Things‖, Springer., Switzerland, 2018

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

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

Course code	Course Name (Theory course)	Category	L	T	P	C
ME19E12	LEAN MANUFACTURING	PE	3	0	0	3

Objectives:

- To provide practical level understanding of the key elements of lean production systems
- To impart knowledge on systematic approach for implementing value stream mapping.
- To inculcate the practice of operational excellence through Toyoto‘s way.

UNIT-I	**Introduction To Lean Management And Lean Elements**	**9**

Introduction to seven wastes and their narration-Evolution of lean-Global competition-L Manufacturing-Value flow and Muda, Muri and Mura-Need for LM- Meeting the stake hold requirement-Elements of LM.

UNIT-II	**Lean Tools And Technqiues**	**9**

Various tool of LM, Fundamental blocks of Lean, 5S system, Need for TPM, Pillars of TP Implementation of TPM, Overview of the Toyota Production System (TPS)

UNIT-III	**Lean System**	**9**

Objective and benefits of Secondary lean tool-Cause and Effect diagram-Pareto chart-Spiderchart-Po yoke-Kanban-Automation-Single minute exchange of die (SMED)-Design for manufacturing and assembly- Just in time (JIT)-Visual workplace-OEE

UNIT-IV	**Project Selection For Lean**	**9**

Resource and project selection, Selecting projects, Process mapping, Current and future value stre mapping, project suitable for lean initiatives.

UNIT-V	**Lean Management And Implementation**	**9**

Standardized work, Continuous improvement. Lean projects: Training, selecting the members, preparing project plan, implementation, review. Productivity Improvement: Process, machinery Operator and equipment

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

Course Outcomes: At the end of the course, the student will be able to

- Identify key requirements and concepts in lean production system.
- Apply the stability and standardized work systems..
- Demonstrate the JIT and Jidoka and implement Lean culture.
- Map the value chain, predict the value addition and apply the value stream.
- Implement the 14 principles of Toyoto‘s operational excellence

Text Books:	
1	Pascal Dennis, Lean Production Simplified: A Plain-Language Guide to the World's Most Powerf Production System, 2015, Third Edition, CRC Press-Taylor & Francis,UK.
2	Don Tapping, Tom Luyster and Tom Shuker, Value Stream Management: Eight Steps to Plannin Mapping, and Sustaining Lean Improvements, Productivity Press, New York, 2002
3	Jeffrey K. Liker, The Toyota Way: 14 management principles from the world‘s greatest manufacturer, 2021, Second edition, MaGraw-Hill Edition.
Reference Books(s) / Web links:	
1	Masaaki Imai, Gemba Kaizen: A Commonsense, Low-Cost Approach to Management,19 MaGraw-Hill.
2	James P. Womack and Daniel T. Jones, Lean Thinking: Banish Waste & Create Wealth in Y Corporation, 2001, Revised Edition, Simon & Shuste
3	John Allen, Charles Robinson and David Stewart, Lean Manufacturing: A Plant Floor Guide, 20 Society of Manufacturing Engineers, Michigan.
4	Mike Rother, ―Toyota Kata: Managing People for Improvement, Addictiveness, and Supe Results‖, 2010, Tata MaGraw-Hill Edition

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

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

Course code	Course Name	Categor	L	T	P	C
ME19E13	ADVANCED MACHINING PROCESSES	PE	3	0	0	3

Objectives: The students can be able to

- Importance of non-traditional machining and mechanical energy-based processes
- Working principles of different chemical and electro chemical energy based processes and its process parameters.
- Working principles of thermo-electric energy-based processes and its process parameters.
- Study about various nano finishing processes.
- Different types of Hybrid non-traditional machining processes.

UNIT – I	Introduction And Mechanical Energy Based Processes	9

Introduction - Need for non-traditional machining processes - Classification of non-traditional machining processes– Brief overview - Abrasive jet machining, Water jet Machining, Ultrasonic machining their principles, equipment, effect of process parameters, applications, advantages and limitations

UNIT – II	Chemical And Electro Chemical Energy Based Processes	9

Principles, 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

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.		
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.		
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 - sElectrochemical Discharge Machining (ECDM), Electric Discharge Grinding (EDG), Abrasive water jet machining		

Total Contact Periods : 45

Course Outcomes: On completion of the course, the student is expected to be able to	
1.	Ability to explain different types of non-traditional machining processes and explain mechanical energy based non traditional machining processes
2.	Ability to explain the working principles of chemical and electro chemical energy-bas processes.
3.	Ability to explain the working principles of thermo-electric energy-based processes.
4.	Ability to explain various nano finishing processes.
5.	Ability to understand hybrid non-traditional machining processes.

Text Book(s):

.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 Machining and Finishing‖, 1st edition, Springer International Publishing., Switzerland, 2016.

Reference Books(s) / Web links:

.Adithan. M., ―Unconventional Machining Processes‖, Atlantic, New Delhi, India, 2009.

Gary F. Benedict, ―Non-traditional Manufacturing Processes‖, Routledge, 2017.

3.Vijay.K. Jain ―Nanofinishing Science and Technology: Basic and Advanced Finishing and Polishi Processes‖ CRC Press, 2016

4.XichunLuo, Yi Qin, Hybrid Machining, Elsevier, 2018

5.Streeter, V. L. and Wylie E. B., Fluid Mechanics, McGraw Hill Publishing Co. (2010).

6.https://nptel.ac.in/courses/112/103/112103202/ -:Advanced MachiningProcesses

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	-	-	-	-	-	2		1	1
CO2	2	1	-	-	1	1	-	-	-	-	-	2		1	1
CO3	2	1	-	-	1	1	-	-	-	-	-	2		1	1
CO4	2	1	-	-	1	1	-	-	-	-	-	2		1	1
CO5	2	1	-	-	1	1	-	-	-	-	-	2		1	1

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

Course Code	Course Name(Theorycourse)	Category	L	T	P	C
ME19E14	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.
- Analyze the best manufacturing processes towards minimization or prevention of air pollution.
- Apply the 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

WEBLINKS:

1. https://www.mdpi.com/2071-1050/4/2/154
2. https://archive.nptel.ac.in/courses/112/104/112104225/
3. https://www.linkedin.com/advice/3/how-can-you-apply-green-design-manufacturing-reducegilpf?trk=public_post_main-feed-card_feed-article-content
4. https://www.classcentral.com/subject/manufacturing
5. https://www.shiksha.com/online-courses/transportation-sustainable-buildings-green-construction

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

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

Course code	Course Name (Theory course)	Category	L	T	P	C
ME19E15	ADDITIVE MANUFACTURING	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 learn the Liquid and Solid based AM processes.
- To study the Powder and Wax based processes.
- To understand the use of Bio Additive manufacturing and 4D printing.

UNIT-I Introduction 9

Need, Fundamentals of Additive and digital Manufacturing, Advantages and Applications, Comparison of Additive Manufacturing with traditional Manufacturing, Additive Manufacturing (AM) process chain: 3D model, converting into STL file, transfer to system, checking, machine setup and building, Post process. Classification of AM process. Materials used in Additive Manufacturing Processes, Need for AM in product development and rapid tooling.

UNIT-II Reverse Engineering And Design For Additive Manufacturing (Dfam) 9

Introduction to Reverse Engineering: Applications, Steps in reverse Engineering. Design for additive manufacturing: CAD model preparation, Part orientation and support generation and removal, Model slicing and software's– Tool path
Generation. File formats in AM. Data Processing and Controllers.

UNIT-III Liquid And Solid Based Additive Manufactring Processes 9

Guidelines for process selection, Liquid based AM process - Stereo lithography apparatus, Polyjet printing, Digital Light Processing - Principle, Process, Machine parameters, Process parameters, Materials used, Strength and weakness, Applications, Case studies. Solid Based AM process-Fused Deposition Modeling (FDM), Solid Ground Curing (SGC), Laminated Object Manufacturing (LOM)-Principle, Process, Machine parameters, Process parameters, Materials used, Strength and weakness, Applications, Case studies.

UNIT-IV Powder Based And Other Additive Manufactring Processes 9

Selective Laser Sintering (SLS), Selective Laser Melting (SLM) and Electron Beam Melting (EBM), Laser EngineeredNet Shaping (LENS): Principle, Process, Machine parameters, Process parameters, Materials used, Strength and weakness, Applications, Case studies. Wax printing– Principle, Process, materials used and applications.

UNIT-V Bio Additive Manufacturing And 4D Printing 9

Bio-Additive Manufacturing, Computer Aided Tissue Engineering (CATE) – Processing Steps and Case Studies.Customized Implants and Prosthesis, Materials used in bio printing and limitations. Design and Production of Medical devices. Sustainability in AM processes– Introduction to 4D printing and Smart materials used.

Total Contact Hours **45**

Course Outcomes: At the end of this course, students can have the

- Ability to demonstrate the development of AM technology and how AM technology propagated into various businesses and developing opportunities.
- Ability to apply the process of transforming a concept/existing product into 3D model used in AM technology.
- Ability to differentiate Liquid and Solid based AM processes.
- Ability to enumerate Powder and Wax based processes.
- Ability to evaluate the advantages, limitations, applications and use of Bio Additive manufacturing and 4D printing.

Text Books:	
1	Andreas Gebhardt and Jan-Steffen Hötter —Additive Manufacturing: 3D Printing for Prototyping Manufacturing‖, Hanser publications, United States, 2015.
2	Ian Gibson, David W. Rosen and Brent Stucker —Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing‖, 2nd edition, Springer., United States, 2015.
Reference Books(s)/Weblinks:	
1	Amit Bandyo padhyay and SusmitaBose, —Additive Manufacturing‖, 1st Edition, CRC Press., United States, 2015.
2	Andreas Gebhardt, —Understanding Additive Manufacturing: Rapid Prototyping, Rapid Manufacturing‖, Hanser Gardner Publication, Cincinnati., Ohio, 2011
3	Kamrani A.K. and Nasr E.A., —Rapid Prototyping: Theory and practice‖, Springer., United States, 2006.
4	Liou, L.W. and Liou, F.W., —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‖, Wood head Publishing., United Kingdom, 2016.

WEBLINKS:

1. https://archive.nptel.ac.in/courses/112/103/112103306/
2. https://www.nist.gov/el/applied-economics-office/manufacturing/topics-manufacturing/additive-manufacturing
3. https://www.coursera.org/learn/additive-manufacturing-3d-printing
4. https://www.udemy.com/course/learn-3d-printing-additive-manufacturing/
5. https://www.linkedin.com/company/additive-manufacturing3d/about/

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

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

Course code	Course Name (Theory course)	Category	L	T	P	C
ME19E16	WELDING TECHNOLOGY	PE	3	0	0	3

Objectives:	
●	To learn the principles, types, merits demerits and applications of gas and arc welding processes.
●	To study the principles, types, merits demerits and applications of resistance welding processes.
●	To understand the principles, types, merits demerits and applications of solid-state welding processes.
●	To understand different other welding processes for the automation in aerospace, nuclear and surface transport vehicles.
●	To investigate the weldability of various materials and testing of weldments.

UNIT-I	Gas And Arc Welding Processes	9
Fundamental principles–Oxy-acetylene welding, Types of Flames, Carbon arc welding, Shielded metal arc welding, Submerged arc welding, TIG &MIG welding, Plasma arc welding, CO_2 welding and Electro slag welding processes–Welding Defects -advantages, limitations and applications.		
UNIT-II	**Resistance Welding Processes**	**7**
Spot welding, Seam welding, Projection welding, Resistance Butt welding, Flash Butt welding, Percussion welding and High frequency resistance welding processes-advantages, limitations and applications.		
UNIT-III	**Solid State Welding Processes**	**9**
Cold welding, Diffusion bonding, Explosive welding, Ultrasonic welding, Friction welding, Forge welding, Roll welding and Hot pressure welding processes-advantages, limitations and applications.		
UNIT-IV	**Other Welding Processes**	**9**
Thermit welding, Atomic hydrogen welding, Electron beam welding, Laser Beam welding, Friction stir welding, Under Water welding, Welding automation in aerospace, nuclear and surface transport vehicles.		
UNIT-V	**Design Of Weld Joints, Weldability And Testing Of Weldments**	**11**
Various weld joint designs – Weldability of Aluminium, Copper, and Stainless steels. Destructive - (Tensile, Bend, Impact, Nick break, Hardness, Etch tests) and Non Destructive testing of weldments - (Leak, Stethoscope, X-ray and γ-ray radiography, Magnetic particle testing, Liquid (Dye) penetrate test, Fluorescent penetrate, Ultrasonic inspection and Eddy current testing). Welding safety, Virtual reality in welding.		
	Total Contact Hours	**45**

Course Outcomes: On successful completion of this course, the students will be able to	
●	Identify the appropriate type of gas and arc welding type for an application.
●	Select the appropriate type of resistance welding type for an application.
●	Select the appropriate type of solid-state welding type for an application
●	Explain about other advanced welding methods and its automation in industries.
●	Identify and select various non-destructive testing of weldments.

Text Books:	
1	Parmer R.S., ―Welding Engineering and Technology‖, 1st edition, Khanna Publishers, New Delhi,2008.
3	Little R.L., ―Welding and Welding Technology‖, Tata McGraw Hill Publishing Co. Ltd., New Delhi, 34th reprint, 2008.

Reference Books(s)/Web links:	
1	Schwartz M.M. ―Metals Joining Manual‖. McGraw Hill Books, 1979.
2	Tylecote R.F. ―The Solid Phase Welding of Metals‖. Edward Arnold Publishers Ltd. London, 1968.
3	AWS-Welding Hand Book. 8th Edition. Vol-2. ―Welding Process‖.
4	Nadkarni S.V. ―Modern Arc Welding Technology‖, 1st edition, Oxford IBH Publishers, 2005.
5.	Christopher Davis. ―Laser Welding-Practical Guide‖. Jaico Publishing House, 1994.
6.	Davis A.C., ―The Science and Practice of Welding‖, Cambridge University Press, Cambridge, 1993.
7.	P.N.Rao– ―Manufacturing Technology‖–Tata McGraw Hill Publishing Company, 2003.
8.	S.K.Garg–Welding Technology-University Science press.

WEBLINKS:

1. https://archive.nptel.ac.in/courses/112/103/112103263/
2. https://alison.com/course/advances-in-welding-and-joining-technologies
3. https://www.classcentral.com/subject/welding
4. https://iiwindia.com/

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

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

Course Code	Course Name(Theory course)	Categor	L	T	P	C
ME19E17	ELECTRONICS MANUFACTURING TECHNOLOGY	PE	3	0	0	3

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

UNIT-I	**Introduction To Electronics Manufacturing**	**9**
History, definition, wafer preparation by growing, machining and polishing, diffusion, microlithography, etching and cleaning, Printed circuit board–fabrication, types, single sided, double sided, multi-layer and flexible printed circuit board.		
UNIT-II	**Components And Packaging**	**7**
Introduction to packaging, types - Through hole technology(THT) and Surface mount technology (SMT), Through hole components – axial, radial, multi leaded, odd form Surface-mount components - active, passive. Interconnections - chip to lead interconnection, die bonding, wire bonding, TAB, flip chip, chip on board, multi chip module, direct chip array module, leaded, leadless, area array and embedded packaging, miniaturization and trends		
UNIT-III	**Surface Mount Technology**	**9**
SMT Process, SMT equipment and material handling systems, handling of components and assemblies –moisture sensitivity and ESD, safety and precautions needed, IPC and other standards, stencil printing process - solder paste material, storage and handling, stencils and squeegees, process parameters, quality control. Component placement –equipment type, flexibility, accuracy of placement, throughput, packaging of components for automated assembly, soldering - wave soldering, reflow process, process parameters, profile generation and control, adhesive, underfill and encapsulation process.		
UNIT-IV	**Inspection And Testing**	**9**
Inspection techniques, equipment and principle - AOI, X-ray. Defects and Corrective action-stencil printing process, component placement process, reflow soldering process, electrical testing of PCB assemblies –In circuit test, functional testing, fixtures and jigs.		
UNIT-V	**Repair, Rework, Quality And Reliability Of Electronics Assemblies**	**11**
Repair and rework of PCB – Coating removal, base board repair, conduct or repair, thermo-mechanical effects and thermal management, Reliability fundamentals, reliability testing, failure analysis, design for manufacturability, assembly, reworkability, testing, reliability, and environment.		
	Total Contact Hours	**45**

Course Outcomes: At the end of this course, the students should be able to:	
•	Perceive wafer preparation and PCB fabrication
•	Recognize the importance of Through Hole Technology (THT) and Surface Mount Technology (SMT)
•	Demonstrate various steps in Surface Mount Technology (SMT)
•	Identify various testing and inspection methods of populated PCBS
•	Discuss various techniques in repair, rework, quality and reliability of electronic Assemblies

Text Books:	
1	Prasad R.,—Surface Mount Technology –Principles and practice‖, 2ndEdition, Chapman and Hall., New York, 1997, ISBN0-41-12921-3.
2	Tummala.R.R., —Fundamentals of micro system packaging‖, Tata McGraw Hill Co. Ltd., NewDelhi, 2001, ISBN00-71-37169-9.

Reference Books(s)/Web links:	
1	Harper C.A., —Electronic Packaging and Interconnection Handbook‖ 2nd Edition, McGraw HillInc., New York, N.Y., 1997, ISBN0-07-026694-8.
2	Lee N.C., —Reflow Soldering Process and Trouble Shooting SMT, BGA, CSP and Flip Chip Technologies‖, Elsevier Science, United Kingdom, 2001.
3	Puligandla Viswanadham and Pratap Singh., —Failure Modes and Mechanisms in Electronic Packages‖, Chapman and Hall, New York, 1997, N.Y. ISBN 0-412-105591-8. Science and Technology, UnitedKingdom, 1997, ISBN0750698756.
4	Totta P., Puttlitz K. and Stalter K., —Area Array Interconnection Handbook‖, Kluwer Academic Publishers, Norwell, MA, UnitedStates, 2001, ISBN0-7923-7919-5.
5.	Zarrow P. and Kopp D., —Surface Mount Technology Terms and Concepts‖, Elsevier, 1997.

WEBLINKS:

1. https://www.edx.org/learn/manufacturing
2.https://onlinecourses.nptel.ac.in/noc22_me61/preview
3.https://www.deskera.com/blog/electronic-manufacturing-process/
4.https://link.springer.com/book/10.1007/978-94-011-3130-8

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

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

Course Code	Course Name(Theorycourse)	Category	L	T	P	C
ME19E18	DIGITAL TWIN AND INDUSTRY 4.0	PE	3	0	0	3

COURSEOBJECTIVES:
• To understand the basics concepts in digital twin
• To Introduce the concepts in digital twin in a discrete Industry
• To Introduce the concepts in digital twin in a process Industry
• To obtain the knowledge in Industry 4.0
• To know about the advantages in Industry 4.0

UNIT– I Introduction	9
Digital twin– definition, types of Industry and its key requirements, Importance, Application of Digital Twin in process, product, service industries, History of Digital Twin, DTT role in industry innovation, Technologies/tools enabling Digital Twin – Virtual CAD Models – controlParameters-Realtimesystems–controlParameters–HandshakingThroughInternet–cyber physical systems	
UNIT– II Digital Twin In a Discrete Industry	**9**
Basics of Discrete Industry, Trends in the discrete industry, control system requirements in a discrete industry, Digital Twin of a Product, Digital Thread in Discrete Industry, Data collection & analysis for product & production improvements, Automation simulation, Digital Enterprise	
UNIT–III Digital Twin In a Process Industry	**9**
Basics of Process Industry, Trends in the process industry, control system requirements in a process industry, Digital Twin of a plant, Digital Thread in process Industry, Data collection and analysis for process improvements, process safety, Automation simulation, Digital Enterprise	
UNIT– IV Industry 4.0	**9**
Industrial Revolutions, Industry 4.0 – Definition, principles, Application of Industry 4.0 in process & discrete industries, Benefits of Industry 4.0, challenges in Industry 4.0, Smartmanufacturing,InternetofThings4.0,IndustrialGateways,BasicsofCommunicationrequirements–cognitivesystems4.0	
UNIT– V Advantages Of Digital Twin	**9**
Improvement in product quality, production process, process Safety, identify bottlenecks and improve efficiency, achieve flexibility in production, continuous prediction and tuning of production process through Simulation, reducing the time to market.	
	Total Periods :45

COURSEOUTCOMES
Upon successful completion of the course, students should be able to:
• Analyzethebasicsconceptsindigitaltwin
• Developthe concepts in digital twin in a discrete Industry
• Illustrate the concepts in digital twin in a process Industry
• Articulate theknowledge inindustry 4.0
• Transfertheadvantagesin industry4.0with various applications

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

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

TEXTBOOKS:

1. Alp Ustundag and Emre Cevikcan, ―Industry 4.0: Managing The Digital Transformation‖,Springer SeriesinAdvancedManufacturing.,Switzerland,2018
2. AndrewYehChrisNee,FeiTao,andMengZhang,―DigitalTwinDrivenSmartManufacturing‖,Elsevier Science.,UnitedStates,2019

REFERENCES:

1. Alasdair Gilchrist,―Industry4.0:TheIndustrialInternetofThings‖,Apress.,UnitedStates ,2015.
2. Christoph JanBartodziej,―TheConceptIndustry4.0anEmpiricalAnalysisofTechnologies and Applications in Production Logistics‖, Springer Gambler., Germany,2017.
3. Ibrahim Garbie, ―Sustainability in Manufacturing Enterprises, Concepts, analyses and assessments for Industry 4.0‖,Springer.,Switzerland,2016.
4. RonaldR.YagerandJordanPascualEspada,―NewAdvancesintheInternetofThings‖,Springer.,Switzerland,2018
5. Ulrich Sendler, ―The Internet of Things, Industries 4.0 Unleashed‖, Springer., Germany,2018

WEBLINKS:

1. https://www2.deloitte.com/xe/en/insights/focus/industry-4-0/digital-twin-technology-smart-factory.html
2. https://www.toobler.com/blog/industry-4-0-and-digital-twin
3. https://gradhoc.com/Art%C3%ADculo/digital-twin-requirements-in-the-context-of-industry-4-0/
4. https://www.intechopen.com/books/12041
5. https://www.titanteal.com/unraveling-the-future-with-digital-twin-Industry-4-0-and-5-0
6. https://www.ibm.com/topics/industry-4-0

Course Code	Course Name(Theory course)	Category	L	T	P	C
ME19E19	NON-DESTRUCTIVE TESTING AND EVALUATION	PE	3	0	0	3

Objectives:	
●	To create the students for understanding the importance of NDT in quality assurance.
●	To imbibe the students about the basic principles of various NDT techniques, its applications, limitations, codes and standards.
●	To equip the students with proper competencies to locate a flaw in various materials and products.
●	To train the students to be ready to useNDT techniques for in-situ applications too.
●	To inculcate the knowledge of selection of the right NDT technique for a given application.

UNIT-I	**Introduction & Visual Inspection Methods**	**9**
NDT versus Mechanical testing, Need for NDT, Relative merits and limitations, various physical characteristics of materials and their applications in NDT. Visual Inspection-Unaided, Aided-Bore scopes-Video scopes, Special features in Bore scopes, bore scopes, Optical sensors, Microscopes & replication Microscopy Technique and applications, Holography-Case study.		
UNIT-II	**Liquid penetrant testing & Magnetic particle testing**	**9**
LPT - Principle, types, Procedures, Penetrants and their characteristics, Emulsifiers, Solvent Cleaners / Removers, Developers- properties and their forms, Equipment‘s, Advantages and limitations, Inspection and Interpretation, Applications and case study. MPT-Principle, Theory of Magnetism, Magnetising current, Magnetisation methods, Magnetic particles, Procedure, Interpretation, Relevant and Non-relevant indications, Residual magnetism, Demagnetisation–need, methods, Advantages and Limitations, Applications, Magnetic Rubber Inspection, Magnetic Printing, Magnetic Painting –Case study.		
UNIT-III	**Thermography & Eddy current testing**	**9**
Thermography–Introduction, Principle, Contact & Non-Contact inspection methods, Active & Passive methods, Liquid Crystal – Concept, example, advantages & limitations. Electromagnetic spectrum, infrared thermography- approaches, IR detectors, Instrumentation and methods and applications - Case study. Eddy current Testing – Principle, Properties of eddy currents, Eddy current sensing elements, Probes, Instrumentation, Types of arrangement, Advantages& Limitations, Interpretation of Results & applications- Case study.		
UNIT-IV	**Ultrasonic testing & Acoustic Emission Testing**	**9**
Ultrasonic Testing- Principle , Basic Equipment, Transducers, Couplants, Ultrasonic wave, Variables in UT, Transmission and Pulse-echo method, Straight beam and angle beam, A-Scan, B-Scan & C-Scan, Phased Array Ultrasound& Time of Flight Diffraction, Advantages & Limitations, Interpretation of Results& Applications - Case study. Acoustic Emission Technique –Introduction, Types of AE signal, AE wave propagation, Source location, Kaiser effect, AE transducers, Principle, AE parameters, AE instrumentation, Advantages & Limitations, Interpretation of Results, Applications-Case study.		
UNIT-V	**Radiography**	**9**
Introduction, Principle, X-ray Production, Gamma ray sources, Tubing materials, X-ray tubing characteristics, Interaction of X-ray with matter, Imaging, Film techniques, Filmless techniques, Types and uses of filters and screens, Real time radiography, Geometric factors, Inverse square law, Characteristics of film, graininess, density, speed, contrast, characteristic curves, Penetrometers, Exposure charts, Radiographic equivalence. Fluoroscopy-Xero-Radiography, Digital Radiography– Film Digitisation, Direct Radiography & Computed Radiography, Computed Tomography, Gamma ray Radiography, Safety in X-ray and Gamma Ray radiography-Case study.		
	TotalContact Hours	**45**

CourseOutcomes:Attheendofthiscourse,	
●	The students will be able to compare the differences between various visual inspection techniques and apply the same to the components to be inspected.
●	The students will be able to recognize the importance of Penetrant testing in NDT with the understanding of the procedures involved in the Penetration methods.
●	The students will be able to interpret the images and the results obtained from the Thermographic technique and the Eddy current testing.
●	The students will be able to evaluate and interpret the results obtained in the Ultrasonic inspection and Acoustic Emission technique.
●	The students will be able to explain the techniques involved in the Radiographic testing and the various advancements in Radiography.

TextBooks:	
1	ASM Metals Handbook, ―Non-Destructive Evaluation and QualityControl‖, American Society of Metals, Metals Park,Ohio, USA, 200, Volume-17.
2	PaulEMix,―IntroductiontoNon-destructive testing: a training guide‖, Wiley, 2 edition NewJersey, 2005.

ReferenceBooks(s)/Weblinks:	
1	BaldevRaj,T.Jayakumar,M.Thavasimuthu,―PracticalNon-Destructive Testing‖, Narosa Publishing House, 2009.
2	ASNT, American Society for Non Destructive Testing, Columbus, Ohio, NDT Handbook,Vol. 1, Leak Testing, Vol. 2, Liquid Penetrant Testing, Vol. 3, Infrared and Thermal Testing Vol. 4, Radiographic Testing, Vol. 5,ElectromagneticTesting, Vol.6, Acoustic Emission Testing,Vol. 7,Ultrasonic Testing.
3	Charles,J.Hellier,―HandbookofNon-destructiveevaluation‖,McGrawHill,NewYork,2001.
4	RaviPrakash,―Non-Destructive Testing Techniques‖, New Age International Publishers, 1st Revised edition, 2010.
5.	Hellier, Chuck,‖Handbook of Nondestructive Evaluation, 3E‖ New York, N.Y. : McGraw-Hill Education, Third edition.(2020)

WEBLINKS:

1. https://nptel.ac.in/courses/113106070/
2. https://www.udemy.com/course/understanding-nondestructive-testing-and-evaluation-ndtnde/
3. https://www.uti.edu/blog/education/what-is-non-destructive-testing
4. https://www.aerospacetestinginternational.com/features/introduction-to-non-destructive-testing.html
5. https://onlinecourses.nptel.ac.in/noc24_mm14/preview
6. https://www.twitraining.com/home/programmes-and-courses/non-destructive-testing

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

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

VERTICAL 6 : ENERGY SYSTEMS

Course code	Course Name (Theory course)	Categor	L	T	P	C
ME19F11	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 Solar instruments.
- 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, Vibrati Acceleration, Velocity, Level, Flow, Thermal and Nuclear Radiation. Solar instruments: Pyrheliomete Pyranometers – Pyrheliometers – Albedometers – pyrradiometer – Pyrgeometers – Net pyrradiomete Sun photometers.

UNIT-IV	**Measurement Of T Hermo-Physical Properties And Air Pollutants**	**9**

Measurement of Thermal Conductivity–Solids, Liquids and Gas, Viscosity, Gas Diffusion. Calorimet Bomb Calorimeter – Continuous flow Calorimeter. Measurement of Heat Transfer, Humidity, Heat f pH, Air pollution Sampling and Measurement–Particulate Sampling techniques –Measurement of Sulp Dioxide, Combustion products, Opacity and Odour.

UNIT-V	**Control Systems**	**9**

Introduction to Controller – Interfacing with I/O devices of system: Sensors, Display devices, Stepper Servomotors. 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 Contro

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

Course Outcomes: Upon completion of the course students should be able to:

- Analyse 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

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.
Reference Books(s) / Web links:	
1	Barney G.C., ―Intelligent instrumentation: microprocessor applications in measurement and Control‖, Prentice Hall,1988.
2	Bell C., ―Beginning Sensor Networks with Arduino and Raspberry Pi‖, Apress, 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‖,Tata McGrawHill,2007.

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

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

Course code	**Course Name (Theory Course)**	**Category**	**L**	**T**	**P**	**C**
ME19F12	**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.
- Analyzing 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 suppl Power Factor – Energy conservation in Transformers – Harmonics

UNIT III	**Energy Conservation In Major Thermal Utilities**	**9**
Stoichiometry - Combustion principles. Energy conservation in:Boilers - Steam Distributi 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 Integratio		
	Total Contact Hours :	45

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

- Quantify the energy demand and energy supply scenario of nation and appreciate the need for energy auditing for becoming environmentally benign
- Analyze 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

Text Books / Web links:

1.	Guide book for National Certification Examination for ―Energy Managers and Ener 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. NagabhushanRaju, Industrial Energy Conservation Techniques: (concepts, Applicatio and Case Studies), Atlantic Publishers & Dist, 2007.
3.	https://beeindia.gov.in/sites/default/files/2Ch8.pdf

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

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

Course code	Course Name (Theory course)	Category	L	T	P	C
ME19F13	RENEWABLE SOURCES OF ENERGY	PE	3	0	0	3

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

- 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 windfarms - Types of wind mills - Horizontal axis wind turbine - Vertical axis wind turbi components of wind mill – Wind turbine generators and its performance - Building Integrated W 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 conversi mechanical conversion - Biomass combustion and power generation- Biomass gasifier - Type gasifiers - Cogeneration - Carbonization - Pyrolysis - Biogas plants - Digesters - Biodiesel producti 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 - W energy - Ocean Thermal Energy - Open and Closed OTEC – Geothermal energy – Types of Geothe energy – Hydrogen energy technology - Fuel Cells – Types of fuel cell – Energy storage technolog Hybrid technology - Environmental impact assessment.

	Total Contact Hours	: 45

Course Outcomes: Upon completion of this course, the students will be able to	
•	Describe the current energy scenario in terms of conventional renewable energy and future plan.
•	Define 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 Twidell, 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(s) / Web links:	
1	K. Bansal, Non-Conventional Energy Resources, Vikas Publishing House, 2014.
2	dfrey Boyle, ―Renewable Energy, Power for a Sustainable Future‖, Oxford University Press, 20
3	B.H. Khan, ―Non-Conventional Energy Resources‖, McGraw Hill, 2009.
4	ohn A. Duffie and William A. Beckman (2006), Solar Engineering of Thermal Process, 3rd Editio ohn Wiley & Sons.
5	lbert M. Masters (2004), Renewable and Efficient Electric Power Systems, Wiley Interscience.
6	Frank Kreith and D.Yogi Goswami (2007), Handbook of Energy Efficiency and Renewable Energy CRC Press.

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

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

Course code	Course Name (Theory course)	Categor	L	T	P	C
ME19F14	HYBRID AND ELECTRIC VEHICLES	PE	3	0	0	3

Objectives:	
•	To introduce the concept of hybrid and electric drive trains
•	To elaborate on the types and utilization of hybrid and electric drive trains.
•	To expose different types of AC and DC drives for electric vehicles.
•	To learn and utilize different types of energy storage systems
•	To introduce concept of energy management strategies and drive sizing

UNIT-I	Introduction	9
Basics of vehicle performance, vehicle power source characterization, transmission characteristics, History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies.		
UNIT-II	**Hybrid Electric Drive Trains**	**9**
Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis. Electric Drive-trains: Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis.		
UNIT-III	**Control Of AC & DC Drives**	**9**
Introduction to electric components used in hybrid and electric vehicles, Configuration, and control - DC Motor drives, Induction Motor drives, Permanent Magnet Motor drive, and Switch Reluctance Motor drives, drive system efficiency.		
UNIT-IV	**Energy Storage**	**9**
Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Energy storage and its analysis - Battery based, Fuel Cell based, and Super Capacitor based, Hybridization of different energy storage devices.		
UNIT-V	**Drive Sizing And Energy Management Strategies**	**9**
Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selection of appropriate energy storage technology, Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles, classification, and comparison of energy management strategies, Implementation issues.		
	Total Contact Hours	**45**

Course Outcomes: Upon completion of the course students should be able to:	
•	Discuss, Characterize and configure hybrid drivetrains requirement for a vehicle
•	Design and apply appropriate hybrid and electric drive trains in a vehicle
•	Design and install suitable AC and DC drives for electric vehicles.
•	Discuss arrive at a suitable energy storage system for a hybrid / electric vehicle
•	Apply energy management strategies to ensure better economy and efficiency

Text Books:	
1	Iqbal Husain, Electric and Hybrid Vehicles: Design Fundamentals, Third Edition, 2021
2	James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, Second Editio 2012

Reference Books(s) / Web links:	
1	Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric a Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
2	Hybrid, Electric and Fuel-Cell Vehicles, International Edition by Jack Erjavec | 6 June 2012
3	Energy Management in Hybrid Electric Vehicles using Co-Simulation by Christian Paar | February 2011
4	Hybrid Electric Vehicle Design and Control: Intelligent Omni directional Hybrids (MECHANICAL ENGINEERING) by Yangsheng Xu , Jingyu Yan, et al. | 16 December 2013
5	https://archive.nptel.ac.in/courses/108/103/108103009/

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

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

Course code	Course Name (Theory course)	Category	L	T	P	C
ME19F15	INTRODUCTION TO POWER PLANT ENGINEERING	PE	3	0	0	3

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

- To understand the working of various components, operations and maintenance of Steam power plants
- To know the various open and closed cycles and working of diesel and gas turbine power plants
- To understand the working of various types of nuclear power plant and its safety issue
- To understand the construction and working of various types of renewable power plants
- To gain knowledge about energy, economic and environmental issues of power plants

UNIT-I	Introduction & Coal Based Thermal Power Plants	10

Power plants-Features - Components and layouts-Rankine cycle- Reheat and Regenerative cycles, Layout of modern coal power plant, Super Critical Boilers, FBC Boilers, Turbines, Condensers, Steam & Heat rate, Subsystems of thermal power plants – Fuel and ash handling, Draught system, Feed water treatment.

UNIT-II	Diesel, Gas Turbine And Combined Cycle Power Plants	9

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

UNIT-III	**Nuclear Power Plants**	**9**
Basics of Nuclear Engineering, Layout and subsystems of Nuclear Power Plants, Working of Nuclear Reactors : Boiling Water Reactor (BWR), Pressurized Water Reactor (PWR), Canada Deuterium-Uranium reactor (CANDU), Breeder, Gas Cooled and Liquid Metal Cooled Reactors. Safety measures for Nuclear Power plants.		
UNIT-IV	**Power From Renewable Energy**	**9**
Hydro Electric Power Plants – Classification, Typical Layout and associated components including Turbines. Principle, Construction and working of Wind, Tidal, Solar Photo Voltaic (SPV), Solar Thermal, Geo Thermal, Biogas and Fuel Cell power systems.		
UNIT-V	**Energy, Economic And Environmental Issues Of Power Plants**	**8**
Power tariff types, Load distribution parameters, load curve, Comparison of site selection criteria, relative merits & demerits, Capital & Operating Cost of different power plants. Pollution control technologies including Waste Disposal Options for Coal and Nuclear Power Plants.		
	Total Contact Hours	**45**

Course Outcomes: On successful completion of this course, students will be able to	
●	Describe the working of various components, operations and maintenance of Steam power plant
●	Analyse various open and closed cycles relating to diesel and gas turbine power plants & workin of this power plants.
●	Explain the working of various types of nuclear power plants and its safety issue.
●	Describe the construction and working of various types of renewable power plants.
●	Explain about energy, economic and environmental issues of power plants.
Text Book (s):	
1	P. K. Nag, (2017), Power Plant Engineering: Steam and Nuclear, Tata McGraw-Hill Publishing Company Ltd., Fourth Edition.
2	Paul Breeze, ―Power Generation Technologies‖, Elsevier Ltd., 2014
Reference Books(s) / Web links:	
1	El-Wakil. M.M., ―Power Plant Technology‖, Tata McGraw – Hill Publishing Company Ltd., 2010.
2	Black & Veatch, Springer, ―Power Plant Engineering‖, 1996.
3	Thomas C. Elliott, Kao Chen and Robert C. Swanekamp, ―Power Plant Engineering‖, Second Edition, Standard Handbook of McGraw – Hill, 1998
4	Godfrey Boyle, ―Renewable energy‖, Open University, Oxford University Press in association with the Open University, 2004
5	https://archive.nptel.ac.in/courses/112/107/112107291/

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	1	1	-	-	1	-	2	2	3	3
CO2	3	2	3	-	2	2	2	-	-	1	-	3	2	3	3
CO3	3	2	2	-	1	2	1	-	-	1	-	3	2	3	3
CO4	3	2	2	-	1	1	2	-	-	1	-	3	2	3	3
CO5	3	2	2	-	1	2	3	-	-	1	-	3	3	3	3

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

Course code	Course Name (Theory course)	Categor	L	T	P	C
ME19F16	REFRIGERATION AND AIR CONDITIONING	PE	3	0	0	3

Objectives: The main learning objective of this course is to prepare the students	
●	To introduce the underlying principles of operations in different Refrigeration & Air conditionin systems and components.
●	To provide knowledge on design aspects of Refrigeration & Air conditioning systems.
●	To study the Vapour absorption and air refrigeration systems.
●	To learn the psychrometric properties and processes.
●	To study the air conditioning systems and load estimation.

UNIT-I	Introduction	9
Introduction to Refrigeration - Unit of Refrigeration and C.O.P.– Ideal cycles- Refrigerants Desirable properties – Classification - Nomenclature - ODP & GWP..		
UNIT-II	**Vapour Compression Refrigeration System**	**9**
Vapor compression cycle: p-h and T-s diagrams - deviations from theoretical cycle – subcooling and super heating- effects of condenser and evaporator pressure on COP- multi pressure system - low temperature refrigeration - Cascade systems – problems. Equipments: Type of Compressors, Condensers, Expansion devices, Evaporators..		
UNIT-III	**Other Refrigeration Systems**	**9**
Working principles of Vapour absorption systems and adsorption cooling systems – Steam jet refrigeration- Ejector refrigeration systems- Thermoelectric refrigeration- Air refrigeration - MagneticVortex and Pulse tube refrigeration systems.		
UNIT-IV	**Psychrometric Properties And Processes**	**9**
Properties of moist Air-Gibbs Dalton law, Specific humidity, Dew point temperature, Degree of saturation, Relative humidity, Enthalpy, Humid specific heat, Wet bulb temperature Thermodynamic wet bulb temperature, Psychrometric chart; Psychrometric of air-conditioning processes, mixing of air streams.		
UNIT-V	**Air Conditioning Systems And Load Estimation**	**9**
Air conditioning loads: Outside and inside design conditions; Heat transfer through structure, Solar radiation, Electrical appliances, Infiltration and ventilation, internal heat load; Apparatus selection; fresh air load, human comfort & IAQ principles, effective temperature & chart, calculation of summer & winter air conditioning load; Classifications, Layout of plants; Air distribution system;Filters; Air Conditioning Systems with Controls: Temperature, Pressure and Humidity sensors,Actuators & Safety controls.		
	Total Contact Hours : 45	

Course Outcomes: On successful completion of this course, the students will be able to	
●	Explain the basic concepts of Refrigeration
●	Explain the Vapor compression Refrigeration systems and to solve problems
●	Discuss the various types of Refrigeration systems
●	Calculate the Psychrometric properties and its use in psychrometric processes
●	Explain the concepts of Air conditioning and to solve problems

Text Book (s):	
1	Arora, C.P., "Refrigeration and Air Conditioning", 4th edition, McGraw Hill, New Delhi, 2021
2	R.S. Khurmi, Textbook of Refrigeration And Air-Conditioning, Revised Edition, 10 Februa 2019

Reference Books(s) / Web links:	
1	ASHRAE Hand book, Fundamentals, 2010
2	JonesW.P., "Air conditioning engineering", 5th edition, Elsevier Butterworth-Heinemann, 2005
3	Roy J. Dossat, "Principles of Refrigeration", 4th edition, Pearson Education Asia, 2002
4	Stoecker,W.F. and Jones J.W., "Refrigeration and Air Conditioning", McGraw Hill, Ne Delhi,1986.
5	A Textbook of Refrigeration and Air-Conditioning by R.K. Rajput | 1 January 2013
6	https://archive.nptel.ac.in/courses/112/105/112105129/

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	-	-	2	-	1	-	-	1	1	1	3
CO2	2	1	1	1	-	-	2	-	1	-	-	1	1	1	3
CO3	2	1	1	1	-	-	2	-	1	-	-	1	1	1	3
CO4	2	1	1	1	-	-	2	-	1	-	-	1	1	1	3
CO5	2	1	1	1	-	-	2	-	1	-	-	1	1	1	3

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

Course code	Course Name (Theory course)	Category	L	T	P	C
ME19F17	ADVANCED ENERGY STORAGE TECHNOLOGIES	PE	3	0	0	3

Objectives:	
•	To understand the various types of energy storage technologies and its applications.
•	To study the various modeling techniques of energy storage systems using TRNSYS.
•	To learn working concepts and types of batteries.
•	To make the students to get understand the concepts of Hydrogen and Biogas storage.
•	To provide the insights on super capacitor, Fly wheel and compressed energy storage system.

UNIT-I	Introduction	9
Necessity of energy storage–types of energy storage–comparison of energy storage technologies–Applications.		
UNIT-II	**Thermal Storage System**	**9**
Thermal storage–Types–Modelling of thermal storage units–Simple water and rock bed storage system–pressurized water storage system–Modelling of phase change storage system –Simple units, packed bed storage units – Modelling using porous medium approach, Use of TRNSYS software.		
UNIT-III	**Electrical Energy Storage**	**9**
Fundamental concept of batteries–measuring of battery performance, charging and discharging of a battery, storage density, energy density, and safety issues. Types of batteries – Lead Acid, Nickel–Cadmium, Zinc Manganese di oxide and modern batteries for example(i)zinc-Air(ii)Nickel Hydride (iii)Lithium Battery.		
UNIT-IV	**Hydrogen And Biogas Storage**	**9**
Hydrogen storage options–compressed gas–liquid hydrogen–Metal Hydrides, chemical Storage, Cryofuel storage and handling - Biogas storage-comparisons. Safety and management of hydrogen and Biogas storage- Applications.		
UNIT-V	**Alternate Energy Storage Technologies**	**9**
Flywheel, Super capacitors, Principles & Methods–Applications, Compressed air Energy storage, Concept of Hybrid Storage – Applications.		
	Total Contact Hours	**45**

Course Outcomes: Upon completion of the course students should be able to:	
•	Identify the energy storage technologies for suitable applications
•	Analyze the energy storage systems using TRNSYS.
•	Summarise the concepts and types of batteries.
•	Examine the principle of operation of Hydrogen and Biogas storage systems.
•	Explain the working of super capacitor, Flywheel and compressed energy storage systems

Text Books:	
1	Ibrahim Dincer and Mark A. Rosen, Thermal Energy Storage Systems and Applications, John Wiley & Sons 2010
2	Robert Huggins, Energy Storage: Fundamentals, Materials and Applications,2nd edition, Springer,2015.

Reference Books(s) / Web links:	
1	Viswanathan, Fuel cell principle and applications university press, 2006.
2	Luisa F.Cabeza, Advances in Thermal Energy Storage Systems: Methods and Applications, Elsevier Wood head Publishing, 2015.
3	Ru-shiliu, Leizhang, Xueliang sun, Electrochemical technologies for energy storage and conversion, Wiley publications,2012
4	National Energy Technology Laboratory, U.S. Department of Energy, Fuel Cell Handbook (Seventh Edition).
5	https://energystorage.org/why-energy-storage/technologies/
6	https://invenergy.com/what-we-do/advanced-energy-storage
7	Sutton, G.P, Rocket Propulsion elements, John Wiley & Sons Inc., New York, Ninth Edition, 2017.

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

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

Course code	Course Name (Theory course)	Category	L	T	P	C
ME19F18	ENERGY SYSTEMS MODELING AND ANALYSIS	PE	3	0	0	3

Objectives:	
•	To learn to apply mass and energy balances for the energy systems
•	To impart knowledge about the modeling and simulation techniques for energy systems.
•	To provide insight into optimization techniques to optimize the energy system.
•	To learn to use the energy-economy models.
•	To explore the various application and case studies.

UNIT-I	Introduction	9
Primary energy analysis - dead states and energy components - energy balance for closed and control volume systems - applications of energy analysis for selected energy system design - modelling overview - levels and steps in model development - examples of models – curve fitting and regression analysis		
UNIT-II	**Modelling And Systems Simulation**	**9**
Modelling of energy systems – heat exchanger - solar collectors – distillation - rectification turbo machinery components - refrigeration systems - information flow diagram - solution of set of non-linear algebraic equations - successive substitution - Newton Raphson method- examples of energy systems simulation.		
UNIT-III	**Optimisation Techniques**	**9**
Objectives - constraints, problem formulation - unconstrained problems - necessary and sufficiency conditions. Constrained optimization - Lagrange multipliers, constrained variations, Linear Programming - Simplex tableau, pivoting, sensitivity analysis		
UNIT-IV	**Energy- Economy Models**	**9**
Multiplier Analysis - Energy and Environmental Input / Output Analysis - Energy Aggregation – Econometric Energy Demand Modelling - Overview of Econometric Methods - Dynamic programming - Search Techniques - Univariate / Multivariate		
UNIT-V	**Applications And Case Studies**	**9**
Case studies of optimization in Energy systems problems- Dealing with uncertainty probabilistic techniques – Trade-offs between capital and energy using Pinch analysis		
	Total Contact Hours	**45**

Course Outcomes: Upon completion of the course students should be able to:	
•	Apply mass and energy balances for the energy systems
•	Propose simulation and modeling of typical energy system.
•	Identify optimization techniques for energy systems.
•	Appraise Energy-Economic Analysis for the typical applications.
•	Examine the application of optimization for energy systems and its economics.

Text Books:	
1	Stoecker, W.F., Design of Thermal Systems, McGraw Hill, 2011.
2	Bejan, A, Tsatsaronis, G and Moran, M., Thermal Design and Optimization, John Wiley & Sons 1996.

Reference Books(s) / Web links:	
1	Rao, S.S., Engineering Optimization - Theory and Applications, Wiley Eastern, 2000.
2	Meier, P., Energy Systems Analysis for Developing Countries, Springer Verlag, 1984.
3	Beveridge and Schechter, Optimization Theory and Practice, McGraw Hill, 1970.
4	Yogesh Jaluria., Design and Optimization of Thermal Systems, McGrawHill, 2007.
5	Balaji C., Essential of thermal system design and optimization, CRC press, 2011.
6	https://archive.nptel.ac.in/courses/112/106/112106064/

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

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

Course code	Course Name (Theory course)	Category	L	T	P	C
ME19F19	ENERGY ENGINEERING AND MANAGEMENT	PE	3	0	0	3

Objectives:	
•	To create awareness on the energy scenario of India with respect to world
•	To learn the methodology adopted for an energy audit
•	To appreciate the concepts adopted in project management
•	To study the different techniques adopted for financial appraisal of a project
•	To learn the present status of energy policies in the country.

UNIT-I	Energy Scenario	9
Comparison of energy scenario – India and World (energy sources, generation mix, consumption pattern, T&D losses, energy demand, per capita energy consumption) – energy pricing – energy security - energy conservation and its importance - Energy Conservation Act.		
UNIT-II	**Energy Management**	**9**
Energy audit - need – types – methodology – barriers - analysis on energy costing and sharing - bench marking - fuel and energy substitution – billing parameters in TANGEDCO – demand side management - instruments for energy audit – energy monitoring and targeting – CUSUM - energy labelling		
UNIT-III	**Project Management**	**9**
Four Basic Elements of Project Management - Project Management Life Cycle - Steps in Project Management - Project Definition and Scope, Technical Design, Financing, Contracting, Implementation Techniques (Gantt Chart, CPM and PERT) and Performance Monitoring		
UNIT-IV	**Financial Management**	**9**
Investment appraisal for energy conservation projects - Financial analysis techniques -Simple payback period, Return on investment, Net present value, Internal rate of return - Cash flows - Risk and sensitivity analysis: micro and macro factors - Financing options - energy performance contracts - ESCOs.		
UNIT-V	**Energy Policy**	**9**
National & State Level Energy Issues - National & State Energy Policy - Energy Security - National solar mission - state solar energy policy - Framework of Central Electricity Authority (CEA), Central & States Electricity Regulatory Commissions (CERC & ERCs)-Costing Total		
	Total Contact Hours	**45**

Course Outcomes: Upon completion of the course students should be able to:	
•	Explain the importance of energy conservation and suggest measures for improving per capita energy consumption
•	Analyse the energy sharing and cost sharing pattern of fuels used in industries
•	Apply Gantt Chart, CPM and PERT in energy conservation projects
•	Evaluate the techno-economics of a project adopting discounting and non-discounting cash flow techniques
•	Interpret the national and state energy policies.

Text Books:	
1	Energy Manager Training Manual (4Volumes) available at http://www.em-ea.org/gbook1.asp, a website administered by Bureau of Energy Efficiency (BEE), a statutory body under Ministry of Power, Government of India.2004.
2	L.C. Witte, P.S. Schmidt, D.R. Brown, ―Industrial Energy Management and Utilisation‖ Hemisphere Publ, Washington, 1988.

Reference Books(s) / Web links:	
1	W.R. Murphy and G. McKay ―Energy Management‖ Butterworths, London 1987
2	W.C. turner, ―Energy Management Hand book‖ Wiley, New York, 1982
3	Dhandapani Alagiri, Energy Security in India Current Scenario, The ICFAI University Press, 2006.
4	Eastop.T.D & Croft D.R, Energy Efficiency for Engineers and Technologists, Logman Scientific Technical, ISBN-0-582-03184, 1990.
5	https://archive.nptel.ac.in/courses/108/106/108106022/

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

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

VERTICAL 7 : DIVERSIFIED COURSES

Course code	Course Name (Theory course)	Category	L	T	P	C
ME19G11	PRECISION MANUFACTURING	PE	3	0	0	3

Objectives:

- To study the need, significance and progress of precision manufacturing and the different levels of manufacturing.
- To study the principle and working of precision machine elements
- To study the errors involved in precision machine tools and calculate the error budgets for a given situation.
- To study the Selecting a suitable measurement solution to measure and characterize precision machined features.
- To study the applications of precision manufacturing

UNIT-I Fundamentals of Precision Manufacturing **9**

Introduction - Need of precision, accuracy and surface finish - Development of overall machining precision - Classes of achievable machining – Accuracy - Precision machining - High precision machining, Ultra precision machining, Applications of precision machining - Materials for tools and machine elements - Tool and work material compatibility - Role of CAD/CAM in precision manufacturing - Aspects of sustainable manufacturing and design for sustainability.

UNIT-II Precision Machine Elements **9**

Introduction - Guide ways - Drive systems - Spindle drive - Rolling elements - Hydrodynamic and hydrostatic bearings - Hybrid fluid bearings - Aero static and aero dynamic bearings - Hybrid gas bearings - Materials for bearings.

UNIT-III Error Control **9**

Error – Sources – Static stiffness – Variation of the cutting force – total compliance – Different machining methods – Thermal effects – heat source – heat dissipation – Stabilization – decreasing thermal effects – forced vibration on accuracy – clamping & setting errors – Control – errors due to locations – principle of constant location surfaces.

UNIT-IV Measurement and Characterisation **9**

Optical dimensional metrology of precision features – Machine vision, Multi-sensor coordinate metrology, Laser Tracking Systems, Laser scanners, White-Light Interference 3D Microscopes, Focus-Based Optical Metrology- Fringe projection method, Measurement of Typical Nanofeatures. Surface metrology – 3D surface topography – Need, Measurement – Chromatic confocal Microscopy, Interferometry, Non-optical Scanning Microscopy – Scanning electron Microscopes, Scanning probe microscopes, Parameters for characterizing 3D surface topography.

UNIT-V Applications of Precision Manufacturing **9**

Micro machining processes, diamond machining - micro engraving - Micro replication techniques, forming-casting-injection moulding - micro embossing - Energy assisted processes - LBM, EBM, FIB, Micro electro discharge machining, photolithography-LIGA process- Silicon micro machining- Wet and dry etching, thin film deposition.

Total Contact Hours : 45

Course Outcomes: At the end of this course students will be able to:

- Outline precision machining.
- Identify the importance of precision machine elements.
- Recognize the importance of error control. .
- Apply various measurement and characterization techniques.
- Illustrate various precision manufacturing applications

Text Books:	
1	Venkatesh V.C. and Izman S., —Precision Engineering‖, Tata McGraw Hill, 2007.
2	Murthy R.L., —Precision Engineering‖, New Age International, 2009
Reference Books(s) / Web links:	
1	Nakazawa H., —Principles of Precision Engineering‖, Oxford University Press, 1994.
2	4. Madou M.F. —Fundamentals of Micro fabrication‖, CRC Press, 2002, 2nd Edition
3	5. McGeough J.A., —Micromachining of Engineering Materials‖, CRC Press, 2001

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

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

Course code	Course Name (Theory course)	Category	L	T	P	C
ME19G12	INDUSTRIAL SAFETY	PE	3	0	0	3

Objectives:

- To study the fundamental concept and principles of industrial safety
- To study the principles of maintenance engineering
- To analyzing the wear and its reduction.
- To study the faults in various tools, equipments and machines.
- To study the periodic maintenance procedures in preventive maintenance

UNIT-I Industrial Safety **9**

Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods.

UNIT-II Safety In Finishing, Inspection And Testing **9**

Heat treatment operations, electro plating, paint shops, sand and shot blasting, safety in inspection and testing, dynamic balancing, hydro testing, valves, boiler drums and headers, pressure vessels, air leak test, steam testing, safety in radiography, personal monitoring devices, radiation hazards, engineering and administrative controls, Indian Boilers Regulation..

UNIT-III Risk Analysis Quantification And Softwares **9**

Fault Tree Analysis, Event Tree and Bowtie 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)- Layer of Protection Analysis (LOPA)-Safety Integrity Level (SIL)-Basic concepts of Reliability- Software on Risk analysis, CISCON, FETI, ALOHA.

UNIT-IV 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, i. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.

UNIT-V	Periodic And Preventive Maintenance	9

Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of:i. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, Advantages of preventive maintenance. Repair cycle concept and importance.

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

Course Outcomes: At the end of this course students will be able to:

- Explain the fundamental concept and principles of industrial safety
- Apply the principles of maintenance engineering.
- Analyze the wear and its reduction.
- Evaluate faults in various tools, equipments and machines
- Apply periodic maintenance procedures in preventive maintenance

Text Books:

1. L M Deshmukh, Industrial Safety Management, Tata McGraw-Hill Education, 2005.
2. Charles D. Reese, Occupational Health and Safety Management: A Practical Approach, CRC Press, 2003.
3. ―Safety in Industry‖ N.V. Krishnan JaicoPublishery House, 1996

Reference Books(s) / Web links:

1. Edward Ghali, V. S. Sastri, M. Elboujdaini, Corrosion Prevention and Protection: Practical Solutions, John Wiley& Sons, 2007.
2. Garg, HP, Maintenance Engineering, S. Chand Publishing.
3. J Maiti, Pradip Kumar Ray, Industrial Safety Management: 21st Century Perspectives of Asia, Springer, 2017.
4. R. Keith Mobley, Maintenance Fundamentals, Elsevier, 2011.
5. W. E. Vesely, F. F. Goldberg, Fault Tree Handbook, Create space Independent Pub, 2014
6. Brown, D.B. System analysis and Design for safety, Prentice Hall, 1976

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

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

Course code	Course Name (Theory course)	Categor	L	T	P	C
ME19G13	COMPOSITE MATERIALS AND MECHANICS	PE	3	0	0	3

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

- To understand the fundamentals of composite materials and its properties
- To have the fundamental knowledge of the Polymer matrix composites and its manufacturing methods
- To have the fundamental knowledge of the Metal matrix composites and its manufacturing method
- To have knowledge about the Ceramic matrix composites and its manufacturing processes
- To possess knowledge on laminate constitutive equation and its application to various types of laminates.

UNIT-I	**Introduction To Composite Materials**	**7**
Definition-Matrix materials-polymers-metals-ceramics - Reinforcements: Particles, whiskers, inorganic fibers, metal filaments- ceramic fibers- fiber fabrication- natural composite - Advantages and drawbacks of composites over monolithic materials. Mechanical properties and applications of composites, Particulate-Reinforced composite Materials, Dispersion-Strengthened composite, Fiber-reinforced composites. Rule of mixtures, Testing of composite.		
UNIT-II	**Polymer Matrix Composites**	**9**
Polymer resins – Thermosetting resins, thermoplastic resins – Reinforcement fibres – Rovings – woven fabrics – Non woven random mats – Various types of fibres – PMC processes – Hand layup processes – Spray up processes – Compression moulding – Reinforced reaction injection moulding – Resin transfer moulding – Pultrusion – Filament winding – Injection moulding – Fibre reinforced plastics (FRP), glass fibre reinforced plastics (GRP). Laminates – Balanced Laminates, Symmetric Laminates, Angle Ply Laminates, Cross Ply Laminates – Applications of PMC in aerospace, automotive industries.		
UNIT-III	**Metal Matrix Composites**	**9**
Characteristics of MMC, advantages of MMC, limitations of MMC, rule of mixtures – Processing of MMC – Powder metallurgy process – Diffusion bonding – Stir casting – Squeeze casting. In-situ reactions – Interface – measurement of interface properties – Applications of MMC in aerospace, automotive industries.		
UNIT-IV	**Ceramic Matrix Composite & Special Composites**	**9**
Need for CMC –Toughening Mechanism – Processing- Sintering - Hot pressing – Cold Isostatic Pressing (CIPing) – Hot Isostatic Pressing (HIPing) – Applications of CMC in aerospace, automotive industries – Carbon / carbon composites – Advantages of carbon matrix – Limitations of carbon matrix carbon fiber – Chemical vapour deposition of carbon-on-carbon fiber perform – Sol-gel technique.		
UNIT-V	**Introduction, Lamina Constitutive Equations**	**11**
Lamina Constitutive Equations: Lamina Assumptions – Macroscopic Viewpoint. Generalized Hooke's Law. Reduction to Homogeneous Orthotropic Lamina – Isotropic limit case, Orthotropic Stiffness matrix (Qij), Definition of stress and Moment Resultants. Strain Displacement relations. Basic Assumptions of Laminated anisotropic plates. Laminate Constitutive Equations – Coupling Interactions, Balanced Laminates, Symmetric Laminates, Angle Ply Laminates, Cross Ply Laminates, Quasi-Isotropic Laminates. Determination of Lamina stresses within Laminates.		
	Total Contact Hour	**45**

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

- Understand the fundamentals of composite materials.
- Know the types and various manufacturing methods of PMC.
- Know the types and various manufacturing methods of PMC
- Know the types and various manufacturing methods of CMC.
- Calculate the composite lamina properties using fundamentals of composite mechanics.

Text Book:	
1	Krishnan K Chawla, Composite Materials Science and Engineering,2013, Springer Publication.
2	M. Balasubramanian, Composite Material and Processing, 2017, CRC Press.

Reference Books(s) / Web links:	
1	Ronald Gibson, Principles of Composite materials and Mechanics, McGraw Hill Publication.
2	Madhujit Mukhopadhyay, ―Mechanics of Composite Materials and Structures‖, University Press, (India) Pvt. Ltd., Hyderabad, 2004 (Reprinted 2008).
3	P.K. Mallick, Fiber reinforced Composites Materials, Manufacturing, and Design, CRC Press, 2007
4.	https://nptel.ac.in/courses/112104168/.
5.	https://nptel.ac.in/courses/112104249/

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

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

Course code	Course Name (Theory course)	Category	L	T	P	C
ME19G14	MATERIAL CHARACTERISATION TECHNIQUES	PE	3	0	0	3

Objectives:
• To provide understanding of techniques of microstructure and crystal structure evaluation of materials.
• To introduce tools for analysis of microstructure and surface topography of materials.
• To understand the techniques of chemical and thermal analysis of materials.
• To gain knowledge in spectroscopy analysis of materials.
• To gain knowledge in analysis of advanced materials.

UNIT-I	**(Micro/Nano) Structural 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	**Chemical And Thermal 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–Differential Scanning Calorimetry (DSC) and Thermo Gravity Metric Analysis (TGA)		
UNIT-V	**Advanced Materials Characterization**	9
Significance, properties and applications of nanomaterials–Optical–electrical–electronic–mechanical–magnetic and thermal properties of advanced materials.		
		Total Contact Hours:45

Course Outcomes: Upon successful completion of the course, the student will be able to
• Characterize the engineering materials.
• Use the fundamental principle of Top-notch characterization tools.
• Choose appropriate Spectroscopy testing methods.
• Identify the crystal structure and analysis can be made
• Characterize the advanced materials.

Text Book(s):
1. Angelo P C, Material Characterization, Cengage Learning India, 2016.
2. Yang Leng, Materials Characterization: Introduction To Microscopic And Spectroscopic Methods, Hong Kong University Of Science And Technology, John Wiley And Sons (Asia) Pte Ltd., 2 Nd Edition, 2013

Reference Books(s) / Web links:
1. Cullity B.D., Stock S.R And Stock S., Elements Of X Ray Diffraction, 3rdedition. Prentice Hall,2018.
2. Skoog, Holler And Nieman, Principles Of Instrumental Analysis, 7thedition, Cengage Learning,2017.
3. Larkin, Peter. Infrared And Raman Spectroscopy: Principles And Spectral Interpretation. Elsevier, 2017.

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

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

Course code	Course Name (Theory course)	Category	L	T	P	C
ME19G15	PRINCIPLES OF MANAGEMENT	PE	3	0	0	3

Objectives:
• To understand the evolution and basic concepts of management and its theories.
• To understand how the managerial tasks of planning can be executed.
• To understand how the managerial tasks of organizing can be executed.
• To understand how the managerial tasks of directing can be executed.
• To understand how the managerial tasks of controlling can be executed.

UNIT-I	Introduction To Management And Organizations	9
Definition of management -science or art - Manager Vs Entrepreneur- types of managers - managerial roles and skills - Evolution of management -Scientific, human relations, system and contingency approaches- Types of business organization- Sole proprietorship, partnership, company-public and private sector enterprises- Organization culture and environment – Current trends and issues in management.		
UNIT-II	**Planning**	9
Nature and purpose of planning - Planning process - Types of planning - Objectives – Setting objectives - Policies - Planning premises - Strategic Management - Planning Tools and Techniques - Decision making steps and process.		
UNIT-III	**Organising**	9
Nature and purpose - Formal and informal organization - Organization chart – Organization structure - Types - Line and staff authority - Departmentalization - delegation of authority -Centralization and decentralization - Job design - Human resource management – HR planning, recruitment, selection,		

training and development, performance Management, career planning and management.		
UNIT-IV	**Directing**	9
Foundations of individual and group behavior - Motivation - Motivation theories – Motivational techniques – Job satisfaction - Job enrichment - Leadership - types and theories of leadership- Communication - Process of communication - Barriers in communication – Effective communication - Communication and IT.		
UNIT-V	**Controlling & International Management**	9
System and process of controlling - Budgetary and non - Budgetary control techniques - Use of computers and IT in management control - Productivity problems and management – Control and performance - Direct and preventive control – Reporting. International management - stages of internationalism - the multinational company - reasons - modes of foreign investment - problems faced by international managers - management functions in international operations.		
Total Contact Hours:45		

Course Outcomes: Upon successful completion of the course, the student will be able to
• understand the basic concepts of management and its theories.
• understand the management concept of planning.
• understand the management concept of organizing.
• understand the management concept of directing.
• understand the management concept of controlling and international management.

Text Book(s):
1. Harold Koontz and Heinz Weihrich —Essentials of Management‖, Tata McGraw Hill, 1998.
2. Stephen P. Robbins and Mary Coulter, — Management‖, Prentice Hall (India)Pvt. Ltd.,10th Edition, 2009.

Reference Books(s) / Web links:
1. Robert Kreitner and Mamata Mohapatra, —Management‖, Biztantra, 2008.
2. Stephen A. Robbins, David A. Decenzo and Mary Coulter, —Fundamentals of Management‖, Pearson Education,7th Edition, 2011.
3. Tripathy PC and Reddy PN, —Principles of Management‖, Tata Mcgraw Hill, 1999.

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

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

Course code	Course Name (Theory course)	Categor	L	T	P	C
ME19G16	ENTREPRENEURSHIP DEVELOPMENT	PE	3	0	0	3

Objectives:

- To understand the types and characteristics of entrepreneurship and its role in economic development.
- To understand the theories of motivation and the principles of entrepreneurship development programs.
- To select the appropriate form of business ownership in setting up an enterprise.
- To mobilize and manage initial and working capital for the enterprise.
- To identify sickness in industry, select the appropriate corrective measures and identify the growth strategies forthe enterprise.

UNIT-I	**Entrepreneur And Entrepreneurship**	9

Entrepreneurship – definition and characteristics - characteristics of entrepreneur - classification entrepreneurs – Danhofi‘s classification - other classifications - Functions of entrepreneurs – role entrepreneurship in economic development and job creation - Emergence of entrepreneurial class India – Entrepreneurship in ancient period - Entrepreneurship in pre-Independence era Entrepreneurship in post-Independence period.

UNIT-II	**Entrepreneurial Motivation**	9

Theories of entrepreneurship – sociological theories, economic theories, cultural theories a psychological theories - Entrepreneurial motivation: Theories of motivation - Entrepreneur competencies – Entrepreneurship development Programs – need, objectives - Time managemen Stress management.

UNIT-III	**Business**	9

Small Enterprises – Definition, characteristics, project identification and selection – Feasibility a profitability analysis – Formulation of project report– significance and content - Types of busine ownership structures– suitability -Expansion, diversification, forward and backward integration.

UNIT-IV	**Financing And Profitability**	9

Financing: Need, capital structure– Sources of finance – internal and external sources of financ break even analysis – Capital budgeting - simple problems – Introduction to balance sheet and pro and loss statement – Importance of profitability – sustainability - Working capital manageme significance, assessment, factors, sources, management.

UNIT-V	**Support To Entrepreneurs And Case Studies**	9

Sickness in small business: concept, signals, symptoms, magnitude, causes and consequenc corrective measures – Government policy for small scale enterprises – Growth strategies in sm scale enterprise – Institutional support to entrepreneurs: need and support – Taxation benefits to sm scale industry. Case studies in entrepreneurship.

Total Contact Hours:45

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

- Analyse the types, characteristics of entrepreneurship and its role in economic development.
- Apply the theories of motivation and the entrepreneurial competencies.
- Select the appropriate form of business ownership in setting up an enterprise.
- Mobilise and manage initial and working capital for the enterprise.
- Identify sickness in industry, select the appropriate corrective measures and identify t growth strategies inenterprise.

Text Book(s):
1.Kurahko & Hodgetts, ―Entrepreneurship – Theory, Process and Practices‖, 6th edition, Thomson learning, 2009.
2.S.S. Khanka, ―Entrepreneurial Development‖, S.Chand & Co. Ltd., New Delhi, 1999.

Reference Books(s) / Web links:
1. Sangram Kesari Mohanti, ―Fundamentals of Entrepreneurship‖, PHI Learning Private Ltd., Delhi, 2006.
2. Charantimath, P. M., ―Entrepreneurship Development and Small Business Enterprises‖, Pearson, 2006.
3. Hisrich R D and Peters M P, ―Entrepreneurship‖, 5th Edition, Tata McGraw-Hill, 2002.
4. Rabindra N. Kanungo, ―Entrepreneurship and Innovation‖, Sage Publications, New Delhi, 1998.
5. Singh, A. K., ―Entrepreneurship Development and Management‖, University Science Press, 2009.

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

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

Course code	Course Name (Theory course)	Categor	L	T	P	C
ME19G17	MARKETING MANAGEMENT	PE	3	0	0	3

Objectives:
• To understand the basics of marketing process.
• To analyze, design and implement market segmentation.
• To understand the needs and application of marketing research.
• To understand marketing planning and strategy formulation.
• To know about sales promotion, advertising and distribution.

UNIT-I	Marketing Process	9
Definition, Marketing process, dynamics, needs, wants and demands, marketing concepts, environment, mix, types.Philosophies, selling versus marketing, organizations, industrial versus consumer marketing, consumer goods, industrial goods, product hierarchy, Services Marketing.		
UNIT-II	**Buying Behavior And Market Segmentation**	9
Customer Relationship Marketing – Customer database, Data warehousing and mining. Attracting a retaining customers, Consumerism in India, Market segmentation and targeting, Positioning a differentiation strategies, Product life cycle strategies, New product development, Product Mix a Product line decisions, Branding and packaging, segmentation factors - demographic - psycho graph		

and geographic segmentation, process, patterns. Product and brandmanagement.		
UNIT-III	**Product Pricing And Marketing Research**	9
Price setting - objectives, factors and methods, Price adapting policies, Initiating and responding price changes.Introduction, uses and process of marketing research.		
UNIT-IV	**Marketing Planning And Strategy Formulation**	9
The 4 Ps of marketing, Components of marketing plan-strategy formulations and the marketi process,implementations, portfolio analysis, BCG, GEC grids.		
UNIT-V	**Sales Promotion And Distribution**	9
Characteristics, impact, goals, types of sales promotions - point of purchase - unique sell proposition. Identifying and analysing competitors, Designing competitive strategies for leade challengers, followers and nichers. Advertising, types, and case studies. Distribution - Characteristi impact, goals, types and sales promotions - point of purchase - unique selling propositio Characteristics, wholesaling, retailing, channel design, logistics, and modern trends in retailing.		
Total Contact Hours:45		

Course Outcomes: Upon successful completion of the course, the student will be able to
• understand the basics of marketing process.
• analyze, design and implement market segmentation
• understand the needs and application of marketing research.
• understand marketing, planning and strategy formulation.
• implement sales promotion, advertising and distribution.

Text Book(s):
1.Philip Kolter & Keller, ―Marketing Management‖, 14th edition, Prentice Hall of India, 2012.
2.Rajan Saxena, ―Marketing Management‖ - Tata McGraw Hill, 2002.

Reference Books(s) / Web links:
1. Adrain Palmer, ―Introduction to marketing theory and practice‖, Oxford University Press IE, 2004.
2. Chandrasekar. K.S., ―Marketing Management Text and Cases‖, 1st Edition, Tata McGraw Hill – Vijaynicole, 2010.
3. Ramasamy & Namakumari, ―Marketing Management‖, Macmilan India, 2002.
4. Ramphal and Gupta, ―Case and Simulations in Marketing‖, Golgatia, Delhi.

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

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

Course code	Course Name (Theory course)	Categor	L	T	P	C
ME19G18	RESEARCH METHODOLOGY AND INTELLECTUAL PROPERTY RIGHTS	PE	3	0	0	3

Objectives:
• To inculcate the importance of research methodology.
• To understand how to undergo the literature review and write a technical paper.
• To inculcate the importance of Intellectual Property Rights and aware of the rights for the protection of theinvention.
• To understand the patent rights and recent developments in IPR.
• To understand the industrial design and geographical indication procedures to get patents, copy right, trademarksand designs.

UNIT-I	Fundamentals Of Research	9
Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations, analysis of qualitative andmixed-methods research.		
UNIT-II	**Review Of Literature And Technical Writing**	9
Effective literature studies approach, analysis Plagiarism, Research ethics, Effective technical writing, how to writereport, Paper Developing a Research Proposal.		
UNIT-III	**Intellectual Property Rights**	9
Nature of Intellectual Property: Patents, Designs, Trade and Copyright, copyright registration in India Process of Patenting and Development: technological research, innovation, patenting and development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under Patent Cooperation Treaty.		
UNIT-IV	**Patent Rights And Recent Developments In IPR**	9
Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases.Geographical Indications. New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies.		
UNIT-V	**Industrial Designs And Geographical Indications**	9
Industrial designs and IC Layout design, Registrations of designs, conditions and procedures of industrial designs Cancellation of Registration, International convention of design- types and functions. Semiconductor Integrated circuits and layout design Act- Geographical indications- potential benefits of Geographical Indications.		
Total Contact Hours:45		

Course Outcomes: Upon successful completion of the course, the student will be able to
• Apply knowledge on research problem formulation and analyze research related information
• write the literature review and technical paper.
• apply IPR concept to important place in growth of individuals & nation.
• Apply patent right to new products developed.
• describe the procedure and the tools to get patent copy right for their innovative work.

Text Book(s):
1. Neeraj Pandey and Khushdeep Dharni, ―Intellectual Property Rights‖, First edition, PHI learning Pvt. Ltd., Delhi,2014.
2. Uma Sekaran and Roger Bougie, ―Research methods for Business‖, 5th Edition, Wiley India, New

Delhi, 2012.

Reference Books(s) / Web links:

Stuart Melville and Wayne Goddard, ―Research Methodology: An Introduction For Science & EngineeringStudents‖,2nd edition, Juta Academic, 2001.

Ramakrishna B & Anilkumar H S, ―Fundamentals of Intellectual Property Rights‖, 1st edition, Notio Press, 2017.

William G Zikmund, Barry J Babin, Jon C.Carr, Atanu Adhikari,Mitch Griffin, ―Business Researc methods: ASouth Asian Perspective, 8th Edition, Cengage Learning, New Delhi, 2012.

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	3	1	-	2
CO2	3	1	-	-	-	-	-	2	-	-	1	3	-	-	2
CO3	3	1	-	-	-	-	-	-	-	-	1	3	-	-	2
CO4	3	1	-	-	2	1	-	-	-	-	1	3	-	-	3
CO5	3	1	-	-	-	-	-	-	-	-	1	3	-	-	2

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

Course code	Course Name (Theory course)	Categor	L	T	P	C
ME19G19	CORROSION AND SURFACE ENGINEERING	PE	3	0	0	3

Objectives:

- To have knowledge on corrosion
- To understand various theories of friction
- To understand various models of wear
- To impart knowledge on surface engineering and surface modification methods that will come in handy to solve the industrial problems. This will also serve as a precursor for future research in the same field.
- To understand the properties of new materials

UNIT-I	CORROSION	10

Introduction – Principle of corrosion – Classification of corrosion – Types of corrosion – Factors influencing corrosion – Testing of corrosion – In-service monitoring, Simulated service, Laboratory testing – Evaluation of corrosion – Prevention of Corrosion – Material selection, Alteration of environment, Design, Cathodic and Anodic Protection, Corrosion inhibitors.

UNIT-II	FRICTION	7

Topography of Surfaces – Surface features – Properties and measurement – Surface interaction – Adhesive Theory of Sliding Friction – Rolling Friction – Friction properties of metallic and nonmetallic materials – Friction in extreme conditions – Thermal considerations in sliding contact

UNIT-III	WEAR	7

Introduction – Abrasive wear, Erosive, Cavitation, Adhesion, Fatigue wear and Fretting Wear-Laws of wear – Theoretical wear models – Wear of metals and non-metals – International standards in friction and wear measurements

UNIT-IV	SURFACE TREATMENTS	12

Introduction – Surface properties, Superficial layer – Changing surface metallurgy – Wear resistant coatings and Surface treatments – Techniques – PVD – CVD – Physical CVD – Ion implantation – Surface welding – Thermal spraying – Laser surface hardening and alloying, Applications of coatings and surface treatments in wear and friction control – Characteristics of Wear resistant

coatings – New trends in coating technology – DLC – CNC – Thick coatings – Nano-engineered coatings – Other coatings, Corrosion resistant coatings		
UNIT-V	**ENGINEERING MATERIALS**	9
Introduction – Advanced alloys – Super alloys, Titanium alloys, Magnesium alloys, Aluminium alloys, and Nickel based alloys – Ceramics – Polymers – Biomaterials – Applications – Bio Tribology Nano Tribology		
Total Contact Hours:45		

Course Outcomes: Upon successful completion of the course, the student will be able to
CO1: Describe the fundamentals of corrosion process.
CO2: Comprehend the various theories on friction
CO3: Describe the various methods of wear in materials.
CO4: Apply surface modification methods which are necessary to solve the industrial practical problems.
CO5: Determine the properties of advanced materials.

Text Book(s):
1. Fontana G., ―Corrosion Engineering‖, McGraw Hill, 1985
2. W. Stachowiak and A. W. Batchelor, ―Engineering Tribology‖, Butterworth-Heinemann, UK,2005.

Reference Books(s) / Web links:
1. Rabinowicz.E, ―Friction and Wear of materials‖, John Willey &Sons, UK,1995.
2. Halling, J. (Editor) – ―Principles of Tribology ―, Macmillian – 1984
3. Williams J.A. ―Engineering Tribology‖, Oxford Univ. Press, 1994
4. S.K.Basu, S.N.Sengupta & B.B.Ahuja ,‖Fundamentals of Tribology‖, Prentice –Hall of India Pvt Ltd , NewDelhi, 2005.
5. https://nptel.ac.in/courses/112107248/

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

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