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 multidisciplinary 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

CURRICULUM

Choice Based Credit System

SEMESTER I

SL. 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**
PRACTICALS								
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**	

SEMESTER II

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	MA19251	Differential Equations and Vector Calculus	BS	4	3	1	0	**4**
2.	CY19241	Engineering Chemistry	BS	5	3	0	2	**4**
3.	GE19141	Programming using C	ES	6	2	0	4	**4**
4.	ME19201	Manufacturing Processes	PC	3	3	0	0	**3**
5.	GE19201	Engineering Mechanics	ES	3	2	1	0	**3**
PRACTICALS								
6	**GE19122**	Engineering Practices- Electrical and Electronics	ES	2	0	0	2	**1**
NON-CREDIT - MANDATORY COURSE								
7.	MC19102	Indian Constitution and Freedom Movement (Non-Credit)	MC	**3**	**3**	**0**	**0**	**0**
			TOTAL	**26**	**16**	**2**	**8**	**19**

SEMESTER-III

S.NO	Sub. Code	SUBJECT TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	GE19301	Life Science for Engineers	BS	3	3	0	0	**3**
2	MA19355	Transforms and Applications	BS	4	3	1	0	**4**
3	ME19301	Engineering Thermodynamics	PC	4	3	1	0	**4**
4	ME19302	Metal cutting and Machine tools	PC	3	3	0	0	**3**
5	ME19303	Kinematics of Machinery	PC	3	2	1	0	**3**
6	EE19241	Basic Electrical Engineering	ES	5	3	0	2	**4**
7	**ME19311**	**Machine Drawing Lab**	**PC**	**3**	**0**	**0**	**3**	**1.5**
8	**ME19312**	**Manufacturing Tech Lab**	**PC**	**3**	**0**	**0**	**3**	**1.5**
		TOTAL		**28**	**17**	**3**	**8**	**24**

SEMESTER-IV

S.NO	Sub. Code	SUBJECT TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	MA19455	Statistics & 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 & Machinery	PC	3	3	0	0	**3**
5	ME19404	Engineering Materials & Metallurgy	PC	3	3	0	0	**3**
6	GE19303	**Economics for Engineers**	ES	3	3	0	0	**3**
7	**ME19411**	**Strength of Materials and Fluid Mechanics and Machinery Laboratory**	**PC**	**3**	**0**	**0**	**3**	**1.5**
8	**ME19412**	**Thermal Engineering Lab - 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 Credit		**30**	**21**	**1**	**8**	**23**

SEMESTER-V

S.NO	Sub. Code	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
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**
		OPEN ELECTIVE - I	OE	3	3	0	0	**3**
6	**ME19511**	**CAD/CAM LAB**	**PC**	**3**	**0**	**0**	**3**	**1.5**
7	**ME19512**	**Thermal Engineering Lab-II**	PC	**3**	**0**	**0**	**3**	**1.5**
9	**GE19521**	**Soft Skills - II**	EEC	**2**	**0**	**0**	**2**	**1**
		Total Credit		**30**	**18**	**0**	**12**	**24**

SEMESTER-VI

S.NO	Sub. Code	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
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	PE	3	3	0	0	**3**
6		**Open Elective - II**	OE	**3**	**3**	**0**	**0**	**3**
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 Credit		**26**	**18**	**0**	**8**	**22**

SEMESTER-VII

S.NO	Sub. Code	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
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	PE	3	3	0	0	3
5		Professional Elective III	PE	3	3	0	0	3
6		Professional Elective IV	PE	3	3	0	0	3
7	ME19711	**Project – Phase I**	EEC	**2**	**0**	**0**	**2**	**1**
8	ME19712	**Comprehension**	EEC	**2**	**0**	**0**	**2**	**1**
		Total Credit		**24**	**18**	**0**	**6**	**21**

SEMESTER-VIII

S.NO	Sub. Code	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1		Professional Elective V	PE	3	3	0	0	**3**
2		Professional Elective VI	PE	3	3	0	0	**3**
3	ME19811	**Project – Phase II**	EEC	**16**	**0**	**0**	**16**	**8**
		Total Credit		**22**	**6**	**0**	**16**	**14**

Summary of Credits:

CATEGORY	I	II	III	IV	V	VI	VII	VII	Credits	(%)
BS	8	8	4	4	0	0	0	0	24	14.7
HS	3	0	0	0	0	0	-	-	3	1.8
ES	5	8	7	3	3	-	-	-	26	16
PC	0	3	13	15	17	13.5	10	0	71.5	44
PE	0	0	0	0	0	3	9	6	18	11.0
EEC	0	0	0	1	1	2.5	2	8	14.5	8.8
OE	0	0	0	0	3	3	0	0	6	3.7
Non-Credit*/ (Mandatory)	√	√		√						
TOTAL	**16**	**19**	**24**	**23**	**24**	**22**	**21**	**14**	**163**	100

PROFESSIONAL ELECTIVES FOR B.E. MECHANICAL ENGINEERING

SEMESTER VI
ELECTIVE I

SL. NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	**ME19P61**	Composite Materials and Mechanics	PE	3	3	0	0	3
2.	**ME19P62**	Unconventional Machining Processes	PE	3	3	0	0	3
3.	**ME19P63**	Renewable Sources of Energy	PE	3	3	0	0	3
4.	**ME19P64**	Industry 4.0	PE	3	3	0	0	3
6.	**ME19P65**	Robotics	PE	3	3	0	0	3
7.	**ME19P66**	Computer Aided Design	PE	3	3	0	0	3
8.	**ME19P67**	Industrial Safety	PE	3	3	0	0	3
9.	**ME19P68**	Geometric Dimensioning and Tolerancing	PE	3	3	0	0	3

SEMESTER VII
ELECTIVE II

SL. NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	**ME19P71**	Material Testing and Characterization	PE	3	3	0	0	3
2.	**ME19P72**	Additive Manufacturing	PE	3	3	0	0	3
3.	**ME19P73**	Introduction to Power Plant Engineering	PE	3	3	0	0	3
4.	**GE19P71**	Principles of Management	PE	3	3	0	0	3

SEMESTER-VII
ELECTIVE III

SL. NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	**ME19P74**	Hydraulics and Pneumatics	PE	3	3	0	0	3
2.	**ME19P75**	Refrigeration and Air conditioning	PE	3	3	0	0	3
3.	**ME19P76**	Process planning and Cost Estimation	PE	3	3	0	0	3
4.	**GE19P72**	Entrepreneurship Development	PE	3	3	0	0	3

ELECTIVE IV

SL. NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	**ME19P77**	Production Planning and Control	PE	3	3	0	0	3
2.	**ME19P78**	Welding Technology	PE	3	3	0	0	3
3	**ME19P79**	Hybrid and Electrical Vehicles	PE	3	3	0	0	3
4	**GE19P73**	Marketing Management	PE	3	3	0	0	3

SEMESTER VIII

ELECTIVE V

SL. NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	**ME19P81**	Operation Research	PE	3	3	0	0	3
2.	**ME19P82**	Design of Jigs, Fixture & Press tools	PE	3	3	0	0	3
3.	**ME19P83**	Non-Destructive Testing and Evaluation	PE	3	3	0	0	3
4.	**ME19P84**	Computational Fluid Dynamics	PE	3	3	0	0	3
5.	**ME19P85**	Design of Experiments	PE	3	3	0	0	3

ELECTIVE VI

SL. NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	**ME19P86**	Research Methodology and Intellectual Property Rights	PE	3	3	0	0	3
2.	**ME19P87**	Energy Engineering and Management	PE	3	3	0	0	3
3.	**ME19P88**	Supply chain and Logistics management	PE	3	3	0	0	3
4	**ME19P89**	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

SCHEDULE OF COURSES

SEM	THEORY COURSES						THEORY CUM LAB		LAB COURSES			MANDATORY COURSES	CREDITS
1.	HS19151 Technical English (3)	MA19151 Algebra & Calculus (4)	GE19101 Engg. Graphics (4)				PH19141 Physics of Materials (4)		GE19121 Eng. Practices-Civil & mech (1)			MC19101 EVS	16
2.	MA19251 Differential Equation and vector calculus (3)	ME19201 Manufacturing Processes (3)	GE19201 Engineering Mechanics (3)				CY19241 Engineering Chemistry (4)	GE19141 Programming In C (4)	GE19122 Eng. Practices-Electrical & Electronics (1)			MC19102 Indian Constitution and Freedom Movement	19
3.	GE19301 Life Science for Engineers (3)	MA19355 Transforms & Application (4)	ME19301 Engineering Thermodynamics (3)	ME19302 Metal Cutting & machine tools (3)	ME19303 Kinematics Of machinery (3)		EE19241 Basic Electrical Engineering (4)		ME19311 Machine Drawing Lab (1.5)	ME19312 Manufacturing Technology Lab (1.5)			24
4.	MA19455 Statistics & Numerical Method (4)	ME19401 Thermal Engineering (3)	ME19402 Strength of Materials (3)	ME19403 Fluid mechanics & Machinery (3)	ME19404 Engg. Materials & metallurgy (3)	GE19303 Economics for Engineers (3)			ME19411 Strength of Materials and Fluid Mechanics and Machinery Laboratory (1.5)	ME19412 Thermal Engg Lab-I (1.5)	GE19421 Soft Skill Lab-I (1)	MC19301 Essence of Indian Traditional knowledge	23
5.	ME19501 Design of machine Element (3)	ME19502 HMT (3)	EC19351 Basic Electronics Engineering (3)	OPEN ELECTIVE – I (3)			ME19541 Dynamics of machines (4)	ME19542 Metrology & Measurement (4)	ME19511 CAD/CAM Lab (3)	ME19512 Thermal Engg Lab-II (3)	GE19521 Soft Skill lab -II (1)		24
6.	ME19601 FEA (3)	ME19602 Gas Dynamics & jet propulsion (3)	ME19603 TQM (3)	ME19604 Design of transmission system (3)	Professional Elective-I (3)	OPEN ELECTIVE – II (3)			GE19621 Problem solving Techniques (1)	ME19611 Simulation & analysis Lab (1.5)	ME19612 Innovation & Design Thinking Lab(1.5)		22
7.	ME19701 Automobile Engineering (3)	ME19702 Automation in Manufacturing (3)	Professional Elective II (3)	Professional Elective III (3)	Professional Elective IV (3)		ME19741 Mechatronics (4)		ME19711 Project-Phase- (1)	ME19712 Comprehension (1)			21
8.	Professional Elective V (3)	Professional Elective VI (3)							ME19811 Project-Phase-II (8)				14

SEMESTER I

Subject Code	Subject 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-III	**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 Hours : 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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	1	-	-	-	-	-	1	-	2	3	1	3	-	-	-
CO 2	-	3	-	2	-	-	-	-	-	2	1	1	-	-	-
CO 3	-	-	-	1	-	-	-	-	-	3	-	-	-	2	3
CO 4	-	1	-	1	-	-	-	-	-	3	-	2	-	-	-
CO 5	1	1	1	1	1	1	1	1	2	3	1	1	-	-	-

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

Subject Code	Subject Name	Category	L	T	P	C
MA19151	**ALGEBRA AND CALCULUS** **Common to I sem. B.E. – Aeronautical Engineering, Automobile Engineering, Civil Engineering, Mechatronics & 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 Hours : 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	PO1	PO2	PO3	PO 4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO 2	PSO 3
MA19251.1	3	3	3	3	3	2	-	-	-	-	2	2	3	-	1
MA19251.2	3	3	3	3	3	2	-	-	-	-	2	2	3	-	1
MA19251.3	3	3	3	3	2	1	-	-	-	-	2	2	3	-	1
MA19251.4	3	3	2	2	2	1	-	-	-	-	1	1	3	-	1
MA19251.5	3	3	2	2	2	1	-	-	-	-	1	1	3	-	1

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

Subject Code	Subject Name	Category	L	T	P	C
PH19141	**PHYSICS OF MATERIALS** **Common to I sem. B.E. – Aeronautical Engineering, Automobile Engineering, Civil Engineering, Mechanical 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 of 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 properties 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 of 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	PO1	PO 2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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

Subject Code	Subject 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 this skill in developing new products.
●	To improve their technical communication skill in the form of communicative drawings

CONCEPTS AND CONVENTIONS (Not for Examination) **1**

Importance of graphics in engineering applications–Use of drafting instruments– BIS conventions and specifications–Size, layout and folding of drawing sheets– Lettering and dimensioning. Basic Geometrical constructions.

UNIT-I	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 Hours : 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 objects.
●	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		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	2	-	-	-	-	-	-	-	-	1	-	2	-	-	1
CO 2	2	-	-	-	-	-	-	-	-	1	-	2	-	-	1
CO 3	2	-	-	-	-	-	-	-	-	1	-	2	-	-	1
CO 4	2	-	-	-	-	-	-	-	-	1	-	2	-	-	1
CO 5	2	-	-	-	-	-	-	-	-	1	-	2	-	-	1

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

Subject Code	Subject Name (Laboratory Course)	Category	L	T	P	C
GE19121	ENGINEERING PRACTICES – Civil & Mechanical	ES	0	0	2	1

Objectives:

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

List of 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 Hours	**: 30**

Course Outcomes:

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

TOTAL: 30 PERIODS

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

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

Subject Code	Subject 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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MC19101.1	1	1	-	-	-	3	3	2	-	-	-	2	-	-	-
MC19101.2	1	1	-	-	-	3	3	2	-	-	-	2	-	-	-
MC19101.3	1	1	-	-	-	3	3	2	-	-	-	1	-	-	-
MC19101.4	1	1	-	-	-	2	3	2	-	-	-	2	-	-	-
MC19101.5	1	1	-	-	-	2	3	1	-	-	-	1	-	-	-

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

SEMESTER II

Subject Code	Subject 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 & Chemical 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	PO 1	PO 2	PO 3	PO 4	PO5	PO 6	PO7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO3
MA19251.1	3	3	3	3	3	2	-	-	-	-	2	2	3	-	1
MA19251.2	3	3	3	3	3	2	-	-	-	-	2	2	3	-	1
MA19251.3	3	3	3	3	2	1	-	-	-	-	2	2	3	-	1
MA19251.4	3	3	2	2	2	1	-	-	-	-	1	1	3	-	1
MA19251.5	3	3	2	2	2	1	-	-	-	-	1	1	3	-	1

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

Subject Code	Subject Name	Category	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		
	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	PO 1	PO2	PO 3	PO 4	PO 5	PO6	PO7	PO8	PO9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CY19241.1	3	2	2	2	2	1	2	1	1	1	2	2	1	2	1
CY19241.2	3	2	2	2	2	1	3	1	2	1	1	2	1	2	1
CY19241.3	3	2	2	2	2	1	2	-	2	1	1	1	1	2	-
CY19241.4	3	1	1	1	2	1	1	-	1	1	1	1	1	1	-
CY19241.5	3	2	2	2	2	2	2	1	2	1	1	2	2	2	1

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

Subject Code	Subject 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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	2	2	2	1	-	-	-	1	2	1	1	1	-	1
CO2	1	1	1	1	1	-	-	-	-	-	1	1	1	-	-
CO3	1	1	2	1	1	-	-	-	-	-	1	1	1	-	-
CO4	2	2	3	2	1	-	-	-	1	-	2	1	1	-	-
CO5	2	2	3	2	1	-	-	-	-	-	2	1	1	-	-

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

Subject Code	Subject 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 Hours	**:**	**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/

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

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

GE19201	**Engineering Mechanics**	**Category**	**L**	**T**	**P**	**C**
	(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 Hours : 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

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	0	2	0	-	-	-	-	0	0	0	3	0	-	2
2	3	0	2	0	-	-	-	-	0	0	0	3	0	-	2
3	3	0	2	0	-	-	-	-	0	0	0	3	0	-	2
4	3	0	2	0	-	-	-	-	0	0	0	3	0	-	2
5	3	0	2	0	-	-	-	-	0	0	0	3	0	-	2

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

Subject Code	Subject Name (Laboratory Course)	Category	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 AC 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 Hours : 30

Course Outcomes:

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

- fabricate electrical and electronic circuits
- formulate the house wiring
- design the AC-DC converter using diode and passive components

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.

MAPPING OF COs WITH POs AND PSOs

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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)

MC19102	INDIAN CONSTITUTION AND FREEDOM MOVEMENT	Category	L	T	P	C
	(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 Hours	**:**	**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 non-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 ed 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.2nd 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, New Delhi.
- U.R.Gahai, "Indian Political System ", New Academic Publishing House, Jalaendhar.

SEMESTER III

GE19301	LIFE SCIENCE FOR ENGINEERS	Category	L	T	P	C
	Common to all branches of Engineering & Technology	ES	3	0	0	3

Objectives:

- Broad objective of this course is to give an introduction of life science to engineering students. The course helps students to familiarize with human physiology, life style diseases and their management and basic diagnostic aspects

UNIT-I	**OVERVIEW OF CELLS AND TISSUES**	**9**
Introduction to Bacteria, virus, fungi and animal cells. Organisation of cells into tissues and organs. Functions of vital organs		
UNIT-II	**HEALTH AND NUTRITION**	11
Balanced diet, Importance of RDA, BMR, and diet related diseases. Role of antioxidants PUFA, DHA, Essential amino acids, Essential fatty acids in diet. Water and its significance for human health. Physical and Mental health – Significance of exercise and yoga.		
UNIT-III	**UNHEALTHY PRACTICES AND THEIR IMPACT ON HEALTH**	**9**
Drug induced toxicity, Unhealthy practices - Drug abuse/Narcotics/Smoking/Alcohol/Self-medication/Undue usage of electronic gadgets.		
UNIT-IV	**COMMON DISEASES AND LIFESTYLE DISORDERS**	**9**
Prevention and management of food, water and airborne illness (Common cold, dehydration, food poisoning etc). Lifestyle disorders – obesity, diabetes, stroke, heart attack, ulcer, renal calculi, cancer, AIDS, hepatitis- prevention and management.		
UNIT-V	**DIAGNOSTIC TESTS AND THEIR RELEVENCE**	**7**
Normal range of biochemical parameters, significance of organ function tests, organ donation.		
	Total Contact Hours : 45	

Course Outcomes: The students at the end of this course, should be able to

- Classify the living organisms and relate the functions of vital organs
- Demonstrate the importance of balanced diet and plan methods for healthy living
- Analyse the hazards of unhealthy practices and take preventive measures
- Categorise the various life style disorders and recommend ways to manage the common diseases
- Evaluate and interpret biochemical parameters and their significance.

Text Book (s):

1. Diseases of human body, Carol D Tamparo, Marcia A Lewis , Marcia A, Lewis ,EdD, RN, CMA-AC, F.A Davis Company, 2011
2. Textbook of Medical Biochemistry, Chatterjea ; Rana Shinde.

Reference Books(s) / Web links:

1. Biology for Engineers, Arthur.T.,Johnson, CRC Press, Taylor and Francis, 2011
2. Cell Biology and Genetics, Cecie Starr, Ralph Taggart, Christine Evers and Lisa Starr, Cengage Learning, 2008
3. https://nptel.ac.in/courses/122103039/

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO5	PO6	PO7	PO8	PO9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO1	3	1	2	2	2	3	1	1	1	2	1	3	-	-	-
CO2	3	1	2	2	2	3	1	1	1	2	1	3	-	-	-
CO3	3	1	2	2	2	3	1	3	1	2	1	3	-	-	-
CO4	3	1	2	2	2	3	1	1	1	2	1	3	-	-	-
CO5	3	1	2	2	3	3	1	1	1	2	1	3	-	-	-

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

Subject Code	Subject 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 Hours : 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 Company Limited, New Delhi, 2017.
3	Glyn James, "Advanced Modern Engineering Mathematics", 4th Edition, Pearson Education, 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	PO 1	PO 2	PO 3	PO 4	PO5	PO 6	PO7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO3
MA19355.1	3	3	3	3	3	2	-	-	-	-	2	2	3	-	1
MA19355.2	3	3	3	3	3	2	-	-	-	-	2	2	3	-	1
MA19355.3	3	3	3	3	2	1	-	-	-	-	2	2	3	-	1
MA19355.4	3	3	2	2	2	1	-	-	-	-	1	1	3	-	1
MA19355.5	3	3	2	2	2	1	-	-	-	-	1	1	3	-	1

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

Subject Code	Subject Name (Theory course)	Category	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 Hours : 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 Publications, New Delhi, 2016.

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

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

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

Subject Code	**Subject Name (Theory course)**	**Category**	**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 Hours : 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”, Taylor & 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/

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

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

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
ME 19303	KINEMATICS OF MACHINERY	PC	2	1	0	3

Objectives:	
●	To understand the basic concepts of mechanisms and construct the velocity, and acceleration diagram of mechanisms
●	To understand the basic concepts of cam mechanism, gears and gear trains
●	To have the basic knowledge on friction in machine elements
●	To understand the force-motion relationship in components subjected to external forces in simple mechanisms
●	To understand the importance of balancing in machines and analyze the effect of dynamics of undesirable vibrations

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 Hours	**:**	**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. Ltd., 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/

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

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

Subject Code	**Subject Name (Lab Integrated Theory Courses)**	**Category**	**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 Hours	**:**	**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.

MAPPING OF COs WITH POs AND PSOs

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	3	3	1	1	-	-	-	-	2	1	-	1
CO2	3	3	2	3	3	1	1	-	-	-	-	-	1	-	1
CO3	3	3	2	3	3	2	2	-	1	-	-	2	3	-	2
CO4	3	3	2	3	3	2	2	-	-	-	2	2	1	-	1
CO5	3	3	2	3	3	1	2	1	1	1	2	2	2	-	1
Average	**3**	**3**	**2**	**3**	**3**	**1.4**	**1.6**	**1**	**1**	**1**	**2**	**2**	**1.6**	**-**	**1.2**

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

Subject Code	Subject 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 Hours : 45

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 of 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

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

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

Subject Code	Subject Name (Theory course)	Category	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 Hours	**:**	**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.

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

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

SEMESTER-IV

Subject Code	Subject Name	Category	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 difference 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 Seidel –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 difference solution of one-dimensional heat equation by explicit and implicit methods - Two-dimensional Laplace equation.		
	Total Contact Hours : 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",11th Edition, Pearson Education, , Asia, 2011.
2	Walpole R.E., Myers. R.H., Myers. S.L., and Ye. K., "Probability and Statistics for Engineers and 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.

Subject Code	Subject Name	Category	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
Otto, Diesel, Dual, Brayton cycles, Calculation of mean effective pressure, and air standard efficiency - Comparison of cycles.		
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 and multi-stage turbines, speed regulations –Governors.		
UNIT-IV	**AIR COMPRESSOR**	**9**
Classification and working principle of various types of compressors, work of compression with and without clearance, Volumetric efficiency, Isothermal efficiency and Isentropic efficiency of reciprocating compressors, 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 Principles. - Concept of RSHF, GSHF, ESHF- Cooling Load calculations.		
	Total Contact Hours : 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
9	https://www.mheducation.co.in › engineering › thermal-engineering

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

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

Subject Code	Subject Name (Theory course)	Category	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 Hours : 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/

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

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

Subject Code	Subject Name (Theory course)	Category	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 Hours : 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

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

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

Subject Code	**Subject Name (Theory Courses)**	**Category**	**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 Hours : 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/

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

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

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
GE19303	ECONOMICS FOR ENGINEERS	ES	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:** 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.	**9**
UNIT-II	**PRICE AND CONSUMER BEHAVIOUR:** 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.	**9**
UNIT-III	**PRODUCTION FUNCTION AND COMPETITION:** 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.	**9**
UNIT-IV	**NATIONAL INCOME AND KEYNESIAN MULTIPLIER:** 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.	**9**
UNIT-V	**IS, LM MODEL, MONETARY, FISCAL POLICY AND TAXES:** 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.	**9**
	Total Contact Hours : 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	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
GE19303.1	1	1	-	-	-	2	1	-	-	-	2	2	-	-	-
GE19303.2	1	1	-	-	-	2	1	-	-	-	2-	2	-	-	-
GE19303.3	1	1	-	-	-	2	1	-	-	-	2	2	-	-	-
GE19303.4	1	1	-	-	-	2	1	-	-	-	2	2	-	-	-
GE19303.5	1	1	-	-	-	2	1	-	-	-	2	2	-	-	-
Average	1	1	-	-	-	2	1	-	-	-	2	2	-	-	-

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

ME19411	STRENGTH OF MATERIALS AND FLUID MECHANICS AND MACHINERY LABORATORY	Category	L	T	P	C
		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: 18

OUTCOMES: At the end, the students have the

1. Ability to perform different destructive testing
2. Ability to characterize and compare different materials

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: 27
OUTCOMES: At the end, the students have the 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

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

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

Subject Code	Subject 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 Hours	**:**	**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 turbine

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

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

GE19421	SOFTSKILLS -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

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	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

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

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

Subject Code	Subject Name (Theory course)	Category	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, Mimamsa, 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 Hours : 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.

SEMESTER –V

Subject Code	Subject Name (Theory course)	Category	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-Ty 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 Knu 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 - McKe Eqn. - Sommerfield Number - Raimondi & Boyd - Design of hydrodynamic journal bearings – Design of sliding Contact and rolling contact bearings.

Total Contact Hours	**:**	**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 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/

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

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

Subject Code	Subject Name (Theory course)	Category	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 and 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 Shields. Radiation through gases.		
UNIT-V	**MASS TRANSFER**	**9**
Basic Concepts – Diffusion Mass Transfer – Fick's Law of Diffusion – Steady state Molecular Diffusion– Convective Mass Transfer – Momentum, Heat and Mass Transfer Analogy –Convective Mass Transfer Correlations.		
	Total Contact Hours : 45	

Course Outcomes: 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 Wiley & 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//

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

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

Subject Code	Subject Name (Theory Integrated with Laboratory)	Category	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 Hours	:	45

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

DYNAMICS LABORATORY

OBJECTIVES:

- To supplement the principles of kinematics involved in various mechanisms.
- To explain the principles of dynamics involved in various experiments.

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.

OUTCOMES:

- Ability to measure the various kinematic parameters.
- Ability to measure the vibration parameters in various experiments.

Total contact Hours: 30

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

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

Subject Code	Subject Name (Theory Integrated with Laboratory)	Category	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 Hours : 45	

List of Experiments			
1	Calibration and use of linear measuring instruments – Vernier caliper /Micrometer / Vernier height gauge / Comparators.		
2	Measurement of angles using bevel protractor and sine bar.		
3	Measurement of assembly and transmission elements - screw thread parameters – Screw thread 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 using 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/

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

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

Subject Code	**Subject Name (Theory course)**	**Category**	**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 Hours	**:**	**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

Subject Code	Subject Name (Laboratory Course)	Category	L	T	P	C
ME 19511	**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**
1. **Part Programming - CNC Milling Machine** ▪ Linear Cutting. ▪ Circular cutting. ▪ Cutter Radius Compensation. ▪ Canned Cycle Operations.	

2. **Part Programming - CNC Turning Machine** o Straight, Taper and Radius Turning. o Thread Cutting. o Rough and Finish Turning Cycle. o Drilling and Tapping Cycle.			
	Total Contact Hours	**:**	**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

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

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

Subject Code	**Subject 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 Hours	**:**	**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

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

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

Course Code	:	**GE19521**
Course Title	:	**Soft Skills-II**
Teaching Period	:	5thSemester
Credit Points	:	L T P C – 0 0 2 1
Course Category	:	**EEC**

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 have to find words and their meaning from the article they have not come across before and share it with the group. They then use these words in sentences of their own	The aim of this activity is not only to get the students to read the newspaper but also aims at enhancing the students' vocabulary.
2	Court Case	The facilitator provides the participants the premise of a story and proceeds to convert the story into a court case. The students are required, department-wise to debate and provide their points to win the case for their clients.	The aim of the lesson is to encourage creative and out-of-the -box thinking to ensure a good debate and defense skills.
3	The ultimate weekend	The students design activities they are going to do over the weekend and they have to invite their classmates to join in the activity. The students move around the class and talk to other students and invite them.	The aim of this activity is to develop the art of conversation among students. It also aims at practicing the grammatical structures of "going to" "have to" and asking questions.
4	The Four Corners	This is a debate game that uses four corners of the classroom to get students moving. The following is written on the 4 corners of the room "Strongly	This activity aims at getting students to come up with their own opinions and stand by it instead of being

		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	overshadowed by others and forcing themselves to change based on others opinions.
5	Debate	Boarding school or day school? Which is more beneficial for a student?	The aim of this activity is to encourage students to draw up feasible points on the advantages and benefits of both. And enhance their debating ability
6	Grand Master	The facilitator starts the session by keeping an individual in mind, upon which the students guess it only through "Yes or No" questions. Post few trials the students are given same opportunity to do the same with the crowd.	The aim of the lesson is designed to teach the art of questioning. It also helps to enhance the students' speaking and listening skills.
7	Debate	Does violence on the TV and Video games influence children negatively?	This activity aims at encouraging the students to debate on real life scenarios that most students spend a lot of time on.
8	Turn Tables	This is a speaking activity where the students need to speak for and against the given topics when the facilitator shouts out 'Turn Table'.	The aim of this activity is to make the participants become spontaneous and have good presence of mind.
9	Debate	Do marks define the capabilities of a student?	This debate activity aims at allowing the students to argue on this worrisome adage of marks.
10	FictionAD	The Participants are asked to create an Ad for a 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 students are selected at random and supported to present any of their own skills.	The aim of this activity is designed to evoke their inner talents and break the shyness and the fear of participating in front of a crowd
	Feedback	At the end of the session in the final week (12) the trainer would provide feedback to the students on best practices for future benefits.	The aim is to do both give feedback to students as well as obtain feedback on the course from them.

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

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

SEMESTER -VI

Subject Code	Subject 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-III	**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-IV	**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 Hours :	**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

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

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

Subject Code	Subject Name (Theory course)	Category	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 – Operating principle, cycle analysis and use of stagnation state performance of ram jet, turbojet, turbofan and 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 Hours : 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

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

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

Subject Code	Subject Name (Theory course)	Category	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 Hours : 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.

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

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

Subject Code	**Subject Name (Theory course)**	**Category**	**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 Hours	**:**	**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/

CO - PO – PSO matrices of course

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO8	PO9	PO10	PO11	PO12	**PSO1**	**PSO2**	**PSO3**
CO 1	3	1	1	-	-	-	-	-	1	1	-	2	2	-	1
CO 2	3	1	1	-	-	-	-	-	1	1	-	2	2	-	1
CO 3	3	1	1	-	-	-	-	-	1	1	-	2	2	-	1
CO 4	3	1	1	-	-	-	-	-	1	1	-	2	2	-	1
CO 5	3	1	1	-	-	-	-	-	1	1	-	2	2	-	1

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

Course Code	:	**GE19621**
Course Title	:	**Problem-Solving Techniques**
Teaching Period	:	**6th Semester**
Credit Points	:	**L T P C – 0 0 2 1**
Course Category	:	**EEC**

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 Outcome:

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

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

Subject Code	Subject 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: 45	

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

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

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

Subject Code	Subject 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 to	
●	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	Marks
1	Review – I	10
2	Review – II	20
3	Review – III	20

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

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

SEMESTER-VII

Subject Code	Subject Name (Theory course)	Category	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 Hours : 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.

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

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

Subject Code	Subject Name (Theory course)	Category	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 Hours : 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.

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

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

Subject Code	Subject Name (Theory course)	Category	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 Hours : 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 Pi 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 1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO 1	3	1	-	-	-	-	-	-	-	-	-	-	2	-	-
CO 2	3	1	1	-	2	-	-	-	-	-	-	2	2	2	1
CO 3	3	2	2	-	-	-	-	-	-	-	-	-	2	-	2
CO 4	3	1	1	1	2	-	-	-	-	-	-	2	2	2	1
CO 5	2	2	3	2	2	1	1	-	-	-	-	2	2	-	2

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

Subject Code	Subject 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.

TOTAL:30 PERIODS

Scheme for Internal Evaluation

S.NO	Description	Marks
1	Review –I	10
2	Review –II	20
3	Review-III	20

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.

Subject Code	Subject Name (Laboratory course)	Category	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:

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.

SEMESTER-VIII

Subject Code	Subject Name (Laboratory course)	Category	L	T	P	C
ME19811	**PROJECT PHASE-II**	**EEC**	**0**	**0**	**16**	**8**

OBJECTIVES

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

The students in a group of 2 to 3 works on a topic approved by the Head of the Department under the guidance of a faculty member and prepare a comprehensive project report after completing the project work including Literature survey/Methodology to the satisfaction of the supervisor. The progress of the project is evaluated based on a minimum of three reviews. The review committee may be constituted by the Head of the Department. A project report is required at the end of the semester. The project work is evaluated based on oral presentation and the project report jointly by external and internal examiners constituted by the Head of the Department.

TOTAL: 240 PERIODS

Scheme for Internal Evaluation

S.NO	Description	Marks
1	Review –I	10
2	Review –II	20
3	Review-III	20

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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PROFESSIONAL ELECTIVES FOR B.E. MECHANICAL ENGINEERING

SEMESTER VI

ELECTIVE I

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
ME19P61	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 methods
- 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 Hours	**:**	**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 1	PO 2	PO 3	PO 4	PO5	PO6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO1	PSO 2	PSO 3
CO 1	3	-	-	-	-	-	-	-	-	-	-	1	-	2	1
CO 2	3	-	-	-	-	-	-	-	-	-	-	1	-	2	1
CO 3	3	-	-	-	-	-	-	-	-	-	-	1	-	2	1
CO 4	3	-	-	-	-	-	-	-	-	-	-	1	-	2	1
CO 5	3	3	1	-	-	-	-	-	-	-	-	1	-	2	1

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

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
ME19P62	**Unconventional Machining Processes**	**PE**	**3**	**0**	**0**	**3**

Objectives: Students can understand the	
●	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. .
●	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, equipments of Assisted hybrid processes and combined or mixed-type processes. Assisted hybrid processes-Vibration assisted EDM, Ultrasonic-Assisted ECM		

(USECM),Laser assisted ECM (LAECM), Laser-Assisted EDM (LAEDM).Combined hybrid machining - Electrochemical Discharge Machining (ECDM), Electric Discharge Grinding (EDG), Abrasive water jet machining			
	Total Contact Hours	**:**	**45**

Course Outcomes: At the end of this course, students can have the	
●	Ability to explain different types of non-traditional machining processes and explain mechanical energy based non-traditional machining processes.
●	Ability to explain the working principles of chemical and electro chemical energy-based processes.
●	Ability to explain the working principles of thermo-electric energy-based processes.
●	Ability to explain various nano finishing processes.
●	Ability to understand hybrid non-traditional machining processes.

Text Books:	
1	Vijay.K. Jain "Advanced Machining Processes" Allied Publishers Pvt. Ltd., New Delhi, 2007.
2	Kapil Gupta, Neelesh K. Jain and Laubscher R.F., "Hybrid Machining Processes: Perspectives on Machining and Finishing", 1st edition, Springer International Publishing., Switzerland, 2016.

Reference Books(s) / Web links:	
1	Adithan. M., "Unconventional Machining Processes", Atlantic, New Delhi, India, 2009.
2	Gary F. Benedict, "Non-traditional Manufacturing Processes", Routledge, 2017.
3	Vijay.K. Jain "Nanofinishing Science and Technology: Basic and Advanced Finishing and Polishing Processes" CRC Press, 2016.
4	XichunLuo, Yi Qin, Hybrid Machining, Elsevier, 2018
5	https://nptel.ac.in/courses/112/103/112103202/ -:Advanced MachiningProcesses

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

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

Subject Code	**Subject Name (Theory course)**	**Category**	**L**	**T**	**P**	**C**
ME19P63	**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 – Economics of renewable energy sources - Sustainability development - Global Environmental issues – Emission of carbon dioxide – Review on new technologies and future energy plans.		
UNIT-II	**SOLAR ENERGY**	**9**

Solar radiation - Availability of solar energy - 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 - 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 selection for windfarms - Types of wind mills - Horizontal axis wind turbine - Vertical axis wind turbine – components of wind mill - Wind turbine generators and its performance - Building Integrated Wind Energy - Environmental issues - Applications - Indian wind potential.		
UNIT-IV	**BIO-ENERGY**	**9**
Bio resources - Biomass direct combustion - biochemical conversion-thermochemical conversion - mechanical conversion - Biomass combustion and power generation- Biomass gasifier - Types of gasifiers - Cogeneration - Carbonization - Pyrolysis - Biogas plants - Digesters - Biodiesel production - Ethanol production - Waste to energy technologies - Heat Pumps.		
UNIT-V	**WATER AND OTHER RENEWABLE ENERGY RESOURCES**	**9**
Technologies for harnessing Water energy - small hydro - Tidal energy - types of Tidal energy - Wave energy - Ocean Thermal Energy - Open and Closed OTEC – Geothermal energy – Types of Geothermal energy – Hydrogen energy technology - Fuel Cells – Types of fuel cell – Energy storage technology – Hybrid technology - Environmental impact assessment.		
	Total Contact Hours : 45	

Course Outcomes: Upon completion of 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 Book(s):	
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	N.K. Bansal, Non-Conventional Energy Resources, Vikas Publishing House, 2014.
2	Godfrey Boyle, “Renewable Energy, Power for a Sustainable Future”, Oxford University Press, 2012.
3	B.H. Khan, “Non-Conventional Energy Resources”, McGraw Hill, 2009.
4	John A. Duffie and William A. Beckman (2006), Solar Engineering of Thermal Process, 3rd Edition, John Wiley & Sons.
5	Gilbert 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.

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

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

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
ME 19P64	INDUSTRY 4.0	PE	3	0	0	3

Objectives:	
●	To understand the basics, drivers and enablers of Industry 4.0
●	To learn about the smartness in smart manufacturing factories, smart devices, smart cities and smart services.
●	To learn about the different enabling technologies and its role in establishing Industry 4.0
●	To study different design principles of Industry 4.0
●	To understand the impact of industry 4.0 on different sectors and challenges in implementing 4.0.

UNIT-I	Introduction to Industry 4.0	9
Introduction to Industry 4.0- The Various Industrial Revolutions, Digitalisation and the Networked Economy, Drivers, Enablers, Comparison of Industry 4.0 Factory and Today's Factory, Trends of Industrial Big Data and Predictive Analytics for Smart Business Transformation.		
UNIT-II	**Road to Industry 4.0**	9
Internet of Things (IoT) & Industrial Internet of Things (IIoT) & Internet of Services, Big data, Value chains in Manufacturing companies, Smart factories, Smart Devices and Products, Smart Logistics, Smart Cities, smart services, Predictive Analytics, Case studies.		
UNIT-III	**Technologies for enabling Industry 4.0**	10
Cyber Physical Systems, Robotic Automation and Collaborative Robots, Support System for Industry 4.0, Mobile Computing, Cyber Security, Augmented / Virtual reality, Artificial Intelligence, System integration, digital twin, 3D printing, Case studies.		
UNIT-IV	**Industry 4.0 Design principles**	8
Introduction to Industry 4.0 design principles – Interoperability, Communication systems and standards for Industry 4.0 , virtualization, Decentralization, Modularity, real time capability, information transparency – Foundation of Industry 4.0 - Could Manufacturing and the connected factories.		
UNIT-V	**Impact of Industry 4.0**	9
Impact of Industry 4.0 on – service and business models, IT security, manufacturing, machine safety, product life cycle, socio economic factors, textile industries, healthcare industries, real estate industries, maritime industries, tourism industries - Compelling Forces and Challenges in implementing Industry 4.0. Case studies.		
	Total Contact Hours : 45	

Course Outcomes: At the end of this course, students will have	
●	The basic knowledge on Industry 4.0, its drivers, enablers, and difference between Industry 4.0 factories with today's factory.
●	An idea of IoT, IIoT, smart manufacturing factories, smart devices, smart cities and smart services.
●	The basic understanding of different technologies enabling Industry 4.0 with some case studies.
●	The awareness on different design principles could manufacture and connected factories.
●	The ability to understand the impact of Industry 4.0 in different sectors including challenges in implementing Industry 4.0.

Text Books:	
1	Alasdair Gilchrist, "Industry 4.0: The Industrial Internet of Things", Apress, 2016.
2	Bruno S.Sergi, Elena G.popkova, et al. " Understanding Industry 4.0: AI, The internet of things, and the future of work", 2019, Emerald publishing limited.

Reference Books(s) / Web links:	
1	Kaushik kumar, DivyaZindani, J. Paulo Davim, " Digital manufacturing and assembly systems in Industry 4.0", CRC Press, Taylor and Francis group, 2020.

2	Antonio sartal, Diego Carou, J.PauloDavim, " Enabling technologies for the successful deployment of Industry 4.0, CRC press, 2020.
3	Alp Ustundag, Emrecavikcan, " Industry 4.0 : Managing the digital transformation", springer internation publishing , 2018.
4	https://onlinecourses.nptel.ac.in/noc20_cs69/preview
5	https://www.udemy.com/course/intro-to-industry-4/

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

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

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
ME19P65	**ROBOTICS**	**PE**	**3**	**0**	**0**	**3**

Objectives:

- To understand the fundamentals of robot anatomy, its classification and applications.
- To infer different types of robot drive system and end effectors.
- To understand the different types of sensors, image capturing and processing techniques being employed in robots nowadays.
- To learn the kinematics involved in the robots and the basics of programming languages.
- To understand the economy of implementing robots in the industry and their returns.

UNIT-I	**FUNDAMENTALS OF ROBOT**	6

History of robots, Classification of robots, Present status and future trends. Basic components of robotic system; Robot - Definition - Robot Anatomy - Coordinate Systems, Work Envelope Types and Classification- Specifications-Pitch, Yaw, Roll, Joint Notations, Speed of Motion, Pay Load- Robot Parts and their Functions-Need for Robot-Robot Applications-Material handling, Machine loading and unloading, assembly, Inspection, Welding, Spray painting, Inspection.

UNIT-II	**ROBOT DRIVE SYSTEMS AND END EFFECTORS**	9

Introduction-Types of actuators and Characteristics- Pneumatic Drives-Hydraulic Drives-Mechanical Drives-Electrical Drives-D.C. Servo Motors, Stepper Motors, A.C. Servo Motors-Salient Features, Applications and Comparison of all these Drives, End Effectors-Grippers-Mechanical Grippers, Pneumatic and Hydraulic- Grippers, Magnetic Grippers, Vacuum Grippers; Two Fingered and Three Fingered Grippers; Internal Grippers and External Grippers; Selection and Design Considerations.

UNIT-III	**SENSORS AND MACHINE VISION**	12

Requirements of a sensor, Principles and Applications of the following types of sensors- Position sensors - Piezo Electric Sensor, LVDT, Resolvers, Optical Encoders, pneumatic Position Sensors, Range Sensors Triangulations Principles, Structured, Lighting Approach, Time of Flight, Range Finders, Laser Range Meters, Touch Sensors,binary Sensors., Analog Sensors, Wrist Sensors, Robotic Compliance Sensors, Slip Sensors, Camera, Frame Grabber, Sensing and Digitizing Image Data- Signal Conversion, Image Storage, Lighting Techniques, Image Processing and Analysis-Data Reduction, Segmentation, Feature Extraction, Object Recognition, Other Algorithms, Applications Inspection, Identification, Visual Serving and Navigation.

UNIT-IV	**ROBOT KINEMATICS AND ROBOT PROGRAMMING**	13

2D, 3D Transformation, Scaling, Rotation, Translation, Homogeneous coordinates, multiple transformation, Simple problems; Robot Kinematics-Forward Kinematics, Inverse Kinematics and Difference; Manipulator Kinematics-Forward Kinematics and Reverse Kinematics of manipulators with Two, Three Degrees of Freedom (in 2 Dimension), Four Degrees of freedom (in 3 Dimension) Jacobians, Velocity and Forces-Manipulator Dynamics, Trajectory Generator, Manipulator Mechanism Design-Derivations and problems. Teach Pendant-Coordinate systems of Robot; Lead through Programming, Robot programming Languages-VAL Programming, RAPID Language and AML-Motion Commands, Sensor Commands, End Effector commands and simple Programs.

UNIT-V	IMPLEMENTATION AND ROBOT ECONOMICS	5
RGV-Model Logic, AGV-FMS Navigation, Types and applications; AGV/ASRS Integration- Implementation of Robots in Industries-Various Steps; Safety Considerations for Robot Operations; Safety aspects in robot work cell - Economic Analysis of Robots; Introduction of Mobile Robotics and Co-bots.		
	Total Contact Hours : 45	

Course Outcomes: On Successful completion of the course, students Will be able to	
●	Explain the fundamentals of robots, robot anatomy, robot workspaces and classification and applications of robots
●	Learn the different drive systems to actuate the robot and its end effector.
●	Explain the different types of sensors used in robot, image processing techniques for gathering information from the image.
●	Explain the forward and reverse kinematics of simple robots with 2, 3 or 4 degrees of freedom, programming and performing simple operations using VAL.
●	Explain the practical aspects behind implementing robots in industries and to perform economic analysis.

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

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

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

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

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
ME19P66	**COMPUTER AIDED DESIGN**	**PE**	**3**	**0**	**0**	**3**

Objectives: The main learning objective of this course is	
●	To provide an overview of computer graphics architecture, object transformations, clipping and viewing.
●	To impart knowledge on modeling of curves, surfaces, solid models using CSG and B-representation.
●	To provide an understanding of visual realism and rendering techniques.
●	To impart knowledge on how to assemble parts, analyze tolerance and calculate mass properties.

●	To impart knowledge on CAD standards and data exchange standards.

UNIT-I	**INTRODUCTION TO COMPUTER GRAPHICS FUNDAMENTALS**	9
Product cycle and CAD/CAM- Design process- sequential and concurrent engineering Output primitives (points, lines, curves etc.,), 2-D & 3-D transformation (Translation, scaling, rotators) windowing - view ports - clipping transformation.		
UNIT-II	**CURVES AND SURFACES MODELLING**	9
Introduction to curves - Analytical curves: line, circle and conics – synthetic curves: Hermite cubic spline- Bezier curve and B-Spline curve – curve manipulations. Introduction to surfaces - Analytical surfaces: Plane surface, ruled surface, surface of revolution and tabulated cylinder – synthetic surfaces: Hermite, bi-cubic surface- Bezier surface and B-Spline surface- surface manipulations.		
UNIT-III	**NURBS AND SOLID MODELING**	9
NURBS- Basics- curves, lines, arcs, circle and bi linear surface. Regularized Boolean set operations - primitive instancing - sweep representations - boundary representations – Constructive solid Geometry - comparison of representations - user interface for solid modeling.		
UNIT-IV	**VISUAL REALISM**	9
Hidden – Line – Surface – solid removal algorithms shading – coloring. Introduction to parametric and variational geometry based software's and their principles creation of prismatic and lofted parts using these packages.		
UNIT-V	**ASSEMBLY OF PARTS AND PRODUCT DATA EXCHANGE**	9
Assembly modeling - interferences of positions and orientation - tolerances analysis – mass property calculations - mechanism simulation. Graphics and computing standards– Open GL Data Exchange standards – IGES, STEP etc– Communication standards.		
	Total Contact Hours : 45	

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

●	Demonstrate the fundamentals of computer graphics architecture, object transformations, clipping and viewing.
●	Model curves and surfaces, using surface modelling techniques.
●	Model curves, surfaces, solid models using NURBS and solid modelling techniques.
●	Apply the knowledge of hidden line algorithms, colouring and shading techniques.
●	Apply the knowledge of assembly modelling, tolerance analysis and CAD standards.

Text Books:	
1	Ibrahim Zeid "Mastering CAD CAM" Tata McGraw-Hill Publishing Co.2007.
2	Donald Hearn and M. Pauline Baker. "Computer Graphics", Prentice Hall, Inc., 2012.

Reference Books(s) / Web links:	
1	William M Neumann and Robert F.Sproull. "Principles of Computer Graphics", Mc Graw Hill Book Co. Singapore, 2001.
2	Rao PN, "CAD / CAM Principles and Applications "- Mc Graw Hill Publisher, 2017
3	Ibrahim Zeid and Subramanian R , CAD/CAM --Theory and Practice - McGraw Hill, International Edition, 2009

CO - PO – PSO matrices of course

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO8	PO9	PO10	PO11	PO12	**PSO1**	**PSO2**	**PSO3**
CO 1	3	1	1	-	3	-	-	-	2	2	-	2	1	-	2
CO 2	3	1	1	-	3	-	-	-	2	2	-	2	1	-	2
CO 3	3	1	1	-	3	-	-	-	2	2	-	2	1	-	2
CO 4	3	1	1	-	3	-	-	-	2	2	-	2	1	-	2
CO 5	3	1	1	-	3	-	-	-	2	2	-	2	1	-	2

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

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
ME19P67	INDUSTRIAL SAFETY	PE	3	0	0	3

Objectives:	
	To understand the Fundamental concept and Principle of Industrial Safety
	To apply the principle of Maintenance Engineering
	To Study about various types of wear and methods to reduce it.
	To know about various fault-finding methods of machine tools
	To understand about preventive and periodic maintenance methods.

UNIT-I	Industrial Safety	10
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 colour codes. Fire prevention and firefighting, equipment and methods.		
UNIT-II	**Physical and Chemical Hazards**	**11**
Noise, compensation aspects, noise exposure regulation, properties of sound, occupational damage, risk factors, sound measuring instruments. Prevention and control of noise. Recognition of chemical hazards-dust, fumes, mist, vapour, fo gases, types, concentration, Exposure vs. Dose, TLV - Methods of Evaluation, process or operation description, Field Survey, Sampling methodology, Industrial Hygiene calculations, Comparison with OSHAS Standard.		
UNIT-III	**ENVIRONMENTAL CONTROL**	**8**
Industrial Health Hazards – Environmental Control – Industrial Noise - Noise measuring instruments, Control of Noise, Vibration, - Personal Protection.		
UNIT-IV	**HAZARD ANALYSIS**	**8**
System Safety Analysis –Techniques – Fault Tree Analysis (FTA), Failure Modes and Effects Analysis (FMEA), HAZOP analysis and Risk Assessment.		
UNIT -V	**SAFETY REGULATIONS**	**8**
Explosions – Disaster management – catastrophe control, hazard control ,Safety education and training - Factories Act, Safety regulations Product safety – case studies.		
		Total contact Hours: 45

Course Outcomes: At the end of this course, the student can	
●	Explain the fundamental concept and principles of industrial safety
●	Apply the principle of Maintenance engineering
●	Able to understand the types of wear and methods to reduce it.
●	Able to find various faults in machine tools
●	Able to apply periodic maintenance for various equipment's.

Text Books:

1. John V.Grimaldi, "Safety Management", AITB S Publishers, 2003

Reference/Websites:

1. Charles D. Reese, Occupational Health and Safety Management: A Practical Approach, CRC Press, 2003.
2. L M Deshmukh, Industrial Safety Management, Tata McGraw-Hill Education, 2005.
3. J Maiti, Pradip Kumar Ray, Industrial Safety Management: 21st Century Perspectives of Asia, Springer,2017.
4. David L.Goetsch, "Occupational Safety and Health for Technologists", 5th Edition, Engineers and managers, Pearson Education Ltd., 2005.of Asia, Springer,20175 .
5. https://nptel.ac.in/courses/110/105/110105094/

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

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
ME19P68	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 to a 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.		
	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, ASME Y14.5-2018,2019.
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 edition. 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.

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

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

SEMESTER VII
ELECTIVE II

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
ME19P71	Material Testing and Characterization	PE	3	0	0	3

Objectives:	
●	To understand and gain knowledge in Crystal structure, techniques in microstructure evaluation of materials
●	To enhance the knowledge in analysis of microstructure and surface topography of materials through various tools
●	To learn and understand the techniques of chemical and thermal analysis of materials.
●	To learn and impart knowledge in various static mechanical testing methods.
●	To learn and impart knowledge in various dynamic mechanical testing methods.

UNIT-I	**MICRO AND CRYSTAL STRUCTURE ANALYSIS**	**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 - Elements of Crystallography – X- ray Diffraction – Bragg ‘s law – Techniques of X-ray Crystallography – Debye – Scherer camera – Geiger Diffractometer – analysis of Diffraction patterns – Inter planer spacing – Identification of Crystal Structure.		
UNIT-II	**ELECTRON MICROSCOPY**	**9**
Interaction of Electron Beam with Materials – Transmission Electron Microscopy – Specimen Preparation – Imaging Techniques – BF and DF – SAD – Electron Probe Microanalysis – Scanning Electron Microscopy – Construction and working of SEM - Back scattered and Secondary Electron Imaging Techniques – Applications- Atomic Force Microscopy- Construction and working of AFM - Contact and Non-Contact modes Applications.		
UNIT-III	**CHEMICAL AND THERMAL ANALYSIS**	**9**
Basic Principles, Practice and Applications of X-Ray Spectrometry, Energy dispersive and Wave Dispersive X-Ray Spectrometry, Auger Spectroscopy, Secondary Ion Mass Spectroscopy, Differential Scanning Calorimetry (DSC) And Thermo Gravity Metric Analysis (TGA) - Dynamic Mechanical Analysis (DMA)		
UNIT-IV	**MECHANICAL TESTING – STATIC TESTS**	**9**
Hardness – Brinell, Vickers, Rockwell and Micro Hardness Test, Rebound hardness and Indentation – Tensile Test – Stress – Strain plot – Proof Stress – Torsion Test - Ductility Measurement – Impact Test – Charpy and Izod – DWTT - Fracture Toughness Test		
UNIT-V	**MECHANICAL TESTING – DYNAMIC TESTS**	**9**
Fatigue – Low and High Cycle Fatigues – Rotating Beam and Plate Bending HCF tests – S-N curve – LCF tests – Crack Growth studies – Creep Tests – LM parameters - Applications of Dynamic Tests – Fatigue life estimation.		
	Total Contact Hours : 45	

Course Outcomes: On completion of this course, the students will be able to	
●	To Study the basics about crystal structure analysis using optical microscope and characterize the engineering materials.
●	To analyze the microstructure of a material using electron microscope and other characterization tools
●	To determine the chemical and thermal property of a given material.
●	To predict the mechanical characteristics of a material using static test
●	To determine the dynamic mechanical characteristics of a material
Text Book:	
1	Angelo P C, Material characterization, Cengage Learning India, 2016.
2	Dieter, George E., “Engineering Design - A Materials and Processing Approach”, McGraw Hill, International Editions, Singapore, 2000.

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	Suryanarayana A. V. K., Testing of metallic materialism's publications, 2007.
4.	Suryanarayana C, Experimental Techniques in materials and Mechanics, CRC Press,2011.
5.	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.
6.	https://nptel.ac.in/courses/113106034/
7.	https://nptel.ac.in/courses/115/103/115103030/

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

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

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
ME19P72	**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 be familiar with Liquid and Solid based AM processes.
●	To be familiar with 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 Engineered Net 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 explain the development of AM technology and how AM technology propagated into various businesses and developing opportunities.
●	Ability to explain the process of transforming a concept / existing product into 3D model used in AM technology.
●	Ability to explain Liquid and Solid based AM processes.
●	Ability to explain 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 and 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) / Web links:	
1	Amit Bandyopadhyay and Susmita Bose, "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", Woodhead Publishing., United Kingdom, 2016.

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

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

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
ME 19P73	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 plants.
●	Analyse various open and closed cycles relating to diesel and gas turbine power plants & working 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, (2001), Power Plant Engineering: Steam and Nuclear, Tata McGraw-Hill Publishing Company Ltd., Second Edition.

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

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

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

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
GE19P71	**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: At the end of this course, students can have the	
●	Ability to understand the basic concepts of management and its theories.
●	Ability to understand the management concept of planning.
●	Ability to understand the management concept of organizing.
●	Ability to understand the management concept of directing.
●	Ability to understand the management concept of controlling and international management.

Text Books:	
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):	
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.

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

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

SEMESTER-VII
ELECTIVE III

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
ME19P74	HYDRAULICS AND PNEUMATICS	PE	3	0	0	3

Objectives:

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

UNIT-I	**FLUID POWER PRINCIPLES AND HYDRAULIC SYSTEMS (ACTUATOR-PUMPS)**	**7**
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 SYSTEM (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, Hydrostatic transmission, Accumulators application circuits, Electro hydraulic circuits, Mechanical Hydraulic servo systems		
UNIT-IV	**PNEUMATIC SYSTEM**	**8**
Compressors- Filter, Regulator, Lubricator, Muffler, Air control Valves, Quick Exhaust valves, Pneumatic actuators, Servo systems. Introduction to Fluidics, Pneumatic logic circuits.		
UNIT-V	**DESIGN OF HYDRALIC AND PNEUMATIC CIRCUITS**	**12**
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: On Successful Completion of the course, students Will be able to

1	Apply the basics of fluid power system and its applications in industry
2	Analyze the Hydraulic systems and its components
3	Design the Hydraulic circuits and Hydro static transmission
4	Execute the basic concepts of pneumatic system and its logic circuits.
5	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, 2017

Reference Books(s) / Web links:

1	Shanmugasundaram.K, "Hydraulic and Pneumatic controls", Chand & Co, 2011.
2	Srinivasan. R, "Hydraulic and Pneumatic Control", IInd Edition, Tata McGraw - Hill Education,2012.
3	Majumdar, S.R., "Pneumatic Systems – Principles and Maintenance", Tata McGraw Hill, 2007
4.	https://nptel.ac.in/courses/112/105/112105046/

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PS03
CO 1	2	2	1	-	-	-	-	-	-	-	-	2	1	-	2
CO 2	2	2	1	-	-	-	-	-	-	-	-	2	1	-	2
CO 3	2	2	2	1	-	-	-	-	-	-	-	2	1	-	2
CO 4	2	2	2	1	2	-	-	-	-	-	-	2	2	-	2
CO 5	2	2	3	2	2	-	-	-		-	-	2	2	-	2

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

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
ME19P75	**REFRIGERATION AND AIR CONDITIONING**	**PE**	**3**	**0**	**0**	**3**

Objectives: The main learning objective of this course is to prepare the students	
●	To understand the different types of refrigerants, their properties, and selecting appropriate refrigerant for a HVAC system.
●	To understand different types and components of RAC systems.
●	To design the heat load and system size.
●	To understand types of air-conditioning system and air distribution configurations.
●	To Apply the safety and types of control in HVAC systems.

UNIT-I	**INTRODUCTION, REFRIGERANTS AND THEIR ENVIRONMENTALISSUES**	**9**
Applications of air-conditioning and refrigeration, energy usage in air-conditioning/buildings. Introduction of Refrigeration and Heat Pump: Carnot cycle, modification in reversed Carnot cycle, vapour compression cycle, actual vapour compression cycle. Designation of refrigerants, Selection of refrigerants, Ozone Depletion Potential (ODP) and Global Warming (GW), Montreal and Kyoto protocols Total Equivalent Warming Index (TEWI), Azeotropic and zeotropic mixtures, alternative to existing CFC and HCFC refrigerants.		
UNIT-II	**BASIC REFRIGERATION, ADVANCED CYCLES AND THEIR COMPONENTS**	**9**
Single and multi-compressor and multi-evaporator systems, System with flash chamber and intercooler, P-h and T-s diagrams, thermodynamic analysis, effect of inter cooling, sub-cooling and super heating, Cascade refrigeration. Types of compressors, condensers, evaporators, expansion devices - Comparison between air-cooled and water-cooled condenser-based air-conditioning plants.		
UNIT-III	**AIR-CONDITIONING AND HEATING / COOLING LOAD ESTIMATION**	**9**
Introduction to thermal comfort and parameters of indoor environment quality; Psychrometric properties, Psychrometric chart; Basic process in air-conditioning: Humidification and Dehumidification processes; Introduction to evaporative cooling and cooling towers-Thermodynamic analysis. Heating and Cooling Load Estimation: Components of cooling/heat load, Room sensible heat factor (RSHF), Grand sensible Heat factor (GSHF), Heating and cooling load estimation of a typical office / domestic building, Concept of diversity.		
UNIT-IV	**AIR CONDITIONING SYSTEM TYPES AND AIR DISTRIBUTION**	**9**
Major system types in air-conditioning: unitary, package, central chilled water based systems; components of chilled water system, concept of primary-secondary chilled water pumping; concept of variable flow systems, components of non-chilled water based system, types and role for energy efficiency, comparison of variable refrigerant flow and constant flow systems. Fundamentals of duct design, pressure loss and AHU calculations, types of terminal units, advanced air distribution: VAV, UFAD systems; concept of heat recovery systems.		
UNIT-V	**OTHER REFRIGERATION SYSTEMS, CONTROLS AND SAFETY IN RAC**	**9**
Introduction to Vortex tube, steam jet and thermoelectric refrigeration systems, vapor absorption, vapor adsorption systems, reversed Brayton cycle -air based refrigeration. Introduction to Building Management System, major components and use of BMS, instrumentation requirements, concept of Direct Digital Control. Installation, commissioning, noise, vibration, electrical connections and safety in RAC systems		
	Total Contact Hours :	**45**

Course Outcomes: O**n successful completion of this course, the students will be able to**	
●	Explain the different types of refrigerants, their properties, and select appropriate refrigerant for a HVAC system.
●	Explain different types and components of RAC systems
●	Design the heat load and system size
●	Explain types of air-conditioning system and air distribution configurations.
●	Apply the safety and types of control in HVAC systems

Text Book (s):	
1	Arora C P, Refrigeration and Air Conditioning, 3rd Edition, Tata McGraw-Hill, 2017.
2	Stoecker W.F and Jones J.W, Refrigeration and Air Conditioning, 2nd Edition, Tata McGraw-Hill, 1982.

Reference Books(s) / Web links:	
1	Anantanarayanan P.N, Basic Refrigeration and Air Conditioning, 4th Edition, Tata McGraw-Hill, 2013.
2	Arora R.C, Refrigeration and Air Conditioning, Prentice Hall India, 2010.
3	ASHRAE Handbook Series: Fundamentals, Refrigeration, Systems and Equipments and HVAC Applications,2014-18, ASHRAE Inc, Atlanta, USA
4	Dossat Roy J., Principles of Refrigeration, 4th Edition, Pearson Education Asia, 2002
5	Kuehn T.H, Ramsey J W and Therelkeld J L, Thermal Environmental Engineering, Prentice Hall, 1998.

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

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

Subject Code	**Subject Name (Theory course)**	**Category**	**L**	**T**	**P**	**C**
ME19P76	**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.
●	Capability 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 welding 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, 2007.
2	Peter Scallan, “Process Planning, The Design/Manufacture Interface”, Butterworth Heinemann, 2003.

Reference Books(s) / Web links:	
1	Chitale A. K., and Gupta R. C., “Product Design and manufacturing”, Prentice Hall of India, New Delhi, 1997.
2	Gideon Halevi, “Process and operation planning”, Kluwer academic publishers (Printed ebook), 2003.
3	Narang G.B.S. & Kumar. V, “Production and Costing”, Khanna Publishers, 2000.
4	Phillip F. Ostwald & Jairo Munoz, “Manufacturing Processes and Systems”, 9th Edition, Wiley student edition, 2002.
5.	Robert Creese, Adithan M. &Pabla B. S., “Estimating and Costing for the Metal Manufacturing Industries”, Marcel Dekker, 1992.

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

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

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
GE19P72	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 for the enterprise.

UNIT-I	ENTREPRENEUR AND ENTREPRENEURSHIP	9
Entrepreneurship – definition and characteristics - characteristics of entrepreneur - classification of entrepreneurs – Danhofi's classification - other classifications - Functions of entrepreneurs – role of entrepreneurship in economic development and job creation - Emergence of entrepreneurial class in 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 and psychological theories - Entrepreneurial motivation: Theories of motivation - Entrepreneurial competencies – Entrepreneurship development Programs – need, objectives - Time management - Stress management.		
UNIT-III	**BUSINESS**	9
Small Enterprises – Definition, characteristics, project identification and selection – Feasibility and profitability analysis – Formulation of project report– significance and content - Types of business 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 finance - break even analysis – Capital budgeting - simple problems – Introduction to balance sheet and profit and loss statement – Importance of profitability – sustainability - Working capital management: significance, assessment, factors, sources, management.		
UNIT-V	**SUPPORT TO ENTREPRENEURS AND CASE STUDIES**	9
Sickness in small business: concept, signals, symptoms, magnitude, causes and consequences, corrective measures – Government policy for small scale enterprises – Growth strategies in small scale enterprise – Institutional support to entrepreneurs: need and support – Taxation benefits to small scale industry. Case studies in entrepreneurship.		
	Total Contact Hours : 45	

Course Outcomes: At the end of this 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 the growth strategies in enterprise.

Text Books:	
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	Mathew J Manimala, "Entrepreneurship theory at cross roads: paradigms and praxis", 2nd edition, Dream Tech., 2006.
5.	Rabindra N. Kanungo, "Entrepreneurship and Innovation", Sage Publications, New Delhi, 1998.
6.	Singh, A. K., "Entrepreneurship Development and Management", University Science Press, 2009.

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

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

ELECTIVE IV

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
ME19P77	**Production Planning and Control**	**PE**	**3**	**0**	**0**	**3**

Objectives:	
●	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, MRP II 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	**WORK STUDY**	**9**
Method study, basic procedure –Selection-Recording of process - Critical analysis, Development - Implementation - Micro motion and memo motion study – work measurement - Techniques of work measurement - Time study - Production study - Work sampling - Synthesis from standard data – 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-MRP I-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 MRP II 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 analyse process capabilities in a multi-product system.
●	Ability to make a better scheduling and line balancing, also to apply techniques for aligning completion times and due dates.
●	Ability to adopt different methods of planning to control Inventory in manufacturing organization and to implement recent trends like JIT, MRP II and ERP systems.

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

Reference Books(s) / Web links:	
1	Elwood S.Buffa, and Rakesh K.Sarin, "Modern Production / Operations Management", 8th Edition, John Wiley and Sons, 2000.
2	Kanishka Bedi, "Production and Operations management", 2nd Edition, Oxford University Press, 2007.
3	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 Hill, 1995.

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

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

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
ME19P78	**Welding Technology**	**PE**	**3**	**0**	**0**	**3**

Objectives:	
●	To understand the principles, types, merits, demerits and applications of gas and arc welding processes.
●	To understand 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 be familiar with 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	
●	Select appropriate type of gas and arc welding type for an application.
●	Select appropriate type of resistance welding type for an application.
●	Select 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.

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

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

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
ME19P79	**HYBRID AND ELECTRICAL VEHICLES**	**PE**	**3**	**0**	**0**	**3**

Objectives: The main learning objective of this course is to prepare the students	
●	To know the History of Electric vehicle and comparison with internal combustion engines
●	To understand different types of Architectural design of Electrical vehicle
●	To learn the Power calculation and energy storage systems
●	To learn the torque calculation for the motor, Electrical connections in the motor and function of control unit
●	To understand Energy management system and learn about the charging station.

UNIT-I	INTRODUCTION: ELECTRIC VEHICLE	9
History-Components of Electric Vehicle-Comparison with Internal combustion Engine: Technology - Comparison with Internal combustion Engine: Benefits and Challenges-EV classification and their electrification levels-EV Terminology.		
UNIT-II	**ELECTRIC VEHICLE ARCHITECTURE DESIGN**	**9**
Types of Electric Vehicle and components-Electrical protection and system requirement-Photovoltaic solar based EV design-Battery Electric vehicle (BEV)-Hybrid electric vehicle (HEV)-Plug-in hybrid vehicle (PHEV-Fuel cell electric vehicle (FCEV)-Electrification Level of EV-Comparison of fuel vs Electric and solar power-Solar Power operated Electric vehicles.		

UNIT-III	POWER CALCULATIONS FOR ELECTRIC VEHICLE & ENERGY STORAGE SOLUTIONS	9
Motor Torque Calculations for Electric Vehicle: Calculating the Rolling Resistance-calculating the grade resistance-Calculating the Acceleration Force-Finding the Total Tractive Effort-Torque Required on The Drive Wheel **Energy Storage Solutions (ESS):** Cell Types (Lead Acid/Li/NiMH)-Battery charging and discharging calculation-Cell Selection and sizing-Battery lay outing design-Battery Pack Configuration-Battery Pack Construction-Battery selection criteria.		
UNIT-IV	**ELECTRIC DRIVE AND CONTROLLER**	**9**
Types of Motors-Selection and sizing of Motor-RPM and Torque calculation of motor-Motor Controllers-Component Sizing-Physical Locations-Mechanical connection of motor-Electrical connection of motor. **Control Unit:** Function of CU-Development Process-Software-Hardware-Data Management-GUI (Graphical User Interface)/HMI (Human-Machine Interface)		
UNIT-V	**MANAGEMENT SYSTEM & CHARGING STATION**	**9**
Battery Management System (BMS)/Energy Management System (EMS): Need of BMS-Rule based control and optimization-based control-Software-based high level supervisory control-Mode of power-Behavior of motor-Advance Features **Electric Vehicles charging station:** Type of Charging Station-Selection and Sizing of charging station-Components of charging station-Single line diagram of charging station		
	Total Contact Hours : 45	

Course Outcomes: **On the successful completion of this course students will be able to**	
●	Explain the importance of Electrical vehicle and challenges with internal combustion engines
●	Compare and contrast the various electric vehicle architecture designs
●	Design the motor Torque and Energy storage systems
●	Explain about different motors, Electrical connections and Control units
●	Describe battery management system and Electrical vehicle changing station

Text Book(s):	
1	Tom Denton, "Electric and Hybrid Vehicles" Published by Routledge- June 10, 2020
2	Husain, I. "Electric and Hybrid Vehicles" Boca Raton, CRC Press, 2010.

Reference Books(s) / Web links:	
1	Mehrdad Ehsani ,Yimin Gao , Sebastien E. Gay and Ali Emadi "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles (Fundamentals, Theory, and Design)" CRC Press, 2004
2	https://www.routledge.com/rsc/downloads/CRC_Hybrid_Vehicles_Freebook.pdf
3	https://nptel.ac.in/courses/108/103/108103009/
4	https://www.energysage.com/electric-vehicles/charging-your-ev/
5	https://www.mpoweruk.com/infrastructure.htm
6	https://www.orionbms.com/general/how-it-works/

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

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

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
GE19P73	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 and retaining customers, Consumerism in India, Market segmentation and targeting, Positioning and differentiation strategies, Product life cycle strategies, New product development, Product Mix and Product line decisions, Branding and packaging, segmentation factors - demographic - psycho graphic and geographic segmentation, process, patterns. Product and brand management.		
UNIT-III	**PRODUCT PRICING AND MARKETING RESEARCH**	9
Price setting - objectives, factors and methods, Price adapting policies, Initiating and responding to price changes. Introduction, uses and process of marketing research.		
UNIT-IV	**MARKETING PLANNING AND STRATEGY FORMULATION**	7
The 4 Ps of marketing, Components of marketing plan-strategy formulations and the marketing process, implementations, portfolio analysis, BCG, GEC grids.		
UNIT-V	**SALES PROMOTION AND DISTRIBUTION**	11
Characteristics, impact, goals, types of sales promotions - point of purchase - unique selling proposition. Identifying and analysing competitors, Designing competitive strategies for leaders, challengers, followers and nichers. Advertising, types, and case studies. Distribution - Characteristics, impact, goals, types and sales promotions - point of purchase - unique selling proposition. Characteristics, wholesaling, retailing, channel design, logistics, and modern trends in retailing.		
	Total Contact Hours : 45	

Course Outcomes: At the end of this course, students can have the	
●	Ability to understand the basics of marketing process.
●	Ability to analyze, design and implement market segmentation
●	Ability to understand the needs and application of marketing research.
●	Ability to understand marketing, planning and strategy formulation.
●	Ability to implement sales promotion, advertising and distribution.

Text Books:	
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.

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

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

Semester VIII

ELECTIVE V

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
ME19P81	OPERATIONS RESEARCH	PE	3	0	0	3

Objectives:	
●	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 n Jobs through 2 Machines, n Jobs through 3 Machines, n Jobs through m 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	**QUEUEING MODELS**	**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 a real-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	Premkumar Gupta and D.S.Hira, “Problems in Operations Research”, S.Chand, 2009.
2	Sharma J K, “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 EEE PHI, 2017.
5.	Tulsian and Pasdey V., “Quantitative Techniques”, Pearson Asia, 2002.

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

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

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
ME19P82	**DESIGN OF JIGS, FIXTURES AND PRESS TOOLS**	**PE**	3	0	0	3

Objectives:	
1	To understand the principles of locating and clamping in Jigs and fixtures and various components related to Press tools
2	To know about DesigningvarioustypesofJigsforgivencomponentsanddrawmultipleviewsofthesamewith dimensions and parts List.
3	To know the design of various type of Fixtures for given components and draw multiple views of the same with dimensions and parts List.
4	To understand the various parts of cutting dies and draw the standard dimensioned views.
5	To understand the Designing of various parts of forming dies and draw the standard dimensioned views

UNITI	**PRINCIPLES OFJIGS, FIXTURESAND PRESSWORKING**	**9**

Objectives and importance of tool design—work holding devices- Basic elements of jigs and fixtures-location–clamping-indexing-operationalchart-FitsandTolerancesToolsforpressworking- Press WorkingTerminologies–cuttingandnoncuttingoperations–Typesofpresses–press accessories– Computation of press capacity– Strip layout–Materia l Utilization–Shearing action– Clearances – Press Work Materials – Center of pressure– knockouts – direct and indirect – pressure pads–Ejectors-Die Block–Punchholder,Dieset,103 guide plates–Stops–Strippers– Pilots–SelectionofStandardparts–Recenttrendsintoolingrecenttrendsin tool design-computer Aids for sheet metal forming Analysis – basic introduction - tooling for numerically controlled machines- set up reduction for work holding– Single minute exchange of dies-PokaYoke.

UNITII	**DESIGN OF JIGS**	9

Design and development of jigs for given component- Types of Jigs–Post, Turnover, Channel, latch,box, pot, angularpost jigs–Indexing jigs.

UNITII I	**DESIGN OF FIXTURES**	**9**

Design and development of fixtures for a given component-General principles of milling, Lathe, boring, broaching and grinding fixtures–Assembly, Inspection and Welding fixtures–Modular fixturing systems- Quick change fixtures.

UNITIV	**DESIGNOF CUTTINGDIES**	**9**

Complete design and preparation of standard views of simple blanking, piercing, compound and progressive dies -fine Blanking dies.

UNITV	**DESIGNOF BENDING, FORMING, DRAWING ANDMISCELLANEOUSDIES**	**9**

Differencebetweenbendingforminganddrawing–Blankdevelopmentforaboveoperations–Types of Bending dies–Press capacity–Spring back–Variables affecting Metal flow indrawing operations–draw die inserts–draw beads-ironing–Design and development of bending, forming, drawing, reverse redrawing and combination dies – Blank development for axisymmetric, rectangular and elliptic parts–Single and double action dies

Total No. of Periods	**45**

Course Outcomes: On completion of this course, the students will be able to	
1	Able to apply the principles of locating and clamping in Jigs and fixtures and various components related to Press tools.
2	Able to design various types of Jigs for given components and draw multiple views of the same with dimensions and parts list.
3	Able to Design various types of Fixtures forgiven components and draw multiple views of the same with dimensions and parts List.
4	Able to design the various part of cutting dies and draw the standard dimensioned views.
5	Able to design the various parts of forming dies and draw the standard dimensioned views.

Text Books:	
1	Joshi, P.H. "Jigs and Fixtures", Second Edition, Tata McGraw Hill Publishing Co., Ltd., New Delhi,2010.
2	Joshi P.H" Press tools-Design and Construction", S.Chand&CoLtd.2001.

Reference Books(s) / Web links:	
1	ASTM–Fundamentals of tool design", Prentice Hall of India, 1984.
2	Donaldson, Lecain and Goold, "Tool Design", Tata McGrawHill,2000.
3	Hoffman "Jigs and Fixture Design"–Thomson Delmar Learning, Singapore,2004.
4	K.Venkataraman, "Design of Jigs Fixtures&PressTools",AnnePublications,2015
5.	https://nptel.ac.in/courses/112/105/112105127/

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

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

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
ME19P83	**NON-DESTRUCTIVE TESTING AND EVALUATION**	**PE**	**3**	**0**	**0**	**3**

Objectives:	
●	To make the students understand the importance of NDT in quality assurance.
●	To imbibe the students 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 make the students to be ready to use NDT 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- Borescopes -Video scopes, Special features in Borescopes, Selection of borescopes, 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.		
	Total Contact Hours : 45	

Course Outcomes: At the end of this course,	
•	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.

Text Books:	
1	ASM Metals Handbook, "Non-Destructive Evaluation and Quality Control", American Society of Metals, Metals Park, Ohio, USA, 200, Volume-17.
2	Paul E Mix, "Introduction to Non-destructive testing: a training guide", Wiley, 2nd edition New Jersey, 2005.

Reference Books(s) / Web links:	
1	Baldev Raj, T.Jayakumar, M.Thavasimuthu, "Practical Non-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, Electromagnetic Testing, Vol. 6, Acoustic Emission Testing, Vol. 7, Ultrasonic Testing.
3	Charles, J. Hellier," Handbook of Non-destructive evaluation", McGraw Hill, New York, 2001.
4	Ravi Prakash, "Non-Destructive Testing Techniques", New Age International Publishers, 1st Revised edition, 2010.
5.	https://nptel.ac.in/courses/113106070/

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

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

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
ME19P84	**COMPUTATIONAL FLUID DYNAMICS**	**PE**	**3**	**0**	**0**	**3**

Objectives: The main learning objective of this course is to prepare the students	
●	To analyse mathematical and computational methods for fluid flow and heat transfer simulations
●	To use the Finite difference and volume method for solving diffusion problems
●	To use finite volume method for convection diffusion
●	To assess the flow parameters in internal and external flows
●	To expose the students to various models in flow analysis

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: On successful completion of this course, students will 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
●	Analyze Finite volume method for Convective diffusion problems
●	Analyze Flow field problems
●	Explain the Turbulence models and Mesh generation techniques

Text Book(s):	
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.
3	Jiyuan TL, Guan Heng Yeoh, "Computational Fluid Dynamics a Practical Approach" Butterworth-Heinemann, 1st Edition 2008.
4	Anderson, Jr., John D.., "Computational fluid Mechanics the Basics withApplications" McGraw Hill Education, 2012.

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

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

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

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
ME19P85	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 know about Taguchi method for parameter Optimization.
●	To create exposure on 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 Hours : 45	

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

- Ability to understand the fundamental principles of Classical Design of Experiments.
- Ability to apply single factor experiment for process parameter understanding and optimization.
- Ability to apply Factorial Design principles for understanding of process parameters and its optimization.
- Ability to gain 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, 2019.
2. Krishnaiah K and Shahabuddin P, "Applied Design of Experiments and Taguchi Methods", PHI, 1st Edition, 2011.

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, 2005.
2. Krishnaiah K, "Applied Statistical Quality Control and Improvement", 1st Edition,2014.
3. Phillip J. Ross, "Taguchi Techniques for Quality Engineering", Tata McGraw-Hill, India, 2005.

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

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

ELECTIVE VI

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
ME19P86	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 the invention.
●	To understand the patent rights and recent developments in IPR.
●	To understand the industrial design and geographical indication procedures to get patents, copy right, trademarks and 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 and mixed-methods research.		
UNIT-II	**REVIEW OF LITERATURE AND TECHNICAL WRITING**	9
Effective literature studies approach, analysis Plagiarism, Research ethics, Effective technical writing, how to write report, 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: At the end of this course, students can have the	
●	Ability to Apply knowledge on research problem formulation and analyze research related information.
●	Ability to write the literature review and technical paper.
●	Ability to apply IPR concept to important place in growth of individuals & nation.
●	Ability to Apply patent right to new products developed.
●	Ability to describe the procedure and the tools to get patent copy right for their innovative work.

Text Books:	
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:	
1	Stuart Melville and Wayne Goddard, “Research Methodology: An Introduction For Science & Engineering Students”,2nd edition, Juta Academic, 2001.
2	Ramakrishna B & Anilkumar H S, “Fundamentals of Intellectual Property Rights”, 1st edition, Notion Press, 2017.
3	William G Zikmund, Barry J Babin, Jon C.Carr, Atanu Adhikari,Mitch Griffin, “Business Research methods: A South Asian Perspective, 8th Edition, Cengage Learning, New Delhi, 2012.

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

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

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
ME19P87	**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 know the 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 Contact Hours : 45	

Course Outcomes: On successful completion of this course, students will 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
●	Perform energy audit in an Industry

Reference Books(s) / Web links:	
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.
3	W.R. Murphy and G. McKay "Energy Management" Butterworths, London 1987
4	W.C. turner, "Energy Management Hand book" Wiley, New York, 1982
5	Dhandapani Alagiri, Energy Security in India Current Scenario, The ICFAI University Press, 2006.

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

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

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
ME19P88	SUPPLY CHAIN AND LOGISTICS MANAGEMENT	PE	3	0	0	3

Objectives: The students can	
●	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 network Decisions – Impact of uncertainty on Network Design – Network design decisions – Network design decisions using 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 SUPPLY CHAIN**	**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.

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.

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

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

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
ME19P89	**CORROSION AND SURFACE ENGINEERING**	**PE**	**3**	**0**	**0**	**3**

Objectives:

- 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.

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**	**6**

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: On successful completion of this course, the students will be able to	
	● Describe the fundamentals of corrosion process.
	● Comprehend the various theories on friction
	● Describe the various methods of wear in materials.
	● Apply surface modification methods which are necessary to solve the industrial practical problems.
	● Determine the properties of advanced materials.

TEXTBOOKS	
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:	
2	Rabinowicz.E, "Friction and Wear of materials", John Willey &Sons, UK,1995.
3	Halling, J. (Editor) – "Principles of Tribology ", Macmillian – 1984
4	Williams J.A. "Engineering Tribology", Oxford Univ. Press, 1994
5	S.K.Basu, S.N.Sengupta & B.B.Ahuja ,"Fundamentals of Tribology", Prentice –Hall of India Pvt Ltd , New Delhi, 2005.
7.	https://nptel.ac.in/courses/112107248/

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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)