Department of Mechanical Engineering

Scheme of Teaching and Examinations

Bachelor of Technology

(Mechanical Engineering)

3rd and 4th year

W.E.F 2025

DELHI TECHNOLOGICAL UNIVERSITY

(Formerly Delhi College of Engineering)

(Estd. By Govt. of NCT of Delhi vide Act 6 of 2009)

Delhi Technological University
(Formerly Delhi College of Engineering)
Shahbad Daulatpur, Bawana Road, Delhi – 110 042

Vision & Mission of the University

VISION

To be a world class university through education, innovation and research for the service of humanity.

MISSION

1. To establish centres of excellence in emerging areas of science, engineering, technology, management and allied areas.
2. To foster an ecosystem for incubation, product development, transfer of technology and entrepreneurship.
3. To create environment of collaboration, experimentation, imagination and creativity.
4. To develop human potential with analytical abilities, ethics and integrity.
5. To provide environment friendly, reasonable and sustainable solutions for local & global needs.

DEPARTMENT OF MECHANICAL ENGINEERING

VISION

To become a global hub of academic excellence, research and innovation in the field of Mechanical, Production & Industrial, and Automobile Engineering.

MISSION

To produce world class skilled Mechanical, Production & Industrial, and Automobile Engineers by imparting quality education through cutting edge technologies, and Research & Development enabling them to work towards sustainable professional development

Program Educational Objectives (PEOs)

Mechanical Engineering

PEO 1: Graduate shall have ability to understand and apply core subject knowledge to various mechanical engineering problems.

PEO 2: The graduates will be able to work in team, investigate the problem and present an ecological sustainable solution.

PEO 3: The graduates shall be competent in engineering modelling and experimental capabilities to pursue research and higher education.

PEO 4: The graduates shall have good communication skill, high ethical and social values.

Program Specific Outcomes (PSOs):

PSO1: An ability to identify industrial problems and to provide solutions with the help of production engineering tools.

PSO2: An ability of collaborative learning to find out sustainable, solution for social issues

PSO3: Apply the knowledge of Manufacturing Engineering and Engineering Management to the solution of complex Engineering Problems through empathy and creativity.

Program Outcomes (POs)

Engineering Graduates will be able to:

POs1: Engineering knowledge : Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

POs2: 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.

POs3: 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.

POs4: 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.

POs5: 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.

POs6: 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.

POs7: 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.

POs8: Ethics : Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

POs9: Individual and teamwork : Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

POs10: 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.

POs11: 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.

POs12: Lifelong 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.

BACHELOR OF TECHNOLOGY

Mechanical Engineering

II Year: Third Semester

S. No.	Code	Title	Area	Cr	L	T	P	TH	PH	CWS	PRS	MTE	ETE	PRE
1.	PE251	Engineering Materials & Metallurgy	AEC	4	3	0	2	3	0	15	25	20	40	
2.	ME201	Mechanics of Solids	DCC	4	3	0	2	3	0	15	25	20	40	-
3.	ME203	Thermal Engineering-II	DCC	4	3	0	2	3	0	15	25	20	40	-
4.	ME205	Fluid Mechanics	DCC	4	3	0	2	3	0	15	25	20	40	-
5.	ME207	Industrial Engineering	DCC	4	3	0	2	3	0	15	25	20	40	-
6.	AEC/VAC			2	2/1 /0	0	0/2 /4	3/3 /0	0/2 /3	25/ 15/0	0/25 /50	25/ 20/0	50/ 40/0	0/0 /50
		Total		**22**										

II Year: Fourth Semester

S. No.	Code	Title	Area	Cr	L	T	P	TH	PH	CWS	PRS	MTE	ETE	PRE
1.	PE252	Manufacturing Machines	AEC	4	3	0	2	3	0	15	25	20	40	-
2.	ME202	Heat Transfer	DCC	4	3	0	2	3	0	15	25	20	40	-
3.	ME204	Manufacturing Technology-I	DCC	4	0	0	6	0	3	0	50	-	-	50
4.	ME206	Theory of Machines	DCC	4	3	0	2	3	0	15	25	20	40	-
5.	ME208	Machine Drawing and Solid Modeling	DCC	4	3	0	2	3	0	15	25	20	40	-
6.	AEC/VAC			2	2/1 /0	0	0/2 /4	3/3 /0	0/2 /3	25/ 15/0	0/25 /50	25/ 20/0	50/ 40/0	0/0 /50
		Total		**22**										

BACHELOR OF TECHNOLOGY

Mechanical Engineering: III Year: Fifth Semester

S. No.	Code	Title	Area	Cr	L	T	P	TH	PH	CWS	PRS	MTE	ETE	PRE
1.	ME301	Design of Machine Element - I	DCC	4	3	0	2	3	0	15	25	20	40	
2.	ME303	Manufacturing Technology II	DCC	4	3	0	2	3	0	15	25	20	40	-
3.	ME305	Refrigeration and Air Conditioning	DCC	4	3	0	2	3	0	15	25	20	40	-
4.	MG301	Fundamentals of management	HMC	3	3	0	0	3	0	25	0	25	50	-
5.	ME3XX	Department Elective course I	DEC	4	3	0/1	2/0	3	0	15/25	25/0	20/25	40/50	-
6.	ME3XX	Generic Elective course I	GEC	4	3	0/1	2/0	3	0	15/25	25/0	20/25	40/50	-
		Total		**23**										

III Year: Sixth Semester

S. No.	Code	Title	Area	Cr	L	T	P	TH	PH	CWS	PRS	MTE	ETE	PRE
1.	ME302	Operations & Supply Chain management	DCC	4	3	0	2	3	0	15	25	20	40	-
2.	ME304	Design of Machine Elements - II	DCC	4	3	0	2	3	0	15	25	20	40	-
3.	HU302	Engineering Economics	HMC	3	3	0	0	3	0	25	0	25	50	-
4.	ME3XX	Department Elective course 2	DEC	4	3	0/1	2/0	3	0	15/25	25/0	20/25	40/50	-
5.	ME3XX	Department Elective course 3	DEC	4	3	0/1	2/0	3	0	15/25	25/0	20/25	40/50	-
6.	ME3XX	Generic Elective course 2	GEC	4	3	0/1	2/0	3	0	15/25	25/0	20/25	40/50	-
		Total		**23**										

BACHELOR OF TECHNOLOGY

Mechanical Engineering: IV Year: Seventh Semester

S. No.	Code	Title	Area	Cr	L	T	P	TH	PH	CWS	PRS	MTE	ETE	PRE
1.	ME401	B Tech Project - I	DCC	4	-	-	-	-	-	40	-	-	60	
2.	ME403	Internship	DCC	4	-	-	-	-	-	40	-	-	60	-
3.	ME4XX	Department Elective course 4	DEC	4	3	0/1	2/0	3	0	15/25	25/0	20/25	40/50	-
4.	ME4XX	Department Elective course 5	DEC	4	3	0/1	2/0	3	0	15/25	25/0	20/25	40/50	-
5.	ME4XX	Generic Elective course 3	GEC	4	3	0/1	2/0	3	0	15/25	25/0	20/25	40/50	-
6.	ME4XX	Indian Knowledge System	VAC	No Credit	-	-								-
		Total		**18**										

IV Year: Eighth Semester

S. No.	Code	Title	Area	Cr	L	T	P	TH	PH	CWS	PRS	MTE	ETE	PRE
1.	ME402	B Tech Project II	DCC	8	-	-	-	-	-	80	-	-	120	-
2.	ME4XX	Department Elective course 6	DEC	4	3	0/1	2/0	3	0	15/25	25/0	20/25	40/50	-
3.	ME4XX	Generic Elective course 4	GEC	4	3	0/1	2/0	3	0	15/25	25/0	20/25	40/50	-
		Total		**16**										

List of Departmental Elective Courses

S.No.	Subject Code	Subject	Elective No.
1.	ME-351	Power Plant Engineering	DEC -1
2.	ME-353	Clean Energy	
3.	ME-355	Thermal Systems	
4.	ME-357	Industrial Engineering	
5.	ME-359	Product Design & Simulation	
6.	ME-361	Computational Fluid Dynamics	
7.	ME-363	Finite Element Methods	
8.	ME-365	Total Life Cycle Management	
9.	ME-367	Value Engineering	
10.	ME -308	Gas Dynamics & Jet Propulsion	DEC -2,3
11.	ME -310	Automation in Manufacturing	
12.	ME -312	Quality Management & Six Sigma Applications	
13.	ME -314	Mechanical Vibrations	
14.	ME -316	Power Plant Engineering	
15.	ME -318	Computer Aided Manufacturing	
16.	ME -320	Reliability & Maintenance Engineering	
17.	ME -322	Design of Mechanical Assemblies	
18.	ME -324	System modeling, simulation and analysis	
19.	ME -326	Pressure vessels and Piping Technology	
20.	ME -328	Composite Material Technology	
21.	ME-330	Production and Operations Management	
22.	ME -332	Finite Element Method	
23.	ME -334	Industrial Economics & Management	

24.	ME 407	Carbon Capture and Climate Change	
24.	ME -409	Mechatronics & Control	
25.	ME -411	I.C. Engines	
26.	ME -413	Metrology	
27.	ME -415	Project Management	
28.	ME -417	Robotics & Automation	
29.	ME -419	Computational Fluid Dynamics	**DEC 4,5**
30.	ME -421	Advanced Manufacturing Processes	
31.	ME -423	Operations Research	
32.	ME -425	Industrial Tribology	
33.	ME -427	Non-conventional Energy Sources	
34.	ME -429	Computer Integrated Manufacturing	
35.	ME -431	Optimization techniques	
36.	ME 404	Industrial Engineering	
37.	ME -406	Elastic & Plastic Behaviour of Materials	
38.	ME -408	Combustion Generated Pollution	
39.	ME -410	Advances in Welding & Casting	
40.	ME -412	Supply Chain Management	**DEC -6**
41.	ME -414	Fracture Mechanics	
42.	ME -416	Nuclear Energy	
43.	ME -418	Operations and Manufacturing Strategy	
44.	ME -420	Materials management	
45.	ME-422	Fuel Cell	
46.	ME-424	Sustainable Energy Technologies	

ME301 Design of Machine Element – I										
L	**T**	**P**	Credit	Area		**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
3	0	2	4	DCC		15	25	20	40	-

Objective: To enable the students to formulate and analyze the stresses and strains in various machine elements under static and dynamic loads. Students will be able to select a suitable material and factor of safety depending upon the design parameters.

Syllabus		**Contact Hours**
Unit-1	Introduction to Mechanical Engineering Design, design process, Interaction between design process elements, Design-economics, Uncertainty, Stress and strength, Codes and Standards, Factors of safety (FOS), selection of FOS, Probabilistic approach to Design, Engineering materials-ferrous and non-ferrous, Designation of steels as per IS and ASTM standards. Selection of materials- the basics, selection strategy, computer aided selection. Manufacturing considerations in design, interchangeability, Limits, Fits, and Tolerances as per Indian Std. System.	**8**
Unit-2	Failures resulting from static loading, static strength, and stress concentration. Failures resulting from variable loading, introduction to fatigue in metals, Strain life relationship, stress life relationship. Endurance limit modifying factors, stress concentration and notch sensitivity, Goodman, Soderberg and Gerber criteria, Cumulative damage in fatigue, design factors in fatigue.	**6**
Unit-3	Design of Cotter joints and knuckle joints. Riveted joints: Stresses in riveted joints; failure analysis on strength basis; Riveted joints in boilers and pressure vessels; structural riveted joints, eccentric loading of structural rivets. Threaded fasteners and joints: Thread standards; stresses in screw threads; preloading of bolts; bolted joints; eccentric loading; design of power screws and screw jack.	**8**
Unit-4	Springs: Stresses in helical springs; deflection of helical springs; extension, compression and torsion springs; design of helical springs for static and fatigue loading; critical frequency of helical springs; design of concentric springs, stress analysis and design of leaf springs.	**6**
Unit-5	Design of shafts: Design for static loads; torsional and lateral rigidity, reversed bending and steady torsion; Stresses in solid and hollow shafts; design for strength and deflection; design of shafts under fatigue loading; Design of keys, pins and couplings: rigid and flexible couplings.	**8**
Unit-6	Pipe joints: Design of Oval, square and round flanged pipe joints under low and high pressure. Welded joints: Types of welded joints; stresses in butt and fillet welds; torsion and bending in welded joints; welds subjected to fluctuating loads	**6**
	Total	**42**

Reference Books:	
1	Mechanical Engineering Design, Shigley, J. E., Mischke, C. R. and Budynas, R. G., McGraw Hill, 7th Edition, 2004. International.
2	Fundamental of Machine Component Design, " Juvinall, R. C., and Marshek, K. M., John Wiley and Sons, 2000.
3	Fundamentals of Machine Elements Hamrock, B. J., Jacobson, B. Schmidt, S. R.,. McGraw Hill, 1999.
4	An Integrated Approach, Norton, R. L., Machine Design: Pearson Education, Indian Reprint-2001.
5	Design of machine elements 5th edition, Bhandari
6.	Machine Design D. K. Aggarwal and P. C. Sharma DhanpatRai

Course Outcomes

CO1	To define and understand suitable materials for various machine elements
CO2	To understand and estimate allowable loads in machine elements using failure theories
CO3	To analyze steady and variable stresses induced in machine elements for different applications
CO4	To describe screws, keys, riveted joints, pipes and pipe joints for specific applications
CO5	To design Keys and couplings for specific applications
CO6	To design Mechanical springs for specific applications

CO-PO/PSOMatrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	2	0	0	0	0	0	0	2	2	1	1
CO2	3	3	2	3	1	0	0	0	0	0	0	1	2	1	1
CO3	3	3	3	3	1	0	0	0	0	0	0	2	3	3	2
CO4	3	3	3	3	1	0	0	0	0	0	0	1	3	3	2
CO5	2	2	2	2	2	0	0	0	0	0	0	1	2	2	2

ME303 Manufacturing Technology II										
L	**T**	**P**	Credit	Area		**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
3	0	2	4	DCC		15	25	20	40	-

Objective: To familiarize students with cutting too materials, chip formation, force analysis, machine tool drive metrology, Gig and fixtures. To impart in-depth knowledge of non-conventional machining processes.

Syllabus		**Contact Hours**
Unit-1	**Theory of Metal Cutting:** Mechanics of metal cutting- Orthogonal and oblique cutting, Chip formation, Types of chips, Chip control, Merchants theory of cutting forces at tool point, Limitations and modifications of Merchants theory, Plowing forces and the 'Size effect', Heat generation in metal cutting, Cutting fluids and their physical action, Tool wear, Tool life and Machinability, Nomenclature of cutting tools and Cutting tool materials, Economics of machining, Analysis of milling and grinding processes.	**8**
Unit-2	**Design Features of Machine Tools:** Design requirements of machine tools, Kinematic drives of machine tools, Types of machine tool drives	**6**
Unit-3	**Design of machine tool spindle**: Functions of spindle unit and requirements, materials of spindles, effect of machine tool compliance on machining accuracy, design calculations of spindles, bearing and its types .	**6**
Unit-4	**Non-conventional machining:** Studies on basic principle, working and effects of process parameters of the following processes: Ultrasonic machining (USM), Abrasive jet machining (AJM), Electro-discharge machining (EDM), Electro-chemical machining (ECM), Electron beam machining (EBM), Plasma arc machining (PAM) and Laser beam machining (LBM).	**8**
Unit-5	**Metrology:** Introduction to Metrology and its relevance, Limits, fits, and tolerances, Linear and angular measurements.	**8**
Unit-6	**Jigs & Fixtures**: Important considerations in jigs and fixture design. Main principles of designing of jigs and fixtures. Different devices and methods of locations. Different types of clamps used in jigs & fixtures.	**6**
	Total	**42**

Reference Book:	
1	Fundamentals of Machining & Machine Tools by Geoffrey Boothroyd & Winston A. Knight, Marcel & Dekker Publications.
2	Fundamentals of Metal Cutting & Machine Tools by B.L. Juneja, G.S. Sekhon & Nitin Seth, New Age International Publications
3	Manufacturing Technology by P.N.Rao, Tata McGraw Hill Publications
4	Production Engineering Sciences by P.C. Pandey& C.K. Singh, Standard Publications.
5	Engineering Metrology by R.K. Jain, Khanna Publications
6	Engineering Metrology by I.C.Gupta

Course Outcomes

CO1	To understand cutting tool materials, chip formation, cutting fluids.
CO2	To understand machine tool drives, jigs and fixtures design principles
CO3	To discuss limits, fits, tolerances and measurements.
CO4	To describe working principles of non-conventional machining processes.
CO5	To explain design features of different types of machines tools.
CO6	To apply fundamentals of conventional and non-conventional machining processes for verity of practical problems.

CO-PO/PSOMatrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	2	0	0	0	0	0	0	2	2	1	1
CO2	3	3	2	3	1	0	0	0	0	0	0	1	2	1	1
CO3	3	3	3	3	1	0	0	0	0	0	0	2	3	3	2
CO4	3	3	3	3	1	0	0	0	0	0	0	1	3	3	2
CO5	2	2	2	2	2	0	0	0	0	0	0	1	2	2	2

ME305 Refrigeration and Air Conditioning										
L	**T**	**P**	Credit	Area		**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
3	0	2	4	DCC		15	25	20	40	-

Objective: To learn properties of different refrigerants, and thermodynamic cycles of refrigeration. To understand comfort parameters and air conditioning.

Syllabus		**Contact Hours**
Unit-1	**Introduction to Refrigeration**: Necessity and applications, unit of refrigeration and C.O.P., types of Ideal cycles of refrigeration, air-refrigeration, bell coleman cycle, open and dense air systems, actual air-refrigeration system problems, refrigeration needs of aircrafts, actual refrigeration system	**8**
Unit-2	**Vapour Compression Refrigeration**: Working principle and essential components of the plant, simple vapour compression refrigeration cycle - COP, Representation of cycle on T-S and p-h charts - effects of sub cooling and super heating - cycle analysis - Actual cycle, Influence of various parameters on system performance – necessity of multistaging, multistage compression system, and their analysis, necessity and working of cascading system	**10**
Unit-3	**Refrigerants and Absorption Refrigeration:** Desirable properties of refrigerants, classification of refrigerants used, nomenclature, ozone depletion, global warming, vapor absorption system, calculation of max COP, description and working of NH3 - water system and Li Br –water, three fluid absorption system and its salient features, steam jet refrigeration system - working principle, basic components and analysis, principle and operation of vortex tube or hilsch tube.	**8**
Unit-4	**Air Conditioning**: Psychometric properties & processes, comfort 8 air-conditioning, summer and winter air-conditioning, cooling & dehumidification systems, load calculation and applied psychrometry	**8**
Unit-5	**Human Comfort:** Requirements of human comfort and concept 6 of effective temperature, comfort chart, comfort air-conditioning, requirements of industrial air-conditioning, air-conditioning load calculations.	**6**
Unit-6	**Evaporators and condensers**: Study of different types of evaporators and condensers used in refrigeration and air-conditioning systems. Effects on performance of refrigeration and air-conditioning systems for different design features of evaporators and condensers.	**2**
	Total	**42**

Reference Books:	
1	**Refrigeration and Air Conditioning** by C. P. Arora, Tata McGraw Hill, ISBN-9788120339156.
2	**Refrigeration and Air Conditioning** by A. R .Trott and T. C. Welch, Butterworth-Heinemann, ISBN-9780080540436.
3	**Basic Refrigeration and Air Conditioning** by P. N. Ananthanarayan, Tata McGraw Hill, ISBN-9789383286560.
4	**Refrigeration and Air Conditioning** by Wilbert F. Stoecker and Jerold W. Jones, Tata McGraw Hill, ISBN-007061623X.
5	**Refrigeration and Air Conditioning by** Richard Charles Jordan, Gayle B. Priester, Prentice hall of India Ltd, ISBN-9780406269313.
6.	**ASHRAE Handbook – Refrigeration 2010,** ISBN- 9781933742922.

Course Outcomes

CO1	To define and illustrate the fundamental principles of refrigeration and air conditioning system
CO2	To understand cooling capacity and coefficient of performance by conducting test on vapour compression refrigeration systems
CO3	To demonstrate the working of vapour absorption refrigeration systems
CO4	To analyze the properties, applications and environmental issues of different refrigerants
CO5	To describe and calculate cooling load for air conditioning systems used for various
CO6	To apply and implement knowledge of the refrigeration and air conditioning systems in practical problems.

CO-PO/PSOMatrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	2	0	0	0	0	0	0	2	2	1	1
CO2	3	3	2	3	1	0	0	0	0	0	0	1	2	1	1
CO3	3	3	3	3	1	0	0	0	0	0	0	2	3	3	2
CO4	3	3	3	3	1	0	0	0	0	0	0	1	3	3	2
CO5	2	2	2	2	2	0	0	0	0	0	0	1	2	2	2

MG301 Fundamentals of management										
L	**T**	**P**	Credit	Area		**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
3	0	0	3	HMC		25	--	25	50	-

Objective: The basic objective of this paper is to acquaint the students with the basic concepts of management necessary to deal with emerging business environment besides sensitizing them about societal challenges.

Syllabus		**Contact Hours**
Unit-1	Definition of management, importance of management, management principals, managerial roles, managerial ethos, management vs administration, managerial functions, task and responsibilities, organizational structure, motivation: meaning, theories and techniques.	**6**
Unit-2	Concept of business environment, corporate social responsibility and corporate governance, managerial values and ethics.	**4**
Unit-3	Objectives and importance of financial management, basics of capital budgeting, cost of capital, emerging sources of funds for new projects, introduction to stock market.	**4**
Unit-4	Functions of marketing, marketing Vs sales, interface of marketing with other departments, customer life time value, new product development, unethical issues in marketing.	**6**
Unit-5	Introduction to knowledge management, knowledge society, knowledge economy, building knowledge assets, sources of knowledge, technology innovation process.	**6**
Unit-6	E-governance: definition, objectives and significance; challenges in Indian context, Digital India programme.	**4**
	Total	**30**

Reference Books:	
1	Fundamental of Management, Stephen P. Robbins, David A. De Cenzo and Mary Coulter, Pearson Education, 2011 (ISBN:9780273755869)
2	Financial Accounting, 4 ed, S.N. Maheshwari and S.K. Maheshwari, Vikas Pulication,2005 (ISBN: 8125918523)
3	Management, James A F Stonner, Pearson Education,2010 (ISBN: 9788131707043)
4	Marketing Management, 14th ed., Philip Kotler, Kevin Lane Keller, Abraham Koshy and Mithileswar Jha, Pearson Education, 2013 (ISBN: 9788131767160)
5	Knowledge Management in Organizations: A Critical Introduction, Donald Hislop, Oxford University Press, 2013 ISBN: 9780199691937.
6.	PC Tripathi , PN Reddy , Ashish Bajpai .Principles of Management. 2021. McGrawHill.

Course Outcomes

CO1	To define and evaluate the influence of historical forces on the current practice of management
CO2	To identify and evaluate social responsibility and ethical issues involved in business situations and logically articulate own position on such issues.
CO3	To develop the process of management's four functions: planning, organizing, leading, and controlling.
CO4	To evaluate leadership styles to anticipate the consequences of each leadership style.
CO5	To describe the areas to control and selecting the Appropriate controlling methods/Techniques
CO6	To apply the circumstances that lead to management evolution and how it will affect future managers

CO-PO/PSOMatrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	2	0	0	0	0	0	0	2	2	1	1
CO2	3	3	2	3	1	0	0	0	0	0	0	1	2	1	1
CO3	3	3	3	3	1	0	0	0	0	0	0	2	3	3	2
CO4	3	3	3	3	1	0	0	0	0	0	0	1	3	3	2
CO5	2	2	2	2	2	0	0	0	0	0	0	1	2	2	2

ME302 Operations & Supply chain management										
L	**T**	**P**	Credit	Area		**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
3	0	2	4	DCC		15	25	20	40	-

Objective: To apply the most widely used quantitative techniques in decision making. To realize the importance of certain mathematical techniques in getting the best possible solution to a problem involving limited resources.

Syllabus		**Contact Hours**
Unit-1	**Introduction** Introduction to operations management- role, scope and interface with marketing, finance, strategy; **Work study and Ergonomics** Work Study, Work Measurement, Activity Sampling, MOST, Ergonomics, Learning Curve.	**8**
Unit-2	**Forecasting** Demand forecasting, Time Series, Regression Analysis and Qualitative techniques, Forecast Error **Product Design and Development** Product Design and Process Selection, Service Design, Outsourcing, Make buy decision, Value Engineering, QFD, Concurrent Engineering	**6**
Unit-3	**Facility Planning** Facility Planning- location, layout; Line balancing; Analytical tools and techniques for facility planning and design, Single Facility Location **Quality Management** Total Quality Management (TQM), Statistical Process Control (SPC); Concepts of Six-sigma; Maintenance management and equipment replacement policies; World class manufacturing; Concepts of supply chain management, Case studies.	**6**
Unit-4	Introduction to supply chain and logistics management, Historical evolution of SCM, JIT and logistics, Value stream mapping, Inbound and outbound logistics, product postponement and decoupling point in supply chain. Purpose and cost associated with inventory management, Types of inventory, ABC/VED/FSN analysis, Deterministic and probabilistic inventory model, Newspaper boy problem.	**12**
Unit-5	Information technology in supply chain, Uncertainties in demand and supply, Bullwhip effect and its quantification, causes and methods to reduce bullwhip effect, computerized bear game.	**6**
Unit-6	Transportation and warehousing strategies, centralized and decentralized distribution system, concept of Risk pulling.	**4**
	Total	**42**

Reference Books:	
1	Operations Management, Haizer, Render, and Jagdeesh, Prentice Hall
2	Operations Management, Chase, Jacob, and Equilano, Tata McGraw Hill
3	Operations Management, Evans and Collier, Cengage Learning
4	Designing and Managing the Supply Chain: Concepts, strategies and case studies, 3/e, by Simchi Levi, Kaminsky, Simchi levi, Ravi Shankar, TMH.
5	Winser, Leong and Tan, Supply Chain management: a balanced approach, Cengage Learning.
6.	Mohanti and Deshmukh, Biztantra.Supply Chain Management Theory and practices

Course Outcomes

CO1	To define and describe the scope of operations management, trends in business and management process and forecast the demand for products and services for a given organization.
CO2	To solve managerial problems related to product and service design and capacity planning.
CO3	To analyze managerial problems related to plant location and layout, assembly line balancing, aggregate and material requirement planning for a given organization.
CO4	To develop an understanding of the importance of logistics in the formulation of the business strategy and the conduct of supply chain operations.
CO5	To imlement an in-depth understanding of logistics operating areas and their interrelationship.
CO6	To apply strengthen integrative management analytical and problem-solving skills in case studies.

CO-PO/PSOMatrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	2	0	0	0	0	0	0	2	2	1	1
CO2	3	3	2	3	1	0	0	0	0	0	0	1	2	1	1
CO3	3	3	3	3	1	0	0	0	0	0	0	2	3	3	2
CO4	3	3	3	3	1	0	0	0	0	0	0	1	3	3	2
CO5	2	2	2	2	2	0	0	0	0	0	0	1	2	2	2

ME304 Design of Machine Elements - II										
L	**T**	**P**	Credit	Area		**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
3	0	2	4	DCC		15	25	20	40	-

Objective: To enable the students to formulate and analyze the stresses and strains in various machine elements under static and dynamic loads. Students will be able to select a suitable material and factor of safety depending upon the design parameters.

Syllabus		**Contact Hours**
Unit-1	**Friction elements:** Design of Friction clutches- Criteria of uniform wear, and uniform pressure assumptions; Single and Multi-plate clutches, Cone clutch, Centrifugal clutch and applications. Brakes: Design of internal expansion and external contraction type brakes, assumptions, design Band brakes, block brakes, short and long shoes, multiple block brakes, Design of disc brakes.	**8**
Unit-2	**Bearings and Lubrication:** Types of Lubrication, viscosity, journal bearing with perfect lubrication, hydrostatic and hydrodynamic lubrication theory, journal bearing design, heat generation and temperature rise criteria. Types, Selection, and applications of rolling element bearings with axial and radial loads, static and dynamic load rating capacity and calculations, bearing materials, bearing seals, mounting of bearings.	**8**
Unit-3	**Design of Gears:** Helical, Bevel, and Worm gears, design stresses, stress concentration, overload factors, velocity factors, bending strength of gear tooth, Buckingham equation for dynamic loads, and wear characteristics, AGMA design equations, Design of an automobile gear box.	**8**
Unit-4	**Mechanical drives:** selection of transmission, Belt and Chain drives: Flat belts, V-Belts, Roller chains.	**6**
Unit-5	**Hoisting elements:** Theory of curved beams, stresses in curved beams, expression for radius of neutral axis for different cross-sections, C-clamps, Crane hooks and its design, Snatch block assembly elements.	**6**
Unit-6	**Design of Engine parts:** Types and selection of materials for Connecting rod, Design of Connecting rod, thrust in connecting rod, stress due to whipping action on connecting rod ends, Cranks and Crank shafts, strength and proportions of over hung and center cranks, Crank pins, and Crank shafts, design of pistons, Proportions of pistons and cylinders, liners.	**6**
	Total	**42**

Reference Books:	
1	Mechanical Engineering Design Shigley, J. E., Mischke, C. R. and Budynas, R. G., , McGraw Hill, 7th Edition, 2004. International.
2	Fundamental of Machine Component Design, Juvinall, R. C., and Marshek, K. M., John Wiley and Sons, 2000.
3	Fundamentals of Machine Elements Hamrock, B. J., Jacobson, B. Schmidt, S. R.,. McGraw Hill, 1999.
4	Machine Design: An Integrated Approach, Norton, R. L. , Pearson Education, Indian Reprint-2001.
5	Machine Design D. K. Aggarwal and P. C. Sharma DhanpatRai
6.	Design of machine elements 5th edition, Bhandari

Course Outcomes

CO1	To define principles of gear design to spur gears and industrial spur gear boxes.
CO2	To develop proficiency in Design of Helical and Bevel Gear
CO3	To develop capability to analyze Rolling contact bearing and its selection from manufacturer's Catalogue
CO4	To learn a skill to design worm gear box for various industrial applications.
CO5	To inculcate an ability to design belt drives and selection of belt, rope and chain drives.
CO6	To achieve an expertise in design of Sliding contact bearing in industrial applications.

CO-PO/PSOMatrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	2	0	0	0	0	0	0	2	2	1	1
CO2	3	3	2	3	1	0	0	0	0	0	0	1	2	1	1
CO3	3	3	3	3	1	0	0	0	0	0	0	2	3	3	2
CO4	3	3	3	3	1	0	0	0	0	0	0	1	3	3	2
CO5	2	2	2	2	2	0	0	0	0	0	0	1	2	2	2

HU302 Engineering Economics										
L	**T**	**P**	Credit	Area		**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
3	0		3	HMC		25	--	25	50	-

Objective: To enable the students to understand the economic theories which may be applied to maximize return and the economic environment in which they have to operate.

Syllabus		**Contact Hours**
Unit-1	Introduction: Nature and significance of economics, Goods and Utility, Basic Concept of Demand and Supply, Elasticity of Demand-Price elasticity of Demand, Cross elasticity of Demand.	**4**
Unit-2	Production Function, Production Process and Factors of Production, Market – Introduction to Monopoly, Perfect Competition, Oligopoly and Monopolistic Competition, Cost Concepts-Opportunity Cost, Total Cost, Average Cost; Marginal Cost; Life Cycle cost, Sunk Cost; Preparation of Cost Sheet Profit Maximization- numerical problem.	**6**
Unit-3	Money- its evaluation and function, Bank- Commercial Bank and Central Bank and brief idea about function of banking system: Tax and Subsidy, Type of Tax- Direct and Indirect, Monetary and fiscal policy, Inflation and Business cycle, International trade, terms of Trade, Gain from International Trade, Free Trade vs. Protection, Dumping, Balance of Payment.	**4**
Unit-4	Role of Science, Engineering and Technology in Economic Development: Seven salient Features of the Indian Economy; Inclusive Growth; relevance for the Indian Economy; Globalisation & opening up of the Indian Economy; GDP- definition and Its measurement; How knowledge of engineering and technology may be used to improve life at slums; Green Revolution and White revolution. Reasons for their success and can we replicate them	**6**
Unit-5	Appropriate Technology & Sustainable Development. Entrepreneurship: Macro environment for promotion of entrepreneurship: How environment has changed after advent of IT and Globalisation.	**4**
Unit-6	Elementary Economic Analysis: Interest formulas and their Applications; Calculations of economic equivalence, Bases for Comparison of Alternatives: Present Worth Method, Future worth method, Annual equivalent, Internal Rate of Return; Business Risk; Factors which should be taken care while deciding price of the product in the market	**6**
	Total	**30**

Reference Books:	
1	G.J. Thuesen, & W.J. Fabrycky, Engineering Economy, Pearson Education, 2007, ISBN 013028128X
2	William G. Sullivan, Elin M. Wicks, C. Patrick Koelling, Engineering Economy, Prentice Hall, (First Indian reprint). 2009, ISBN 0131486497
3	Donald G. Newman, Jerome P. Lavelle & Ted G. Eschenbach, Engineering Economic Analysis, Oxford University Press, USA, 2004, ISBN 0195168070
4	Seema Singh, Economics for Engineering Students, IK International Publishing House Pvt. Ltd, 2014, ISBN 8190777041
5	Pravin Kumar. Fundamentals of Engineering Economics. 2012. Wiley
6.	Panneerselvam. Engineering Economics. 2013. PHI

Course Outcomes

CO1	Define the basic concept of micro and macroeconomics, engineering economics and their application in engineering economy.
CO2	Evaluate numerically the effects of changes in demand and supply on price determination of products and services.
CO3	The macroeconomic environment and financial systems of the country and its impact on business, society and enterprise.
CO4	The ability to account for time value of money using engineering economy factors and formulae.
CO5	Knowledge of mathematics, economics and engineering principles to solve engineering problems and to analyze decision alternatives in engineering projects considering upon depreciation, taxes and inflation.
CO6	To apply the economics concepts to engineering applications

CO-PO/PSOMatrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	2	0	0	0	0	0	0	2	2	1	1
CO2	3	3	2	3	1	0	0	0	0	0	0	1	2	1	1
CO3	3	3	3	3	1	0	0	0	0	0	0	2	3	3	2
CO4	3	3	3	3	1	0	0	0	0	0	0	1	3	3	2
CO5	2	2	2	2	2	0	0	0	0	0	0	1	2	2	2

ME351 Power Plant Engineering										
L	**T**	**P**	Credit	Area		**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
3	0/1	2/0	4	DEC/GEC		15/25	25	20/25	40/50	-

Objective: To enable the students to understand the fundamental of classification of power plants, base load and Peak load power stations. To impart in-depth knowledge of steam generators, combined cycle power plants and concept of energy conservation and energy auditing.

Syllabus		**Contact Hours**
Unit-1	Indian energy scenario, Indian coals: formation, properties, analysis, benefication and heating value calculation of coals; coking and noncoking coals, fuel handling systems; coal gasification. Classification of power plants, base load and Peak load power stations, co-generated power plant, captive power plant, and their fields of application & selection criteria.	8
Unit-2	**Steam Generators:** High pressure utility boiler, natural and forced circulation, fuel handling, coking and non-coking coal, coal benefication, coal pulverization, pulverized fuel firing system, combustion process, need of excess air, cyclone furnace, fluidized bed boiler, placement of evaporator, economizers, super heaters, re-heaters, air pre-heater in the boiler, de-aeration, boiler blow- down, ash collection by bag house, gravity separation, electrostatic precipitators and wet scrubbers, boiler efficiency calculations, water treatment: external and internal treatment.	**8**
Unit-3	**Combined Cycle Power Plants:** Binary vapour cycles, coupled cycles, gas turbine- steam turbine power plant, gas pipe line control, MHD- Steam power plant, thermionic steam power plant, integrated coal combined cycle (IGCC) power plant.	**6**
Unit-4	**Other power plants:** Nuclear power plants - working and types of nuclear reactors, boiling water reactor, pressurized water reactor, fast breeder reactor, controls in nuclear power plants, hydro power plant -classification and working of hydroelectric power plants, tidal power plants, diesel and gas power plants.	**6**
Unit-5	**Instrumentation and Controls in power plants:** Important instruments used for temperature, flow, pressure, water/steam conductivity measurement; flue gas analysis, drum level control, combustion control, super heater and re-heater temperature control, furnace safeguard and supervisory system (FSSS), auto turbine run-up system (ATRS), interlocks and protection of turbines.	**8**
Unit-6	**Environment Pollution and Energy conservation:** Economics of power generation: load duration curves, power plant economics, pollution from power plants, disposal/management of nuclear power plant waste, concept of energy conservation and energy auditing.	**6**
	Total	**42**

Reference Book:	
1	**Power Plant Engineering** by M.M. Elwakil, Tata McGraw Hill, ISBN- 0070662746.

2	**Power Plant Engineering** by P.K Nag, Tata McGraw Hill, ISBN- 0070435993.
3	**Steam and Gas turbines** by A Kostyuk and V Frolov, MIR Publishers, ISBN-9785030000329.
4	**Modern Power Plant Engineering** by J Wiesman and R Eckart, Prentice hall India Ltd, ISBN- 97801359725.
5	**Planning Fundamentals of thermal Power Plants** by F.S Aschner, John Wiley, ISBN- 07065159X.
6	**Applied Thermodynamics** by T.D Eastop and McConkey, Longman Scientific and Technical, ISBN-0582305351.
7	**CEGB volumes on power plant, Central Electricity Generation Board, ISBN- 0080155680.**
8	**NTPC/NPTI publications on Power plants**, ISBN- 9788132227205.

Course Outcomes

CO1	Importance of coal based thermal power plants and other power plants.
CO2	Working of components of power plants, combined power plants, coal handling
CO3	Controls in power plants, power plant economics, energy conservation.
CO4	Understand the concept of combined cycle plants
CO5	Importance of Controls in power plants
CO6	Applications of power plant economics, energy conservation.

CO-PO/PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	2	2	1	0	1	0	0	3	3	2	2
CO2	2	3	3	2	1	1	0	1	2	0	2	2	2	2	2
CO3	2	2	2	3	1	1	0	0	0	0	0	3	3	1	1
CO4	3	3	3	3	2	2	1	0	1	0	0	3	3	2	2
CO5	2	3	3	2	1	1	0	1	2	0	2	2	2	2	2
CO6	3	3	3	3	2	2	1	0	1	0	0	3	3	2	2

ME353 Clean Energy

L	T	P	Credit	Area		CWS	PRS	MTE	ETE	PRE
3	0/1	2/0	4	DEC/GEC		15/25	25	20/25	40/50	-

Objective: To enable the students to understand the fundamental of clean energy, sustainability. To impart in-depth knowledge of solar energy, wind energy, biomass energy and energy storage systems.

Syllabus		Contact Hours
Unit-1	**Introduction to Clean Energy and Sustainability.** Overview of global energy demand and its environmental impacts; Concept of sustainability and carbon neutrality; Classification of energy resources: Conventional vs Non-conventional; Importance of clean energy in mitigating climate change; Policies, international agreements, and regulatory frameworks promoting clean energy (e.g., Paris Agreement, SDGs)	**8**
Unit-2	**Solar Energy Technologies.** Solar radiation fundamentals and measurement; Photovoltaic (PV) technology: Types of solar cells, working principle, and advancements; Concentrated Solar Power (CSP): Parabolic troughs, solar towers, Fresnel reflectors; Solar thermal applications: Water heating, space heating, and solar drying systems; Case studies on solar power plants and solar microgrids	**8**
Unit-3	**Wind Energy Systems.** Wind Energy: Basics of wind power, aerodynamics of wind turbines, types of turbines, and wind resource assessment; Wind farm layout and integration into the grid	**6**
Unit-4	**Biomass Energy Systems.** Biomass Energy: Biomass conversion technologies (combustion, gasification, pyrolysis, and fermentation); Biogas production, biodiesel synthesis, and their applications Environmental benefits and challenges of wind and biomass energy	**8**
Unit-5	**Energy Storage and Hybrid Systems.** Overview of energy storage technologies: Mechanical, chemical, electrochemical, and thermal. Battery technologies: Li-ion, flow batteries, and emerging advancements. Role of hydrogen in clean energy: Hydrogen production, storage, and fuel cells. Design and operation of hybrid renewable energy systems (HRES) Case studies of hybrid systems integrating solar, wind, and storage	**6**
Unit-6	**Future Trends and Emerging Technologies.** Smart grids and digitalization in energy systems. Artificial intelligence and machine learning in clean energy optimization. Advances in wave, tidal, and geothermal energy technologies. Circular economy approaches in clean energy production. Socio-economic and environmental impacts of clean energy deployment	**6**
	Total	**42**

Reference Book:	
1	"Renewable Energy Resources" by John Twidell and Tony Weir, Publisher: Routledge
2	"Solar Engineering of Thermal Processes" by John A. Duffie and William A. Beckman, Wiley.
3	"Solar Energy: Principles of Thermal Collection and Storage" by S.P. Sukhatme and J.K. Nayak, Publisher: Tata McGraw-Hill
4	"Non-Conventional Energy Sources" by G.D. Rai, Publisher: Khanna Publishers
5	"Fundamentals of Renewable Energy Systems" by D. Mukherjee and S. Chakrabarti, Publisher: New Age International
6	"Solar Engineering of Thermal Processes" by John A. Duffie and William A. Beckman, Publisher: Wiley
7	"Wind Energy Explained: Theory, Design, and Application" by James F. Manwell et al., Publisher: Wiley
8	"Biomass for Renewable Energy, Fuels, and Chemicals" by Donald L. Klass, Academic Press.
9	"Energy Storage for Renewable Energy Systems" by Augustus W. Clarke, CRC Press.
10	"Hydrogen and Fuel Cells: Emerging Technologies and Applications" by Bent Sørensen, Academic Press.
11	"Solar Engineering of Thermal Processes" by John A. Duffie and William A. Beckman, Publisher: Wiley

Course Outcomes

CO1	Understand the fundamental principles of clean energy technologies and their importance in sustainable development
CO2	Analyze renewable energy sources and assess their technical, economic, and environmental feasibility.
CO3	Design systems using solar, wind, and biomass energy for real-world applications.
CO4	Evaluate the role of energy storage and hybrid systems in enhancing clean energy utilization.

CO5	Develop strategies for integrating clean energy systems into existing energy infrastructure to mitigate environmental impacts.
CO6	Applications of clean energy

CO-PO/PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	2	0	0	0	0	0	0	2	2	1	1
CO2	3	3	2	3	1	0	0	0	0	0	0	1	2	1	1
CO3	3	3	3	3	1	0	0	0	0	0	0	2	3	3	2
CO4	3	3	3	3	1	0	0	0	0	0	0	1	3	3	2
CO5	2	2	2	2	2	0	0	0	0	0	0	1	2	2	2

ME355 THERMAL SYSTEM										
L	**T**	**P**	Credit	Area		**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
3	0/1	2/0	4	DEC/GEC		15/25	25	20/25	40/50	-

Objective: To enable the students to understand the basics of pure substance, ideal and real gases, Rankine cycle. To understand boilers, steam turbines, and condensers.

Syllabus		**Contact Hours**
Unit-1	**Fundamentals**: properties of pure substance in Solid, Liquid and Vapour Phases, PVT Behavior of simple compressible system, T-S and H-S diagram, Steam Tables, determination of quality of steam, Throttling Calorimeter, Combined Separating & Throttling Calorimeter, Maxwell and other thermodynamics relations, mixture of non reactive ideal gases, Real gases, Compressibility chart, Law of corresponding state, Air water vapor mixture, calculation of properties of air water vapour mixture.	**8**
Unit-2	**Rankine Cycle and Analysis**: Rankine cycle and its representation on T-S and H-S diagrams; Effect of low backpressure and high entry pressure and temperature and its limitations; necessity of re-heating, ideal and actual regenerative feed water heating cycle and its limitations. Typical feed water heating arrangements for various capacity power plants.	**8**
Unit-3	**Introduction To Boilers**: Classification of Boilers, Boiler mountings and accessories; draft systems, circulation system; Combustion and its calculations, and Boiler performance.	**6**
Unit-4	**Steam Nozzles**: Types of Nozzles, Flow of steam through nozzles; Condition for maximum discharge through nozzle; Nozzle efficiency. Effect of friction and Supersaturated flow through nozzle.	**6**
Unit-5	**Steam Turbines** : Working principle and types of steam turbines; Velocity diagrams for impulse and reaction turbines, compounding of impulse turbines; Optimum velocity ratio and maximum efficiency. Comparison of impulse and reaction turbines. Condition line and reheat-factor, losses in steam turbines; governing of steam turbines.	**8**
Unit-6	**Condensers and Cooling towers**: Types and working of condensers, types and performance of cooling towers.	**6**
	Total	**42**

Reference Book:	
1	**Engineering Thermodynamics** by P.K.Nag, Tata McGraw Hill Publishing Company Limited, ISBN – 1259062562, 2013.
2	**Engineering Thermodynamics**byRogers, Pearson Education, ISBN- 631197036.
3	**Thermodynamics** by Kenneth Wark, Mcgraw-hill Book Company, 5th edition, ISBN- 0070682860, 1988.
4	**Engineering Thermodynamics: work and heat transfer** by Gordon Rogers and Yon Mayhew, Longman, 4th edition, ISBN – 0471861731, 1992.
5	**Fundamentals of Classical Thermodynamics** by Van Wylen and Sonntag, John Wiley & Sons Inc., 3rd edition, ISBN – 0471861731, 1986.
6	**Fundamentals of Engineering Thermodynamics** by Moran and Shaprio, **John Wiley & Sons, Inc., 7th edition, ISBN – 0470917687, 2010.**
7	**Thermodynamics: An Engineering Approach** by Cengel and Boles, The McGraw-Hill Companies, 8th edition, ISBN: 0073398179, 2014.
8	**Applied Thermodynamics for Engineering Technologists**byT.D. Eastop, Prentice Hall, 5th edition, ISBN-05820919344, 1993.
9	**Treatise on Heat Engineering** by V. P.Vasandani and D.S. Kumar, Metropolitan Book Co. (p) Ltd., ISBN- 810003500.

Course Outcomes

CO1	Use thermodynamic terminology correctly.
CO2	Explain fundamental thermodynamic properties.
CO3	Derive and discuss the first and second laws of thermodynamics.
CO4	Solve problems using the properties and relationships of thermodynamic fluids.
CO5	Students must have understanding of thermodynamic fundamentals before studying their application in applied thermodynamics.
CO6	The understanding of thermodynamic properties and processes will assist students in other related coursework.

CO-PO/PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	2	0	0	0	0	0	0	2	2	1	1
CO2	3	3	2	3	1	0	0	0	0	0	0	1	2	1	1
CO3	3	3	3	3	1	0	0	0	0	0	0	2	3	3	2
CO4	3	3	3	3	1	0	0	0	0	0	0	1	3	3	2
CO5	2	2	2	2	2	0	0	0	0	0	0	1	2	2	2

ME357 Industrial Engineering										
L	**T**	**P**	Credit	Area		**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
3	0/1	2/0	4	DEC/GEC		15/25	25	20/25	40/50	-

Objective: To enable the students to understand the basics of industrial engineering, work measurement systems, quality engineering. To understand reliability and maintenance, material handling systems and plant layout.

Syllabus		**Contact Hours**
Unit-1	**Introduction:** Introduction, Definition and objectives of Industrial Engineering, Scope of Industrial Engineering, Production systems and their classifications; Productivity-Total and partial productivity, Reasons and remedy for poor productivity	**6**
Unit-2	**Job analysis and Work Measurement Systems:** Work System Design: Taylor's scientific management, Gilbreth's contributions; method study, micro-motion study, principles of motion economy; work measurement - stop watch time study, micro motion and memo motion, work sampling, standard data, PMTS; ergonomics; job evaluation, merit rating, incentive schemes, and wage administration; business process reengineering	**8**
Unit-3	**Production Planning and Control:** Types and characteristics of production systems Objective and functions of Production, Planning & Control, Routing, Scheduling and Operations scheduling, production scheduling, job shop scheduling problems, sequencing problems, scheduling tools and techniques, Loading, Dispatching and its sheets & Gantt charts.	**8**
Unit-4	**Quality Engineering:** Quality concept and costs; statistical quality control, Concept of specification limits, statistical control limits, process capability, Process control and control charts for both attributes and variable data. Acceptance Sampling- Single and double sampling.	**6**
Unit-5	**Reliability and Maintenance:** Reliability, availability and maintainability; distribution of failure and repair times; determination of MTBF and MTTR, reliability models; system reliability determination; Maintenance management and its objectives, Various types of Maintenance Planning, House Keeping, 5S concepts.	**8**
Unit-6	**Material Handling:** Principles, functions, and objectives of Material Handling; Selection and classification of Material Handling Equipments; Relation of material handling with plant layout	**6**
	Total	**42**

Reference Book:	
1	Industrial Engineering and Management; B. Kumar, Khanna Publication, ISBN-8174091963, 2011.
2	Introduction to work Study, International Labour Office, Geneva, 3rd edition, Oxford and IBH publishing Co. Pvt. Ltd, New Delhi, ISBN- 8120406028, 2008.
3	Industrial Engineering and Management, Pravin Kumar, Pearson Education, 1st edition, ISBN-9789332543560, 2015.

Course Outcomes

CO1	To identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
CO2	Describe the role and responsibilities of management and the organizational Structures
CO3	Explain the leadership qualities and concept of plant layout.
CO4	Elucidate different quality control techniques.
CO5	Explain various operations management Techniques
CO6	Solve operations management and project management problems

CO-PO/PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	2	0	0	0	0	0	0	2	2	1	1
CO2	3	3	2	3	1	0	0	0	0	0	0	1	2	1	1
CO3	3	3	3	3	1	0	0	0	0	0	0	2	3	3	2
CO4	3	3	3	3	1	0	0	0	0	0	0	1	3	3	2
CO5	2	2	2	2	2	0	0	0	0	0	0	1	2	2	2

ME359 Product Design & Simulation										
L	**T**	**P**	Credit	Area		**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
3	0/1	2/0	4	DEC/GEC		15/25	25	20/25	40/50	-

Objective: To enable the students to understand the basics of various stages of the design process, product life cycle, Value analysis. To understand Concept of reengineering and System Simulation.

Syllabus		**Contact Hours**
Unit-1	**Stages in design process:** Introduction to various stages of the design process: Formulation of problem, Generate alternatives, Evaluation, Guided Redesign. Case study.	**6**
Unit-2	**Product life cycle:** New product introduction: early introduction, increased product life. Life cycle management tool, System integration, QFD, House of quality, Pugh's method, Pahl and Beitz method. Case studies **Value engineering:** Introduction, nature and measurement of value. Value analysis job plan. Creativity. Value analysis test. Case studies	**8**
Unit-3	**Concurrent/ reverse engineering:** Introduction, basic principles, components, benefits of concurrent engineering. Concept of reengineering **Material selection:** Materials in design. The evolution of engineering materials. Design tools and material data. Material selection strategy, attribute limits, selection process, material selection. Case studies	**8**
Unit-4	**Process selection:** Introduction. Process classification: shaping, joining and finishing. Systematic process selection, process cost. Computer – aided process selection	**6**
Unit-5	**Design for manufacture and assembly:** Design for Manufacture and Assembly (DFMA). Reasons for not implementing DFMA. Advantages of DFMA with case studies. Design features and requirements with regard to assembly, Design for Manufacture in relation to any two manufacturing processes: machining and injection molding. Need, objectives	**6**
Unit-6	**System Simulation**: Techniques of simulation, Monte Carlo method, Experimental nature of simulation, Numerical computation techniques, Continuous system models, Analog and Hybrid simulation, Feedback systems, Computers in simulation studies, Simulation software packages **Simulation of Mechanical Systems**: Building of Simulation models, Simulation of translational and rotational mechanical systems, Simulation of hydraulic systems	**8**
	Total	**42**

Reference Book:	
1	David G Ullman, "The Mechanical Design Process." Publisher- McGrawhillIncSingapore, ISBN-13: 9780072975741, 1992.
2	Kevin Otto & Kristin Wood Product Design: "Techniques in Reverse Engineering and new Product Development." 1 / e 2004 , Publisher- Pearson Education New Delhi , ISBN-13: 9780130212719,
3	L D Miles "Value Engineering."Publisher- McGraw-Hill, 1972
4	Karl T Ulrich, Steven D Eppinger , " Product Design &Development."Publisher- Tata McGrawhill New Delhi, ISBN-13: 9780078029066, 2003
5	Hollins B & Pugh S "Successful Product Design." Publisher- Butter worths London, ISBN 9780408038614.
6	N J M Roozenberg , J Ekels , N F M Roozenberg " Product Design Fundamentals and Methods ."Publisher- John Willey & Sons, ISBN-13: 9780471954651, 1995.

Course Outcomes

CO1	Approaching different product design techniques
CO2	Use product development process, requirements setting, conception design.
CO3	Apply basic knowledge in product development management
CO4	Know customer needs and their impact
CO5	Apply knowledge in product design for manufacturing and productivity.
CO6	Able to simulate the mechanical systems

CO-PO/PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	2	0	0	0	0	0	0	2	2	1	1
CO2	3	3	2	3	1	0	0	0	0	0	0	1	2	1	1
CO3	3	3	3	3	1	0	0	0	0	0	0	2	3	3	2
CO4	3	3	3	3	1	0	0	0	0	0	0	1	3	3	2
CO5	2	2	2	2	2	0	0	0	0	0	0	1	2	2	2

ME361 Computational Fluid Dynamics

L	T	P	Credit	Area		CWS	PRS	MTE	ETE	PRE
3	0/1	2/0	4	DEC/GEC		15/25	25	20/25	40/50	-

Objective: To enable the students to understand the introduction to CFD, mathematical behavior of partial differential equations. To understand concept of commercial codes (e.g. FLUENT).

Syllabus		Contact Hours
Unit-1	Introduction to CFD, Historical background, Impact of CFD	6
Unit-2	The Governing Equations of Fluid Dynamics Derivation, Discussion of physical meanings and Presentation of forms particularly suitable to CFD.	8
Unit-3	Mathematical Behavior of Partial Differential Equations: Impact on CFD	6
Unit-4	Basic Aspects of Discretization: Introduction to Finite Difference, Finite Elements and Finite Volume Methods. Detailed treatment of Finite Difference method, explicit and implicit methods, errors and stability analysis.	8
Unit-5	Grids with Appropriate Transformations Adaptive grids and unstructured meshes. Lift reduction, down force generation and drag reduction. An introduction to the aerodynamics of airflows for cooling.	8
Unit-6	Commercial codes (e.g. FLUENT etc.). Grid generation, techniques and application. Basic principles and concepts and the characteristics of wings and diffusers	6
		42

Reference Book:	
1	Computational Fluid Dynamics",John Anderson," McGraw- Hill Ltd.
2	Computational Fluid Dynamics",Tu, Elsevier.
3	Introduction to Computational Fluid Dynamics,Niyogi, Pearson Education, Delhi

Course Outcomes

CO1	Optimization manufacturing of hvac design, aerodynamics design, automobiles design, external building flows, fire/smoke management.
CO2	CFD analysis of velocity, pressure, temperature and chemical concentration allocation etc. helps engineers in understanding the problem appropriately and offers practical ideas for the best decision about the most flawless and productive designing.
CO3	CFD save cost and time, CFD is reliable.
CO4	Basics of Finite Difference, Finite Elements and Finite Volume Methods.
CO5	Grids with Appropriate Transformations Adaptive grids
CO6	Able to use commercial codes and software's

CO-PO/PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	2	0	0	0	0	0	0	2	2	1	1
CO2	3	3	2	3	1	0	0	0	0	0	0	1	2	1	1
CO3	3	3	3	3	1	0	0	0	0	0	0	2	3	3	2
CO4	3	3	3	3	1	0	0	0	0	0	0	1	3	3	2
CO5	2	2	2	2	2	0	0	0	0	0	0	1	2	2	2
CO6	3	3	3	2	2	0	0	0	0	0	0	2	2	1	1

ME363 Finite Element Methods

L	T	P	Credit	Area		CWS	PRS	MTE	ETE	PRE
3	0/1	2/0	4	DEC/GEC		15/25	25	20/25	40/50	-

Objective: To familiarize the students with basics of FEM, formulation of stiffness, load matrix and solution of bar, truss, beam, frames two-dimensional plane problems axisymmetric solids, numerical integration, three dimensional solids, dynamic problem, heat transfer and fluid problems. To impart in-depth knowledge of software MATLAB, ABAQUS & ANSIS to solve real life application.

Syllabus		**Contact Hours**
Unit-1	Fundamental concepts of the Finite Element Method. One Dimensional Problem (Bar of uniform and variable cross sections), The Galerkin Approach, The potential –Energy Approach, shape Functions, Derivation of stiffness matrix and load vector for the element and for the entire domain. Evaluation of displacement, stresses and reaction forces.	8
Unit-2	Trusses: Introduction, Plane Trusses, Local and Global coordinate Systems, Element Stiffness Matrix and Stress calculations	6
Unit-3	Beam Elements-Analysis of Beams and Frames: Beam elements, Reduced integration, Elements based on Bernoulli and Timoshenko theory of beams Two –Dimensional problem using Constant strain triangles (CST), Two dimensional isoparametric elements and numerical integration, element stiffness matrix, Force vector. Three dimensional element.	8
Unit-4	Heat Transfer *and* Fluid Flow: Steady state heat transfer, heat conduction governing equation, boundary conditions, Functional approach for heat conduction, Galerkin approach for heat conduction, heat flux boundary condition, Basic differential equation for fluid flow in pipes and around solid bodies.	8
Unit-5	Dynamic analysis: Element mass matrices, Evaluation of Eigenvalues and Eigenvectors.	6
Unit-6	Electromagnetic simulation using FEM. Application of finite element method to electrical systems. Use of Softwares such as MAT LAB/ABAQUS/ANSYS/ NASTRAN/IDEAS. Basic feature of these softwares.	6
	Total	42

Reference Book:	
1	Finite Element Procedures, K.J. Bathe, Prentice Hall of India.
2	Finite Elements in Engineering by Chandrupatla and Belegundu.
3	Finite element Method by J.N.Reddy.
4	Finite element Method,O.C. Zienkiewicz& R.A. Taylor
5	Finite element Analysis,C.S. Krishnamurthy
6	Finite element Method, Kenneth H. Hubener
7	Finite Element Method, Desai & Abel

Course Outcomes

CO1	Apply and understand the basic concepts of Finite element analysis procedure.
CO2	Apply the knowledge of mathematics and engineering in solving the problems related to structural and heat transfer
CO3	Application of finite element method to electrical systems.

CO4	Use of Galerkin Approach, The potential –Energy Approach, shape Functions
CO5	Able to learn Two dimensional isoparametric elements and numerical integration
CO6	Use the commercial FEA packages like ANSYS and modern CAD/CAE tools for solving real life structural problems.

CO-PO/PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	2	0	0	0	0	0	0	2	2	1	1
CO2	3	3	2	3	1	0	0	0	0	0	0	1	2	1	1
CO3	3	3	3	3	1	0	0	0	0	0	0	2	3	3	2
CO4	3	3	3	3	1	0	0	0	0	0	0	1	3	3	2
CO5	2	2	2	2	2	0	0	0	0	0	0	1	2	2	2
CO6	3	3	3	2	2	0	0	0	0	0	0	2	2	1	1

ME365 Total Life cycle Management										
L	**T**	**P**	Credit	Area		**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
3	0/1	2/0	4	DEC/GEC		15/25	25	20/25	40/50	-

Objective: To enable the students to understand the Concurrent Engineering, Quality function deployment and Rapid prototyping. To understand concept of stages of design of products, product lifecycle and components of PLM.

Syllabus		**Contact Hours**
Unit-1	**Introduction:** Extensive definition of Concurrent Engineering (CE), CE design methodologies, Review of CE techniques like DFM (Design for manufacture), DFA (Design for assembly),	**8**
Unit-2	Quality function deployment (QFD), RP (Rapid prototyping), TD (Total design), for integrating these technologies, Organizing for CE, CE tool box, Collaborative product development	**8**
Unit-3	**Use of Information Technology:** IT support, Solid modeling, Product data management, Collaborative product Commerce, Artificial Intelligence, expert systems, Software hardware component design.	**6**
Unit-4	**Design Stage:** Lifecycle design of products, Opportunities for manufacturing enterprises, Modality of concurrent engineering design, automated analysis, Idealization control, CE in optimal structural design, Real time constraints	**6**
Unit-5	**Need for PLM:** Importance of PLM, Implementing PLM, Responsibility for PLM, Benefits to different managers, Components of PLM, Emergence of PLM, Lifecycle problems to resolve, Opportunities to Seize	**6**
Unit-6	**Components of PLM:** Components of PLM, Product lifecycle activities, Product organizational structure, Human resources in product lifecycle, Methods, techniques, Practices, Methodologies, Processes, System components in lifecycle, slicing and dicing the systems, Interfaces, Information, Standards	**8**
	Total	**42**

Reference Book:	
1	Integrated Product Development M.M. Anderson and L Hein IFS Publications
2	Design for Concurrent Engineering J. Cleetus CE Research Centre, Morgantown
3	Concurrent Engineering Fundamentals: Integrated Product Development Prasad Prentice hall India
4	Concurrent Engineering in Product Design and Development I Moustapha New Age International
5	Product Lifecycle Management John Stark Springer-Verlag, UK
6	Product Lifecycle Management Michael Grieves McGraw Hill
7	Concurrent Engineering: Automation tools and Technology Andrew Kusiak Wiley Eastern

Course Outcomes

CO1	Explain basic concepts of product life cycle management.
CO2	Demonstrate product development approaches.
CO3	Explain elements of product modelling.
CO4	Discuss in detail the concept of product data management.
CO5	Discuss about integration of PLM with other applications.
CO6	Applications of Total Lifecycle Management

CO-PO/PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	2	0	0	0	0	0	0	2	2	1	1
CO2	3	3	2	3	1	0	0	0	0	0	0	1	2	1	1
CO3	3	3	3	3	1	0	0	0	0	0	0	2	3	3	2
CO4	3	3	3	3	1	0	0	0	0	0	0	1	3	3	2
CO5	2	2	2	2	2	0	0	0	0	0	0	1	2	2	2
CO6	3	3	3	2	2	0	0	0	0	0	0	2	2	1	1

ME367 Value Engineering										
L	**T**	**P**	Credit	Area		**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
3	0/1	2/0	4	DEC/GEC		15/25	25	20/25	40/50	-

Objective: To enable the students to understand the Value Engineering, Life Cycle Cost (LCC), Case studies. To understand concept of function analysis system techniques- FAST diagram, Case studies.

Syllabus		**Contact Hours**
Unit-1	An Overview of Value Engineering-Concepts and approaches of value analysis and engineering - importance of value, Function - identity, clarify – analysis	6
Unit-2	Evaluation of VE-Evaluation of function, Problem setting system, problem solving system, setting and solving management - decision - type and services problem, evaluation of value	8
Unit-3	Results accelerators, Basic steps in using the systems	6
Unit-4	Understanding the decision environment, Effect of value analysis on other work in the business- Life Cycle Cost (LCC), Case studies	8
Unit-5	VE Level of Effort-VE Team, coordinator, designer, different services, definitions, construction management contracts, value engineering case studies,	8
Unit-6	Effective organization for value work, function analysis system techniques- FAST diagram, Case studies	6
	Total	42

Reference Book:	
1	Parker, D.E., “Value Engineering Theory”, Sundaram publishers, 1990
2	Miles, L.D., “Techniques of Value Engineering and Analysis”, McGraw Hill Book Co., 2nd End., 1972
3	Khanna, O.P., “Industrial Engineering and Management”, Dhanpat Rai and Sons, 1999.

Course Outcomes

CO1	Understand the basic concepts, techniques and applications of value engineering
CO2	Describe job plan of value engineering
CO3	Illustrate different value engineering techniques and versatility of value engineering.
CO4	Illustrate the efforts of value engineering team during the process of value engineering
CO5	Appraise the value engineering operation in maintenance and repair activities.
CO6	Create the value engineering team and discuss the value engineering case studies.

CO-PO/PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	2	0	0	0	0	0	0	2	2	1	1
CO2	3	3	2	3	1	0	0	0	0	0	0	1	2	1	1
CO3	3	3	3	3	1	0	0	0	0	0	0	2	3	3	2
CO4	3	3	3	3	1	0	0	0	0	0	0	1	3	3	2
CO5	2	2	2	2	2	0	0	0	0	0	0	1	2	2	2
CO6	3	3	3	2	2	0	0	0	0	0	0	2	2	1	1

ME308 Gas Dynamics and Jet Propulsion										
L	**T**	**P**	Credit	Area		**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
3	0/1	2/0	4	DEC/GEC		15/25	25	20/25	40/50	-

Objective: To enable the students to understand the fundamentals of continuity equation, momentum equation, energy equation. To understand concept of aircraft propulsion theory, ramjet engine, pulsejet engine; rocket propulsion and its theory.

Syllabus		**Contact Hours**
Unit-1	Continuity equation, Momentum equation, Energy equation, stagnation properties	6
Unit-2	Isentropic flow with variable area, wave motion; Flow with normal shock waves, oblique shock waves	8
Unit-3	Flow in constant area duct with friction and with heat transfer	6
Unit-4	Measurement of fluid properties, anemometer, flow visualization.	8
Unit-5	Aircraft propulsion theory, Ramjet engine, Pulsejet engine; Rocket propulsion and its theory	8
Unit-6	Liquid propellant, solid propellant, rocket applications, space flights.	6
	Total	42

Reference Book:	
1	S.M. Yahya, "Fundamentals of Compressible Flow ", New Age International (P) Limited, New Delhi, ISBN-9788122426687, 1996.
2	P. Hill and C. Peterson, "Mechanics and Thermodynamics of Propulsion ", Addison -Wesley Publishing Company, ISBN- 0201146592, 1992.
3	N.J. Zucrow, "Aircraft and Missile Propulsion, Vol. I & II ", John Wiley, ISBN- 9780758104519, 1975.
4	N.J. Zucrow, "Principles of Jet Propulsion and Gas Turbines ", John Wiley, New York, ISBN- 1258694360, 1970.
5	H. Cohen, G.E.C. Rogers and Saravanamuttoo, "Gas Turbine Theory ", Longman Group Ltd, ISBN-0582236320, 1980.
6	G.P. Sutton, "Rocket Propulsion Elements ", John Wiley, New York, ISBN- 9780470080245, 1986.
7	A.H. Shapiro, "Dynamics and Thermodynamics of Compressible Fluid Flow Vol. kl "John Wiley, New York, ISBN- 0471066915, 1953.
8	V. Ganesan, "Gas Turbines ", Tata McGraw Hill Publishing Co., New Delhi, ISBN- 0070681929, 1999.

Course Outcomes

CO1	Apply the thermodynamics concepts in relation to compressible flows and derive relationships between various compressible flow parameters
CO2	Understanding of isentropic compressible flows in variable area ducts and apply in design of static components like nozzles and diffusers
CO3	Solve for compressible flow characteristics with friction and heat transfer
CO4	Develop relationship for shocks and determine their characteristics under various conditions
CO5	Analyze the performance of aircraft and rocket propulsion engines
CO6	Apply for aircraft and rocket propulsion

CO-PO/PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	2	0	0	0	0	0	0	2	2	1	1
CO2	3	3	2	3	1	0	0	0	0	0	0	1	2	1	1
CO3	3	3	3	3	1	0	0	0	0	0	0	2	3	3	2
CO4	3	3	3	3	1	0	0	0	0	0	0	1	3	3	2
CO5	2	2	2	2	2	0	0	0	0	0	0	1	2	2	2
CO6	3	3	3	2	2	0	0	0	0	0	0	2	2	1	1

ME -310 Automation in Manufacturing										
L	T	P	Credit	Area		CWS	PRS	MTE	ETE	PRE
3	0/1	2/0	4	DEC/GEC		15/25	25	20/25	40/50	-

Objective: To enable the students to understand the fundamentals of introduction to automation, hydraulic principles. hydraulic pumps. To understand concept of Logic Circuits, Electro Pneumatic, Electro Hydraulic, Robotic Circuits, Automatic machine tool control.

Syllabus		**Contact Hours**
Unit-1	**Basic Principles:** Introduction to Automation. Productivity v/s automation materials handling systems. Evaluation of automatic production. Designing for automation.	6
Unit-2	**Hydraulic System:** Hydraulic Principles. Hydraulic pumps: Characteristics, Pump Selection, Pumping Circuits. Hydraulic Actuators: Linear, Rotary, Selection, Characteristics. Hydraulic Valves: Pressure, Flow, Direction Controls, Applications. Servo and Proportional Valves, Hydraulic Fluids: Symbols.	8
Unit-3	**Pneumatic Systems:** Pneumatic fundamentals. Production of compressed air. Types of cylinders. Control valves: direction, pressure and flow-air hydraulic equipment's Actuators. General approach to control system design. Symbols and drawing. Schematic layout. Cascade, Karnaugh, Veitch mapping method. air hydraulic control.	**8**
Unit-4	**Pneumatic and hydraulic circuits:** Hydraulic circuits: Reciprocating, Quick return, Sequencing synchronizing. Accumulator circuits. Safety circuits. Pneumatic circuits: Classic, Cascade, Step-counter, Karnaugh-Veitch mapping, Combination Methods. Electrical control of fluid power: components and circuits. Micro-electronic control of fluid power: PLC-Microprocessors uses and selection criteria for components.	8
Unit-5	Logic Circuits: Position, Pressure Sensing, Switching, Electro Pneumatic, Electro Hydraulic, Robotic Circuits. Case studies: conveyor feed system, power pack, Bunker automatic circuits, etc.	6
Unit-6	Automation in machine tools, Mechanized feeding. Automatic assembly. Automatic machine tool control. Transfer lines. Factory automation	6
	Total	42

Reference Book:	
1	Hydraulic and Pneumatic Controls, R Srinivasan, Vijay Nicole imprints Pvt. Ltd., Chennai.
2	Introduction to Hydraulic and Pneumatic S. Ilango and V. Soundararajan, Prentice- Hall of India, Delhi
3	Oil Hydraulic Systems: Principles and Maintenance", S. R. Majumdar, "Tata McGraw-Hill, Delhi
4	"Pneumatic Systems: Principles and Maintenance", S. R. Majumdar, Tata McGraw-Hill, Delhi
5	Power Hydraulics "J. Michael, Pinches and John G. Ashby, "Prentice Hall
6	Hydraulics and Pnematics (HB) ", Andrew Parr, "Jaico Publishing House
7	Basic Fluid Power ", Dudleyt A. Pease and John J. Pippenger, "Prentice Hall
8	Fluid Power with Applications ", Anthony Esposite, Prentice Hall

Course Outcomes

CO1	Implement concepts of automation in machine tools and plant
CO2	Students will understand the fundamentals of control in automation as they apply to Manufacturing
CO3	Design of Pneumatic Circuit for manufacturing application
CO4	Design of Hydraulic Circuit for manufacturing application
CO5	Ability to apply PLC timers and counters for the control of industrial processes
CO6	Application of automation in industries

CO-PO/PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	2	0	0	0	0	0	0	2	2	1	1
CO2	3	3	2	3	1	0	0	0	0	0	0	1	2	1	1
CO3	3	3	3	3	1	0	0	0	0	0	0	2	3	3	2
CO4	3	3	3	3	1	0	0	0	0	0	0	1	3	3	2
CO5	2	2	2	2	2	0	0	0	0	0	0	1	2	2	2
CO6	3	3	3	2	2	0	0	0	0	0	0	2	2	1	1

ME312 Quality Management & Six Sigma Applications										
L	**T**	**P**	Credit	Area		**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
3	0/1	2/0	4	DEC/GEC		15/25	25	20/25	40/50	-

Objective: To enable the students to understand the fundamentals of quality, quality planning and quality costs. To understand concept of statistical process control, Sampling process, ISO standards and Six Sigma.

Syllabus		**Contact Hours**
Unit-1	**Introduction to Quality** Definition of Quality- product, user, value, and manufacturing based perspectives, Dimensions of Quality, Quality Planning, Quality costs optimization of quality costs, Quality in manufacturing, services, health care, educational systems, the seven tools of quality.	**8**
Unit-2	**Philosophies in Quality Management Systems** Philosophies of Quality Gurus- Deming, Juran, Crosby, Feigenbaum, Ishikawa, Taguchi. Comparison of Quality Philosophies; Quality Management awards- Deming prize, Malcolm Baldrige National Quality Award, Kirloskar Award.	8
Unit-3	**Statistical Process Control** Introduction to Quality characteristics- variables and attributes, Types and causes of variations, Control Charts for variables and attributes, Process capability.	**6**
Unit-4	**Acceptance Sampling** Sampling process and lots formation; Advantages and applications of acceptance sampling; characteristics of O.C. Curve; Single, double, multiple, sequential sampling; ASN, ATI, AOQL, AOQ, AQL, LQL, Producer's and Consumer's risks.	8
Unit-5	**ISO 9000:2000** Structure of ISO standards, Factors leading to ISO, Implementation and registration, Benefits of ISO.	6
Unit-6	**Six Sigma** Principles of Six Sigma, Statistical basis, Tools and techniques, DMAIC principle, application of six sigma in manufacturing and service organizations.	6
	Total	42

Reference Book:	
1	The Management and Control of Quality by J R Evans and W M, Lindsay, Cengage learning, India, ISBN-0538882425, 1998.
2	Quality Management by Kanishka Bedi, Oxford
3	Total Quality Management by Bester field, Pearson Education.
4	Jura's Quality Planning and Analysis for Enterprise Quality, by F M Gryna, R C H Chua, J A Defeo, Tata McGraw Hill

Course Outcomes

CO1	Understand the fundamental principles of Total Quality Management
CO2	Choose appropriate statistical techniques for improving processes
CO3	Develop research skills that will allow them to keep abreast of changes in the field of Total Quality Management
CO4	Understand the fundamental principles of six sigma
CO5	Choose appropriate six sigma techniques for improving processes
CO6	Develop research skills that will allow them to keep abreast of changes in the field of six sigma

CO-PO/PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	2	0	0	0	0	0	0	2	2	1	1
CO2	3	3	2	3	1	0	0	0	0	0	0	1	2	1	1
CO3	3	3	3	3	1	0	0	0	0	0	0	2	3	3	2
CO4	3	3	3	3	1	0	0	0	0	0	0	1	3	3	2
CO5	2	2	2	2	2	0	0	0	0	0	0	1	2	2	2
CO6	3	3	3	2	2	0	0	0	0	0	0	2	2	1	1

ME314 Mechanical Vibrations										
L	**T**	**P**	Credit	Area		**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
3	0/1	2/0	4	DEC/GEC		15/25	25	20/25	40/50	-

Objective: To enable the students to understand the fundamentals of vibration, Mathematical modeling of vibrating systems and degree of freedom. To understand and use of Vibration measuring Instruments and balancing of rotors.

Syllabus		**Contact Hours**
Unit-1	Introduction: Basics of vibration, Mathematical modeling of vibrating systems- Discrete and Continuous systems, Conservative and Non conservative system with reference to Vibrations.	**8**
Unit-2	Single degree of freedom systems: Force-Balance and Moment- Balance methods, damping factor, Governing equations for different types of Damping and for different types of applied forces, Lagrange's equations.	8
Unit-3	Single Degree of freedom systems subjected to periodic excitations: Response to Harmonic Excitation, frequency-response function, System with rotating Unbalanced masses, system with base excitation.	**6**
Unit-4	Single Degree of Freedom system subjected to Transient Excitation: Response to impulse Excitation, response to: Step input, Ramp input, Spectral Energy of the responses, Response to: Rectangular pulse excitation, Half- sine wave pulses.	8
Unit-5	Two degree of Freedom systems: Free undamped vibrations, Static and dynamic coupling, Principal modes of vibration, dynamic vibration absorber, centrifugal absorber, Vehicle suspension system response.	6
Unit-6	Introduction to Vibration measuring Instruments: Vibration meters, vibration signatures, standards, vibration testing equipment, balancing of rotors.	6
	Total	42

Reference Book:	
1	Fundamentals of vibrations; Balachandran,Magrab,Cengage Learning.
2	Mechanical vibrations; Rao.S.S, Pearson Education.
3	Mechanical Vibrations; Srinivas P, Tata Mcgraw Hill company Limited.
4	Fundamentals of Vibrations; Roger A A, Amerind Publisher Company Pvt Ltd.
5	Engineering Vibration; Daniel J Inman, Prentice Hall, New Jersey.
6	Mechanical Vibrations: T. Thomson

Course Outcomes

CO1	Explain basics of sound, noise and vibration; as well as their control strategies.
CO2	Derive equations of motion for undamped one-dimensional vibrations, and solve problems of damped free vibrations.
CO3	Analyse and solve problems of forced vibrations involving frequency response curves, phase angle plots, vibration isolation and transmissibility.
CO4	Analyse and solve problems involving vibrations of systems having more than one degree of freedom.
CO5	Perform free-vibration analysis of one, two, and multi degree of freedom systems.
CO6	Design simple mechanical systems for vibrations and vibration measuring instruments

CO-PO/PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	2	0	0	0	0	0	0	2	2	1	1
CO2	3	3	2	3	1	0	0	0	0	0	0	1	2	1	1
CO3	3	3	3	3	1	0	0	0	0	0	0	2	3	3	2
CO4	3	3	3	3	1	0	0	0	0	0	0	1	3	3	2
CO5	2	2	2	2	2	0	0	0	0	0	0	1	2	2	2
CO6	3	3	3	2	2	0	0	0	0	0	0	2	2	1	1

ME316 Power Plant Engineering										
L	**T**	**P**	Credit	Area		**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
3	0/1	2/0	4	DEC/GEC		15/25	25	20/25	40/50	-

Objective: To enable the students to understand the fundamentals of fuel handling systems and Steam Generators. To understand Combined Cycle Power Plants and Nuclear power plants.

Syllabus		**Contact Hours**
Unit-1	Indian energy scenario, Indian coals: formation, properties, analysis, benefication and heating value calculation of coals; coking and noncoking coals, fuel handling systems; coal gasification. Classification of power plants, base load and Peak load power stations, co-generated power plant, captive power plant, and their fields of application & selection criteria.	**8**
Unit-2	**Steam Generators:** High pressure utility boiler, natural and forced circulation, fuel handling, coking and non-coking coal, coal benefication, coal pulverization, pulverized fuel firing system, combustion process, need of excess air, cyclone furnace, fluidized bed boiler, placement of evaporator, economizers, super heaters, re-heaters, air pre-heater in the boiler, de-aeration, boiler blow- down, ash collection by bag house, gravity separation, electrostatic precipitators and wet scrubbers, boiler efficiency calculations, water treatment: external and internal treatment.	8
Unit-3	**Combined Cycle Power Plants:** Binary vapour cycles, coupled cycles, gas turbine- steam turbine power plant, gas pipe line control, MHD- Steam power plant, thermionic steam power plant, integrated coal combined cycle (IGCC) power plant.	**6**
Unit-4	**Other power plants:** Nuclear power plants - working and types of nuclear reactors, boiling water reactor, pressurized water reactor, fast breeder reactor, controls in nuclear power plants, hydro power plant -classification and working of hydroelectric power plants, tidal power plants, diesel and gas power plants.	**7**
Unit-5	**Instrumentation and Controls in power plants:** Important instruments used for temperature, flow, pressure, water/steam conductivity measurement; flue gas analysis, drum level control, combustion control, super heater and re-heater temperature control, furnace safeguard and supervisory system (FSSS), auto turbine run-up system (ATRS), interlocks and protection of turbines.	**7**
Unit-6	**Environment Pollution and Energy conservation:** Economics of power generation: load duration curves, power plant economics, pollution from power plants, disposal/management of nuclear power plant waste, concept of energy conservation and energy auditing.	6
	Total	42

Reference Book:	
1	**Power Plant Engineering** by M.M. Elwakil, Tata McGraw Hill, ISBN- 0070662746.
2	**Power Plant Engineering** by P.K Nag, Tata McGraw Hill, ISBN- 0070435993.
3	**Steam and Gas turbines** by A Kostyuk and V Frolov, MIR Publishers, ISBN-9785030000329.
4	**Modern Power Plant Engineering** by J Wiesman and R Eckart, Prentice hall India Ltd, ISBN- 97801359725.
5	**Planning Fundamentals of thermal Power Plants** by F.S Aschner, John Wiley, ISBN- 07065159X.
6	**Applied Thermodynamics** by T.D Eastop and McConkey, Longman Scientific and Technical, ISBN-0582305351.
7	**CEGB volumes on power plant, Central Electricity Generation Board, ISBN- 0080155680.**
8	**NTPC/NPTI publications on Power plants**, ISBN- 9788132227205.

Course Outcomes

CO1	Importance of coal based thermal power plants and other power plants.
CO2	Working of components of power plants, combined power plants, coal handling
CO3	Controls in power plants, power plant economics, energy conservation.
CO4	Understand the concept of combined cycle plants
CO5	Importance of Controls in power plants
CO6	Applications of power plant economics, energy conservation.

CO-PO/PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	2	2	1	0	1	0	0	3	3	2	2
CO2	2	3	3	2	1	1	0	1	2	0	2	2	2	2	2
CO3	2	2	2	3	1	1	0	0	0	0	0	3	3	1	1
CO4	3	3	3	3	2	2	1	0	1	0	0	3	3	2	2
CO5	2	3	3	2	1	1	0	1	2	0	2	2	2	2	2
CO6	2	2	2	3	1	1	0	0	0	0	0	3	3	1	1

ME318 Computer Aided Manufacturing										
L	**T**	**P**	Credit	Area		**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
3	0/1	2/0	4	DEC/GEC		15/25	25	20/25	40/50	-

Objective: To enable the students to understand the fundamentals of CAD, elements of CAD, and Computer Graphics. To understand Fundamentals of Geometric Modeling, part programming and Group Technology.

Syllabus		**Contact Hours**
Unit-1	**Introduction**: Introduction to CAD. Elements and essential requirements of CAD hardware. Concepts of integrated CAD/CAM, Necessity & its importance, Engineering Applications.	**5**
Unit-2	Computer Graphics: CAD/CAM systems, Graphics Input devices cursor control Devices, Digitizers, Keyboard terminals, Image scanner, Speech control devices and Touch, panels, Graphics display devices-Cathode Ray Tube, Random & Raster scan display, Colour CRT monitors, Direct View Storage Tubes, Flat Panel display.	**6**
Unit-3	**Geometric Modeling**: Fundamentals of Geometric Modeling. Its application in analysis and manufacturing. Two Dimensional and Three-dimensional line, surface and volume models; Constructive Solid Geometry (CSG); basics of boundary presentation- spline, Bezier, B-spline, and NURBS; sculpture surfaces, classification, basics of coons, Bezier, B-spline and ruled surfaces; tweaking, constraint based parametric modeling; wire-frame modeling, definition of point, line and circle; polynomial curve fitting. Introduction to rapid prototyping.	8
Unit-4	**Numeric control and part programming:** Principles of NC machines, CNC, DNC; NC modes of point to point, -line and 2D, 3D contouring; NC part programming; ISO standard for coding, preparatory functions (G)- motion, dwell, unit, preset, cutter compensation, coordinate and plane selection groups; miscellaneous (M) codes; CLDATA and tool path simulation; adaptive control, sequence control and PLC; simple part programming examples.	**7**
Unit-5	**Group Technology:** Importance of batch and job shop production; merits of converting zigzag process layout flow to smooth flow in cellular layout, Production Flow Analysis (PFA) and clustering methods; concept of part families and coding; hierarchical, attribute and hybrid coding; OPITZ, MICLASS and DCLASS coding; FMS; material handling; robots, AGV and their programming; agile manufacturing; Introduction to Computer Aided Process Planning (CAPP).	**8**
Unit-6	**Robotics:** Introduction to robots. Types and generations of Robots, Classification of Robots. Structure and operation of Robot, Robot applications in manufacturing industries. Robot languages and programming methods. Introduction to Artificial Intelligence for Intelligent manufacturing.	**8**
	Total	**42**

Reference Book:	
1	Principles of Computer Aided Design and Manufacturing; FaridAmirouche; Pearson.
2	CAD/CAM Theory and Practice by Ibrahim Zeid.
3	CAD/CAM Principles and Applications by P.N. Rao, Tata McGraw Hill Publishing Company Ltd.
4	CAD/CAM Computer Aided Design and Manufacturing by Mikell P. Groover and Emory W. Zimmer, Jr.
5	Computer Integrated Design and Manufacturing by David D. Bedworth, Mark R. Henderson, Philip M. Wolfe.

Course Outcomes

CO1	Recognize the importance of CAD, CAM, CIM, Engineering product specification and interpreting geometric specifications.
CO2	Improve knowledge on the integration of CAD and CAM.
CO3	Exhibit competency in manual part program and generation of CNC part program using CAM packages.
CO4	Describe the implementation of CAD and CAM in manufacturing processes.
CO5	Develop programs for CNC to manufacture industrial components.
CO6	To understand the application of computers in various aspects of Manufacturing viz., Design, Proper planning, Material Handling system

CO-PO/PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	2	2	1	0	1	0	0	3	3	2	2
CO2	2	3	3	2	1	1	0	1	2	0	2	2	2	2	2
CO3	2	2	2	3	1	1	0	0	0	0	0	3	3	1	1
CO4	3	3	3	3	2	2	1	0	1	0	0	3	3	2	2
CO5	2	3	3	2	1	1	0	1	2	0	2	2	2	2	2
CO6	2	2	2	3	1	1	0	0	0	0	0	3	3	1	1

ME320 Reliability and Maintenance Engineering										
L	**T**	**P**	Credit	Area		**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
3	0/1	2/0	4	DEC/GEC		15/25	25	20/25	40/50	-

Objective: To enable the students to understand the fundamentals of reliability, factors influencing system effectiveness and methods of reliability improvements. To understand Fundamentals of steady state availability, Maintainability and Maintenance policies.

Syllabus		**Contact Hours**
Unit-1	**Introduction and Reliability Mathematics:** Relevance of reliability, availability and maintainability, definition of reliability, factors influencing system effectiveness, laws of probability, probability distributions: exponential, Weibull, normal, log normal; data collection, recovery of data, Statistical analysis of failure data.	**5**
Unit-2	**Fundamentals of Reliability:** Various reliability related functions; probability density function, cumulative distribution function, reliability function and hazard rate; reliability models; constant rate, Weibull, normal and lognormal model.	**6**
Unit-3	**System Reliability Assessment:** Types of systems- series, parallel, series parallel, parallel-series, stand by and complex; method of reliability evaluation; cut set and tie set methods, event trees and fault trees methods, Markov method, Reliability of repairable systems.	8
Unit-4	**Reliability Improvements** - Methods of reliability improvements, low level and high-level redundancy, active, stand by and K-out-of-N redundancy, effect of maintenance.	**7**
Unit-5	**Availability and Maintainability Assessments:** Point, mission and steady state availability. Availability assessment, Maintainability and its assessment. Maintenance policies.	**8**
Unit-6	**Design for Reliability** - Reliability allocation, Design for reliability and maintainability, optimization of reliability and maintainability and their trade-off, Practical applications of RAM Engineering to systems, products and processes; Monte Carlo simulation	**8**
	Total	**42**

Reference Book:	
1	Ebeling CharlesE. "An introduction to Reliability and Maintainability Engineering", Tata McGraw-Hill Publishing Co. Ltd., New Delhi, [ISBN 10 0070421382], 2000.
2	Srinath L.S." Reliability Engineering", Affiliated East –West Press Ltd., New Delhi, [ISBN 10 8176710482],2011
3	Dhillon, B.S. "Engineering Maintainbility", Prentice Hall of India, New Delhi,2000.
4	Blanchard, Benjamin,S., "Logistics Engineering and Management", Pearson,[ISBN 10 1292027134], 2013.

Course Outcomes

CO1	Explain quality, reliability, quality control and statistical quality control.

CO2	Analyze failure data, hazard models and system reliability and solve related numerical problems
CO3	Apply reliability improvement and allocation methods to engineering systems
CO4	Explain maintenance objectives and functions, factors influencing Plant Availability.
CO5	Determine the optimal overhaul/repair/replacement maintenance policy
CO6	Explain different maintenance systems and the steps involved in establishing a maintenance plan and designing a technically sound preventive maintenance and lubrication program.

CO-PO/PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	2	2	1	0	1	0	0	3	3	2	2
CO2	2	3	3	2	1	1	0	1	2	0	2	2	2	2	2
CO3	2	2	2	3	1	1	0	0	0	0	0	3	3	1	1
CO4	3	3	3	3	2	2	1	0	1	0	0	3	3	2	2
CO5	2	3	3	2	1	1	0	1	2	0	2	2	2	2	2
CO6	2	2	2	3	1	1	0	0	0	0	0	3	3	1	1

ME322 Design of Mechanical Assemblies										
L	**T**	**P**	Credit	Area		**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
3	0/1	2/0	4	DEC/GEC		15/25	25	20/25	40/50	-

Objective: To enable the students to understand the fundamentals of friction clutches, Lubrication, Bearings and mechanical drives. To understand stages in design of Gears, hoisting elements and design of engine parts.

Syllabus		**Contact Hours**
Unit-1	Design of Friction clutches, uniform wear, and uniform pressure assumptions, centrifugal clutches. Brakes: Design of internal expansion elements, assumptions, design of external contraction elements, Band brakes.	**5**
Unit-2	Bearings and Lubrication: Types of Lubrication, viscosity, journal bearing with perfect lubrication, hydrostatic and hydrodynamic lubrication theory, journal bearing design. Selection, and applications of rolling element bearings with axial and radial loads, bearing materials, bearing seals, mounting of bearings.	**6**
Unit-3	Mechanical drives: selection of transmission, Belt and Chain drives: Flat belts, V Belts, Roller chains.	8
Unit-4	Design of Gears: Helical, Bevel, and Worm gears, design stresses, stress concentration, overload factors, velocity factors, bending strength of gear tooth, Buckingham equation for dynamic loads, and wear characteristics, AGMA design equations, Design of an automobile gear box.	**7**
Unit-5	Hoisting elements: Theory of curved beams, Crane hooks, Snatch block assembly elements.	**8**
Unit-6	Design of Engine parts: Connecting rod, crank shaft, piston	**8**
	Total	**42**

Reference Book:	
1	Mechanical Engineering Design Shigley, J. E., Mischke, C. R. and Budynas, R. G., McGraw Hill, 7th Edition, ISBN- 0071077839, 2004.
2	Fundamental of Machine Component Design, Juvinall, R. C., and Marshek, K. M., John Wiley and Sons, ISBN- 0471448443, 2000.
3	Fundamentals of Machine Elements Hamrock, B. J., Jacobson, B. Schmidt, S. R. McGraw Hill, ISBN-9781482247480, 1999.
4	Machine Design: An Integrated Approach Norton, R. L., Pearson Education, ISBN- 9788131705339, 2001.
5	Machine Design, Bhandari TMH
6	Machine Design, D. K. Aggarwal and P. C. Sharma Dhanpat Rai, ISBN- 9789350142813.

Course Outcomes

CO1	To understand and apply principles of clutch design to spur gears and industrial spur gear boxes.
CO2	To become proficient in Design of Helical and Bevel Gear
CO3	To develop capability to analyze Rolling contact bearing and its selection from manufacturer's Catalogue.
CO4	To learn a skill to design Belt and Chain drives for various industrial applications.
CO5	Use of hoisting elements such as cranes, conveyors, fork lifters, etc
CO6	Design of Engine part namely Connecting rod, crank shaft, piston, etc

CO-PO/PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	2	2	1	0	1	0	0	3	3	2	2
CO2	2	3	3	2	1	1	0	1	2	0	2	2	2	2	2
CO3	2	2	2	3	1	1	0	0	0	0	0	3	3	1	1
CO4	3	3	3	3	2	2	1	0	1	0	0	3	3	2	2
CO5	2	3	3	2	1	1	0	1	2	0	2	2	2	2	2
CO6	2	2	2	3	1	1	0	0	0	0	0	3	3	1	1

ME324 System Modelling, Simulation and Analysis										
L	**T**	**P**	Credit	Area		**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
3	0/1	2/0	4	DEC/GEC		15/25	25	20/25	40/50	-

Objective: To enable the students to understand the fundamentals of probability and statistics, Continuous and discrete systems and Bond graphs. To understand techniques of simulation, System dynamics and Simulation of hydraulic systems.

Syllabus		**Contact Hours**
Unit-1	**Introduction:** A review of basic probability and statistics, random variables and their properties, Estimation of means, variances and correlation.	**5**
Unit-2	**Physical Modelling**: Concept of System and environment, Continuous and discrete systems, Linear and non-linear systems, Stochastic activities, Static and Dynamic models, Principles of modeling, Basic Simulation modeling, Role of simulation in model evaluation and studies, advantages of simulation	**6**
Unit-3	**Modeling of Physical System Dynamics:** A Unified Approach Physical system, Introduction to Bond graphs, Ports, Bonds and Power; Elements of Bond graphs:1-port elements – resistor R, Stiffness C, and Inertia I, Source of Effort Se and Flow SF; 2-port elements – Transformer TF and Gyrator GY, with modulation, Junction elements 1 and 0; Causality, Causality for basic 1-port and multi-ports. Derivation of System equations from Bond graphs in first order state space form.	8
Unit-4	**Bond Graph Modeling of Multi-energy Systems** Mechanical Systems, Translation and rotation (about a fixed axis) **System Simulation**: Techniques of simulation, Monte Carlo method, Experimental nature of simulation, Numerical computation techniques, Continuous system models, Analog and Hybrid simulation, Feedback systems, Computers in simulation studies, Simulation software packages.	**7**
Unit-5	**System Dynamics**: Growth and Decay models, Logistic curves, System dynamics diagrams. Probability Concepts in Simulation: Stochastic variables, discrete and continuous probability functions, Random Numbers, Generation of Random numbers, Variance reduction techniques, Determination of length of simulation runs.	**8**
Unit-6	**Simulation of Mechanical Systems**: Building of Simulation models, Simulation of translational and rotational mechanical systems, Simulation of hydraulic systems.	**8**
	Total	**42**

Reference Book:	
1	**System Simulation**- Geoffrey Gordon -Prentice Hall
2	**System Simulation: The Art and Science** -Robert E. Shannon -Prentice Hall
3	**System Modelling and Control** -J. Schwarzenbach and K.F. Gill Edward Arnold
4	**Modelling and Analysis of Dynamic Systems** -Charles M Close and Dean K. Frederick Houghton Mifflin
5	**Simulation of Manufacturing** -Allan Carrie John Wiley & Sons
6	**Bond Graph in Modeling, Simulation and Fault Identification**-Amalendu Mukherjee, Ranjit Karmakar, Arun Samantary-I.K. Int. Pub. House

Course Outcomes

CO1	Explain modeling and simulation types, entities, objectives and benefits
CO2	Recognize the simulation types and steps for variety of complex systems
CO3	Construct simulation models from enterprise high level models.
CO4	Performance simulations to analyze real-world systems.
CO5	Evaluate the results of simulation and analysis to improve or optimize systems
CO6	Apply and experiment computer packages to implement simulation and analysis.

CO-PO/PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	2	2	1	0	1	0	0	3	3	2	2
CO2	2	3	3	2	1	1	0	1	2	0	2	2	2	2	2
CO3	2	2	2	3	1	1	0	0	0	0	0	3	3	1	1
CO4	3	3	3	3	2	2	1	0	1	0	0	3	3	2	2
CO5	2	3	3	2	1	1	0	1	2	0	2	2	2	2	2
CO6	2	2	2	3	1	1	0	0	0	0	0	3	3	1	1

ME326 Pressure Vessels and Piping Technology										
L	**T**	**P**	Credit	Area		**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
3	0/1	2/0	4	DEC/GEC		15/25	25	20/25	40/50	-

Objective: To enable the students to understand the fundamentals of dilation of pressure vessels, thick cylinder and
thick sphere and stress concentration about a circular and an elliptical opening. To understand fatigue and fatigue life prediction.

Syllabus		**Contact Hours**
Unit-1	**Stresses in pressure vessels** Membrane stresses, dilation of pressure vessels, thick cylinder and thick sphere, bending of plate, discontinuity stresses in pressure vessels, thermal stresses.	**8**
Unit-2	**Factors influencing the design of pressure vessels** Design criterion of elliptical, hemispherical, conical, Autofrettage.	**8**
Unit-3	**Design of pressure vessel components such as shells, heads, nozzles, flanges as per ASME and IS codes** Localised stresses, stress concentration about a circular and an elliptical opening, theory of reinforced openings, nozzle reinforcement, welded joints.	8
Unit-4	**Fracture Control** Fatigue of various components of pressure vessels, Fatigue life prediction, thermal stress fatigue, criteria for design with defects.	**7**
Unit-5	**Piping elements, Dynamic analysis of piping**	**5**
Unit-6	**Use of FEM softwares for stress calculations**	**6**
	Total	**42**

Reference Book:	
1	**Pressure vessel design** by Harvey J. F., CBS Publication, ISBN- 812391041X.

Course Outcomes

CO1	Analyse thin plates and shells for various types of stresses.
CO2	Design shells, end closures and nozzles of pressure vessels using ASME codes.
CO3	Analyse piping systems.
CO4	Ability to design internal pressure vessels and external pressure vessels
CO5	Ability to design special vessels and various parts of vessels
CO6	Knowledge of equipment fabrication and testing methods

CO-PO/PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	2	2	1	0	1	0	0	3	3	2	2
CO2	2	3	3	2	1	1	0	1	2	0	2	2	2	2	2
CO3	2	2	2	3	1	1	0	0	0	0	0	3	3	1	1
CO4	3	3	3	3	2	2	1	0	1	0	0	3	3	2	2
CO5	2	3	3	2	1	1	0	1	2	0	2	2	2	2	2
CO6	2	2	2	3	1	1	0	0	0	0	0	3	3	1	1

ME328 Composite Material Technology										
L	**T**	**P**	Credit	Area		**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
3	0/1	2/0	4	DEC/GEC		15/25	25	20/25	40/50	-

Objective: To enable the students to understand the fundamentals of matrix materials and reinforcements, and reinforcement materials. To understand elastic moduli, and Kirchoff hypothesis,

Syllabus		**Contact Hours**
Unit-1	**Introduction to Composite Materials:** Definition, Classification, Types of matrix materials and reinforcements, Characteristics & selection, Fiber composites, laminated composites, Particulate composites, Prepegs, and sandwich construction. **Metal Matrix Composites:** Re-inforcement materials, Types, Characteristics and selection, Base metals, Selection, Applications.	**8**
Unit-2	**Macro Mechanics of a Lamina:** Hooke's law for different types of materials, Number of elastic constants, Derivation of nine independent constants for orthotropic material, Two - dimensional relationship of compliance and stiffness matrix. Hooke's law for two-dimensional angle lamina, engineering constants - Numerical problems. Invariant properties. Stress-Strain relations for lamina of arbitrary orientation, Numerical problems.	**8**
Unit-3	**Micro Mechanical Analysis of a Lamina:** Introduction, Evaluation of the four elastic moduli, Rule of mixture, Numerical problems. **Biaxial Strength Theories:** Maximum stress theory, Maximum strain theory, Tsa-Hill theory, Tsai, Wu tensor theory, Numerical problems.	8
Unit-4	**Macro Mechanical Analysis of Laminate:** Introduction, code, Kirchoff hypothesis, CL T, A, B, and D matrices (Detailed derivation) Engineering constants, Special cases of laminates, Numerical problems.	**6**
Unit-5	**Manufacturing:** Lay up and curing - open and closed mould processing, Hand lay, Up techniques, Bag moulding and filament winding. Pultrusion, Pulforming, Thermoforming, Injection moulding, Cutting, Machining and joining, tooling, Quality assurance, Introduction, material qualification, Types of defects, NDT methods.	**6**
Unit-6	**Application Developments:** Aircrafts, missiles, Space hardware, automobile, Electrical and Electronics, Marine, Recreational and sports equipment-future potential of composites.	**6**
	Total	**42**

Reference Book:	
1	**Composite Materials handbook,** Mein Schwartz Mc Graw Hill Book Company, 1984.
2	**Mechanics of composite materials,** Autar K. Kaw CRC Press New York.
3	**Mechanics of Composite Materials,** Rober M. Joness Mc-Graw Hill Kogakusha Ltd.
4	**Stress analysis of fiber Reinforced Composite Materials,** Michael W, Hyer Mc-Graw Hill International.
5	**Composite Material Science and Engineering,** Krishan K. Chawla Springer.
6	**Fibre Reinforced Composites,** P.C. Mallik Marcel Decker.

Course Outcomes

CO1	The student will develop a knowledge of the manufacturing of composite materials.
CO2	The student will develop a working knowledge of the various testing and performance protocols for composite materials.
CO3	The student will develop an understanding of the economics of composite materials.
CO4	Summarize the manufacture of metal matrix, ceramic matrix and composites.
CO5	Describe the manufacture of polymer matrix composites.
CO6	Describe the properties of various reinforcements of composite materials.

CO-PO/PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	2	2	1	0	1	0	0	3	3	2	2
CO2	2	3	3	2	1	1	0	1	2	0	2	2	2	2	2
CO3	2	2	2	3	1	1	0	0	0	0	0	3	3	1	1
CO4	3	3	3	3	2	2	1	0	1	0	0	3	3	2	2
CO5	2	3	3	2	1	1	0	1	2	0	2	2	2	2	2
CO6	2	2	2	3	1	1	0	0	0	0	0	3	3	1	1

ME330 Production and Operations Management										
L	**T**	**P**	Credit	Area		**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
3	0/1	2/0	4	DEC/GEC		15/25	25	20/25	40/50	-

Objectives: To enable the students to understand the fundamentals of operations strategy, Process of decision, Product design and learning curve. To understand Fundamentals of inventory and its models and PERT & CPM.

Syllabus		**Contact Hours**
Unit-1	**Introduction to POM** Introduction to POM, Operations strategy, strategy design process, corporate and operations strategies, Operations competitive dimensions, Process of decision-making under- certainty, uncertainty and risk.	**6**
Unit-2	**Product and Process Design** Product design and development processes, product life cycle, Process flow chart, Types of processes, Process performance, Learning curve.	**8**
Unit-3	**Facility location and Layout** Factors affecting the location decisions, methods of facility location factor rating systems, centroid method, and profit volume analysis; Types of layout, Block diagram and Assembly Line Balancing.	**8**
Unit-4	**Demand Forecasting** Qualitative and quantitative forecasting, Time series and regression models, Measures of forecasting errors.	**6**
Unit-5	**Inventory model** Importance of inventory, understocking and overstocking, Fixed order quantity models and fixed time period models (EOQ models), Selective inventory management- ABC, VED, and FSN analysis, JIT manufacturing system, Toyota production systems- KANBAN model, and elimination of waste.	**8**
Unit-6	**Project Management** Defining and organizing projects, feasibility study of projects, project planning, project scheduling- work breakdown structure, PERT & CPM, analyzing cost-time trade off, monitoring and controlling of projects.	**6**
	Total	**42**

Reference Book:	
1	Operations Management, Jay Heizer, Barry Render; Pearson learning, ISBN-0132863308, 2013.
2	Operations management for competitive advantage; Chase, Jacob, and Aquilano; TMH, ISBN- 0070604487, 2000.
3	Modern Production/Operations Management, Buffa and Serin, John Weily India, ISBN- 8126513721, 2007.
4	Operation Management, Krajewski and Ritzwan, Pearson Education.
5	Production and Operations Management, Adam, Jr. Elbert, PHI

Course Outcomes

CO1	To introduce students about industrial terminologies & functions.
CO2	To make inference between students and industry.
CO3	To give the direction to their thoughts towards industry.
CO4	Students will be able to study the concepts of Project management.
CO5	Students will be able to study the concepts and methods in production planning and control.
CO6	Able to acquire knowledge on facility, and problems associated the subject.

CO-PO/PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	1	0	0	2	2	2	2	2	0	2	2	2	0	1
CO2	2	3	1	0	3	2	0	0	0	0	2	2	3	1	2
CO3	3	2	1	0	3	1	0	0	0	0	1	2	3	0	2
CO4	2	3	2	1	2	2	2	0	0	0	3	2	2	1	2
CO5	2	2	2	1	2	2	2	0	0	0	3	3	3	1	2
CO6	2	1	2	1	3	2	2	2	1	0	3	3	3	1	2

ME332 Finite Element Method										
L	**T**	**P**	Credit	Area		**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
3	0/1	2/0	4	DEC/GEC		15/25	25	20/25	40/50	-

Objectives: To familiarize the students with basics of FEM, formulation of stiffness, load matrix and solution of bar, truss, beam, frames two-dimensional plane problems axisymmetric solids, numerical integration, three dimensional solids, dynamic problem, heat transfer and fluid problems. To impart in-depth knowledge of software MATLAB, ABAQUS & ANSIS to solve real life application.

Syllabus		**Contact Hours**
Unit-1	Fundamental concepts of the Finite Element Method. One Dimensional Problem (Bar of uniform and variable cross sections), Galerkin approach, Potential energy approach, shape functions, Derivation of stiffness matrix and load vector for the element and for the entire domain. Evaluation of displacement, stresses and reaction forces.	8
Unit-2	**Trusses**: Introduction, Plane Trusses, Local and Global coordinate Systems, Element Stiffness Matrix and Stress calculations	**6**
Unit-3	**Beams and Frames:** Finite element formulation for stiffness matrix, load vector, boundary conditions, Plane frame problems.	**6**
Unit-4	Two –Dimensional problem using Constant strain triangles (CST), Two dimensional isoparametric elements and numerical integration, element stiffness matrix, Force vector. Axisymmetric solids subjected to axisymmetric loading.	8
Unit-5	Applications of finite element method to fluid mechanics and heat transfer.	6
Unit-6	**Dynamic analysis**: Element mass matrices, Evaluation of Eigenvalues and Eigenvectors. Use of Softwares such as MAT LAB/ABAQUS/ANSYS/ NASTRAN/IDEAS. Basic feature of these softwares.	**8**
	Total	

Reference Book:	
1	Finite Element Procedures, K.J. Bathe, Prentice Hall of India.
2	Finite Elements in Engineering by Chandrupatla and Belegundu.
3	Finite element Method by J.N.Reddy.
4	Finite element Method,O.C. Zienkiewicz& R.A. Taylor
5	Finite element Analysis,C.S. Krishnamurthy
6	Finite element Method, Kenneth H. Hubener
7	Finite Element Method, Desai & Abel

Course Outcomes

CO1	Apply and understand the basic concepts of Finite element analysis procedure.
CO2	Apply the knowledge of mathematics and engineering in solving the problems related to structural and heat transfer
CO3	Application of finite element method to electrical systems.
CO4	Use of Galerkin Approach, The potential –Energy Approach, shape Functions
CO5	Able to learn Two dimensional isoparametric elements and numerical integration
CO6	Use the commercial FEA packages like ANSYS and modern CAD/CAE tools for solving real life structural problems.

CO-PO/PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	2	2	1	0	1	0	0	3	3	2	2
CO2	2	3	3	2	1	1	0	1	2	0	2	2	2	2	2
CO3	2	2	2	3	1	1	0	0	0	0	0	3	3	1	1
CO4	3	3	3	3	2	2	1	0	1	0	0	3	3	2	2
CO5	2	3	3	2	1	1	0	1	2	0	2	2	2	2	2
CO6	2	2	2	3	1	1	0	0	0	0	0	3	3	1	1

Course code: Course Title	Course Structure			Pre-Requisite
ME-334: Industrial Economics & Management	**L**	**T**	**P**	**NIL**
	3	**0**	**2**	

Course Objective: To familiarize the students with the basic concepts of industrial economics, policies, cost estimation. To impart knowledge about fiscal policies, inflations and study for improvement unemployment.

S. No.	ME-334: Industrial Economics & Management	Contact Hours
Unit 1	Introduction to Industrial Economics, Scope of Economics, Microeconomics and its importance and limitations, Macroeconomics and its Importance of microeconomics Policies, Difference between Micro economics and Macroeconomics Law of Demand and determinants of Demand, Exception of Law of Demand, Elasticity of Demand, Variation in Price Elasticity of Demand, Price Elasticity, Income Elasticity and Cross-price Elasticity, Law of Supply and determinant of Supply, Indifference Curve	8
Unit 2	Theory of Production and Concept of Production Function, Law of Variable Proportion and, Law of Returns, Introduction to Cost Estimation, Various types of Costs, Opportunity Cost, Short-run and long-run costs, Elements of Cost: Direct and Indirect Cost, Break-Even Analysis and its terminology,	9
Unit 3	Introduction to Market Structure, Perfect Competition Market and their Characteristics, Monopoly and its Characteristics, Monopolistic Competition and its characteristics, Oligopoly and its Characteristics, Type of Money, Fiscal Policy, Monetary Policy and its working	9
Unit 4	Introduction to National Income and its Measurement, National Income, Domestic Product, and Expenditure, Gross National Income, National Income at Current and Constant Price, Stock and flow concept, Gross Domestic Product, Gross National Product and Net National Product, Personal and Disposable Incomes, Inflation and Its Measurement, CPI and RPI, Cost of Inflation, Type of Inflation, Causes and remedies of Inflation.	8
Unit 5	. **Poverty, Unemployment, and Inflation,** Introduction to Scarcity and Economic Problems, Poverty: Absolute, Relative and Asset poverty, Causes of Poverty, Poverty Reduction, Unemployment and its Measurement, Types of Unemployment, Corporate **Social Responsibility (CSR) and Business Ethics,** Introduction to CSR, Importance of CSR, Types of CSR, Nature and Objectives of Ethics, 3C's of Business Ethics, Need and Objectives of Business Ethics	8
Total		42

REFERENCES

S. No.	Name of Books/Authors/Publishers	Year of Publication / Reprint*
1	Engineering Economy and Management by Pravin Kumar, John Wiley	2019
2	Fundamentals of Engineering Economics by Chan S Park, Pearson India	2017
3	Engineering Economy by Sullivan, Wicks, and Koelling Pearson India	2018

**: Latest edition of the title of author may please be listed.*

S. No.	Course Outcomes (CO)
CO1	To understand types of money, fiscal policy, monetary policy.
CO2	To identify the characteristics of various methods used for the generation of financial management decisions
CO3	To analyze information on investment planning and cost controls, and conduct cost/benefit analysis.
CO4	Quantify and include elements of uncertainty and risk into an economic analysis
CO5	Use modern computer-based tools such a spreadsheet in performing engineering economic analysis
CO6	To apply concept of money and fiscal policy on national economy.

CO-PO Articulation Matrix						
COs	**POs**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	**3**	**2**	**2**	**3**	**3**	**3**
CO2	**2**	**2**	**2**	**3**	**2**	**1**
CO3	**3**	**1**	**2**	**2**	**3**	**1**
CO4	**2**	**1**	**2**	**2**	**2**	**2**
CO5	**2**	**3**	**2**	**2**	**2**	**1**
CO6	**3**	**3**	**2**	**2**	**2**	**3**

ME336 Creativity and Innovation Management										
L	**T**	**P**	Credit	Area		**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
3/4	0	2/0	4	DCC		15/25	25/0	20/25	40/50	-

Objective: To enable the students to formulate and analyze the need and applications of creativity. . Students will be able apply the Scientific *Procedure of Problem Solving for the domestic and industrial problems.*

ME336 Creativity and Innovation Management		**Contact Hours**
Unit-1	Historical journey of human and social development. Need for Creativity and Innovation, Creativity in Lifestyle-Comfort and Luxury Examples and case studies Problem solving principles, Scientific Procedure of Problem Solving, Specifications of Design, objectives and constraints.	**8**
Unit-2	Biomimicry, Nature inspired innovations, case studies such as Green Building, Bullet train, Nike Clothing, Velcro, Adhesive Tape, Self-healing plastic, Friction reducing swimming suit, Automated robot, screen display etc.	**6**
Unit-3	Idea Generation Tools: Brain storming, Mind mapping, SWOC Analysis, Fishbone Diagram, Edward De Bono six thinking hats, Borrowing Brilliance, Da Vinci's seven principles, Provocation and Movement. JUGAAD Innovation: Jugaad tactics, Seek Opportunities in Adversity, Case studies	**6**
Unit-4	Analysis of Innovations: MEDICI EFFECT Introduction, Intersection, Creating Medici effect, Making intersectional ideas happen, Case studies, TRIZ Innovation: Introduction, Ideality, Resources, Contradictions, Pattern of Innovation, Case studies	**8**
Unit-5	Ergonomics Concept; Man-machine-environment interaction system and user-friendly design practice; Human compatibility, comfort and adaptability; Fundamentals of ergonomics, environmental factors influencing human performance; Occupational stress; safety and health issues; Design process involving ergonomics check and ergonomic design evaluation and Participatory ergonomics aspects.	**8**
Unit-6	IPR and Patents: Introduction to IPR; Overview; Importance; PR in India and IPR abroad; Patents; their definition; granting; infringement; Copyrights; their definition; granting; infringement. Trademarks, role in commerce, importance, protection, registration; domain names; Industrial Designs and processes; difference between Designs and process Patents', scope; protection; filing and infringement; Geographical indicators, legal issues, enforcement; Case studies.	**6**
	Total	**42**

Reference Books:	
1	*Benyus, J. M. (1997). "Biomimicry: Innovation Inspired by Nature" Pubisher-Harper Perenial New York (ISBN 978-1-59017-133-2)*
2	*Altshuller, G., and Shulyak, L ,Technical Innovation Center, "Keys to Technical Innovation" Inc, USA. (1997) '40 Principles: TRIZ. (ISBN: 978-0-387-75455-0)*
3	*Edward De Bono, "Lateral thinking be more creative and productive",Publisher-penguin India (ISBN -10: 0141033088)*
4	*Renault Nissan, Jugad innovation- (ISBN-13: 978-1118249741).*
5	*Edward De Bono, "six thinking hats" (ISBN-13: 978-0141033051)*
6.	*Navi Radjou Jaideep Prabhu and Simone Ahuja, Jugad innovation (ISBN-13: 978-1118249741)*

Course Outcomes

CO1	To understand the need for creativity and innovations.
CO2	To be familiar with the nature inspired innovations
CO3	To analyze and steady the idea generation tools for problem solving
CO4	To analyze the innovation ideas using historical studies and tools.
CO5	To understand the ergonomic concepts and their applications in innovations
CO6	To understand the importance and process of patents and IPR.

CO-PO/PSOMatrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	2	2	0	0	0	0	0	0	2	2	1
CO2	3	3	2	3	1	0	0	0	0	0	0	1	2	1
CO3	3	3	3	3	1	0	0	0	0	0	0	2	3	3
CO4	3	3	3	3	1	0	0	0	0	0	0	1	3	3
CO5	2	2	2	2	2	0	0	0	0	0	0	1	2	2

ME407 Carbon Capture and Climate Change										
L	**T**	**P**	Credit	Area		**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
3	0/1	2/0	4	DEC/GEC		15/25	25	20/25	40/50	-

Objectives: To enable the students to understand the Science of climate change, Greenhouse effect and Carbon Emissions Mitigation Strategies. To understand Fundamentals Carbon Capture Technologies and Carbon Storage and Utilization.

Syllabus		**Contact Hours**
Unit-1	Fundamentals of Climate Change. Science of climate change: Greenhouse effect and global warming Sources of greenhouse gases (GHGs) and their environmental impacts Climate change impacts on ecosystems, agriculture, and water resources Global climate models and predictions	6
Unit-2	Carbon Emissions Mitigation Strategies , Global carbon cycle and anthropogenic emissions	6
Unit-3	Mitigation Strategies: Carbon mitigation strategies: Renewable energy, energy efficiency, and sustainable land use. Role of carbon pricing, carbon markets, and carbon credits. Case studies on mitigation strategies	6
Unit-4	Carbon Capture Technologies. Introduction to carbon capture, utilization, and storage (CCUS). Carbon capture methods: Pre-combustion, post-combustion, and oxy-fuel combustion. Technologies for CO_2 capture: Chemical absorption, adsorption, membranes, and cryogenic separation. Challenges and opportunities in CCUS	8
Unit-5	Carbon Storage and Utilization. Geological storage of CO_2: Deep saline aquifers, depleted oil and gas reservoirs. Mineral carbonation and ocean sequestration. Utilization of captured CO_2: Enhanced oil recovery, synthetic fuels, and chemicals Environmental risks and monitoring of carbon storage	8
Unit-6	Policies, Economics, and Innovations. International climate agreements: Paris Agreement, Kyoto Protocol, and IPCC guidelines. National policies for carbon management and climate change mitigation. Socio-economic aspects of carbon capture and climate change. Emerging technologies and innovations for carbon neutrality. Future directions and global efforts for sustainable development.	8
	Total	**42**

Reference Book:	
1	"Introduction to Modern Climate Change" by Andrew Dessler, Cambridge University Press.
2	"Carbon Capture and Storage" by Stephen A. Rackley, Butterworth-Heinemann.
3	"Global Warming: Understanding the Forecast" by David Archer, Wiley.
4	"Carbon Capture" by Jennifer Wilcox, Springer.
5	"Handbook of Climate Change Mitigation and Adaptation" by Wei-Yin Chen, Springer.
6	"Climate Change: The Science of Global Warming and Our Energy Future" by Edmond A. Mathez, Columbia University Press.
7	"Carbon Sequestration and Sustainable Development" by K. Lal and B. Singh, Springer.

Course Outcomes

CO1	Understand the science of climate change, its causes, and its impacts on the environment and society.
CO2	Analyze the principles, methods, and technologies used for carbon capture, utilization, and storage (CCUS).
CO3	Evaluate carbon mitigation strategies and their effectiveness in reducing greenhouse gas emissions.
CO4	Explore the socio-economic, policy, and legal aspects of climate change and carbon management.
CO5	Develop innovative and sustainable solutions to address climate challenges and promote carbon neutrality.
CO6	Applications of Carbon Capture and Climate Change

CO-PO/PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	3	2	3	2	1	2	2	2	1	2	3	2	3
CO2	3	3	2	2	3	3	2	2	1	2	1	1	3	3	3
CO3	3	1	1	3	2	2	3	2	2	3	2	2	3	2	2
CO4	1	2	2	1	2	3	1	2	3	1	3	3	1	3	2
CO5	2	2	1	3	1	3	2	2	3	3	2	1	2	3	1
CO6	3	3	3	3	3	2	2	2	1	1	1	2	3	2	3

ME409 Mechatronics and Control										
L	**T**	**P**	Credit	Area		**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
3	0/1	2/0	4	DEC/GEC		15/25	25	20/25	40/50	-

Objectives: To enable the students to understand the mechatronic systems and components, and simulation of dynamic systems. To understand Fundamentals of Stepper and servo motors and Digital logic.

Syllabus		**Contact Hours**
Unit-1	Introduction to mechatronic systems and components; Sensors and transducers; Actuators- electrical, electromechanical, electromagnetic, hydraulic, pneumatic, smart material actuators, micro actuators, nano actuators. Active actuators- piezoelectric, shape memory alloys (SMA), electro active polymers (EAP), magneto restrictive, magneto rheological fluid (MR).	8
Unit-2	Stepper and servo motors, Encoders and resolvers	6
Unit-3	Modeling, analysis and simulation of dynamic systems; use of MATLAB; Bode, Nyquist and root-locus plot	6
Unit-4	Feedback systems: Open and closed loop control systems; Stability and sensitivity; PID, phase lag and phase lead compensation	6
Unit-5	Sampled data systems and Digital controllers; DA/AD converters, microprocessors, interfacing with computers	8
Unit-6	Digital logic: Analysis and synthesis of mechatronic systems with application to robotics, CNC systems and others	8
	Total	42

Reference Book:	
1	Introduction to Mechatronics and Measurement systems, (special Indian edition), Alciatore, David Tata-McGraw Hill India Ltd.
2	Mechatronics: Principles, Concepts and applications, Mahalik.N, Tata-McGraw Hill India Ltd.
3	Mechatronics: Principles and applications, Onwubolu, Elsevier India Pvt Ltd.
4	Mechatronics by Hindustan Machine Tools Ltd., McGraw- Hill Ltd.
5	Mechatronics: Electronic Control systems in Mechanical and Electrical Engineering. 3/e, Pearson Education.
6	Dan Necsulescu, “Mechatronics”, Pearson Education Asia,2002(Indian reprint)
7	Mechatronics – W. Bolton, Pearson Education

Course Outcomes

CO1	Students will be able to know the basics, details and components of Mechatronic Systems.
CO2	Students will be able to know the principle of Sensors & Transducers and Pneumatic/Hydraulic/Mechanical/Electrical Actuation Systems.
CO3	Students will be able to understand the System Modelling, Analysis and Simulation of dynamic systems using Mechanical/Electrical/Thermal system building blocks.
CO4	Students will be able to know the various Feedback systems: PID controllers and phase lag and phase lead compensation.
CO5	Students will be able to understand the DA/AD converters, microprocessors, interfacing with computers,
CO6	Students will be able to know the Digital logic: Analysis and synthesis of mechatronic systems with application to robotics, CNC systems and others Advanced Applications in Mechatronics.

CO-PO/PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	1	2	2	1	1	1	1	2	2	1	3
CO2	3	3	2	2	2	2	2	1	1	1	1	3	3	2	2
CO3	3	3	3	2	2	2	1	1	1	1	1	2	2	1	3
CO4	3	3	3	3	2	2	2	1	1	1	1	2	3	1	2
CO5	3	3	3	3	3	2	2	1	1	1	1	3	3	2	3
CO6	3	3	3	3	3	2	2	2	1	1	1	2	3	2	3

ME411: I. C. Engines										
L	**T**	**P**	Credit	Area		**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
3	0/1	2/0	4	DEC/GEC		15/25	25	20/25	40/50	-

Objectives: To enable the students to understand the mechatronic systems and components, and simulation of dynamic systems. To understand Fundamentals of Stepper and servo motors and Digital logic.

Syllabus		**Contact Hours**
Unit-1	**Introduction to I.C Engines**: Classification; two and four stroke, SI and CI engines parts, working principle and valve and port timing diagram	**6**
Unit-2	**Combustion Phenomenon in SI engines:** Principles of combustion in SI engine, effect of engines and operating variables on ignition delay & flame propagation, combustion chamber for SI engines, cycle to cycle variation, pre-ignition, abnormal combustion, theory of detonation, effect of engine and operating variables on detonation, surface ignition, adiabatic flame temperature, ignition systems	**8**
Unit-3	**Combustion phenomenon in CI engines:** Principles of combustion in CI engine, delay period, variables affecting delay period, diesel knock, methods of controlling diesel knock, combustion process & combustion chambers for CI engines	**8**
Unit-4	**Fuel system and Mixture requirement in SI and CI Engine:** Carburetion- working principles, chemically correct air-fuel ratio and load variation, compensating devices, venture and jet dimension calculation, modern fuel induction system, multi point fuel injection system, fuel injection: common rail direct injection	**6**
Unit-5	**Engine Testing, Supercharging, Lubrication and Engine Cooling:** Engine performance and testing, measurement of power, supercharging limits of SI &CI engines methods of supercharging, superchargers, turbo charging, lubrication principles, function of lubricating system, properties of lubricating oil, additives, cooling system, air cooling, water cooling	**8**
Unit-6	**Introduction to Automotive Fuels:** Petroleum based fuels and their properties, knock rating of engine fuels, necessity of alternative fuels, LPG, CNG, producer gas, biogas, H2, biodiesel and alcohols	**6**
	Total	**42**

Reference Book:	
1	**I.C Engines and Air Pollution** by E.F. Obert, Intext Educational Publishers, ISBN-9780700221837.
2	**I.C Engines** by Ferguson, John Wiley & Sons, ISBN- 0471356174.
3	**Fundamentals of I.C Engines** by J.B Heywood, Tata McGraw-Hill Companies, ISBN- 9780070286375.
4	**I.C Engines** by Mathur& Sharma, Dhanpat Rai and Sons, ISBN- 9383182428.
5	**The Internal Combustion Engine - Theory and Practice Vols. I & II** by C.F. Taylor, MIT Press, ISBN-02627002711.

Course Outcomes

CO1	Understand the basic principles of working of IC engines and make them realize the need for the development of ICE.
CO2	To Understand the ICE design process and parameters.
CO3	Analyse ideal and real working cycles and performance analysis.
CO4	Describe Fuel system and Mixture requirement in SI and CI Engine.
CO5	Able to understand engine testing, supercharging, lubrication and engine cooling
CO6	Basics of fuels used in engines.

CO-PO/PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	2	0	1	0	0	0	0	3	3	2	2
CO2	2	2	3	3	2	1	1	0	0	0	0	3	3	2	2
CO3	2	2	2	2	2	1	1	0	0	0	0	2	3	2	3
CO4	3	2	1	2	2	1	0	0	0	0	0	2	3	3	2
CO5	2	2	2	3	2	1	0	0	0	0	0	2	2	2	3
CO6	2	2	3	3	2	1	1	0	0	0	0	3	3	2	2

ME413 Metrology										
L	**T**	**P**	Credit	Area		**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
3	0/1	2/0	4	DEC/GEC		15/25	25	20/25	40/50	-

Objectives: To enable the students to understand the basics of metrology, line and end standards, comparators. To understand the concepts of sine bar and measurement of surface texture.

Syllabus		**Contact Hours**
Unit-1	**Principles of measurement**: Definition of Metrology, difference between precision and accuracy. Sources of errors: Controllable and Random Errors, Effects of Environment and Temperature, Effects of support, alignment errors, application of Least Square principles, errors in measurement of a quality which is function of other variables. **Length Standards:** Line standards, end standards and wavelength standards, transfer from line standards to end standards. Numericals based on line standards. Slip gauges – its use and care, methods of building different heights using different sets of slip gauges. **Limits, fits and tolerances**: Various definitions, IS919-1963, different types of fits and methods to provide these fits. Numerical to calculate the limits, fits and tolerances as per IS 919- 1993. ISO system of limits and fits; Gauges and its types, limit gauges – plug and ring gauges. Gauge Design – Taylor's Principle, wear allowance on gauges. Different methods of giving tolerances on gauges, Numericals.	**6**
Unit-2	**Comparators:** Characteristics, Uses, Limitation, Advantages and Disadvantages. Mechanical Comparators: JohansonMikrokator and Signma Mechanical Comparator. Mechanical - optical comparator. Electrical and electronic comparators. Pneumatic comparators – Systems of Penumatic gauging: Flow type and back pressure type, different type of sensitivities and overall magnification. Solex Pneumatic gauge and differential comparators. Numericals.	**8**
Unit-3	**Angular Measurement**: Sine Bar – different types of sine bars, use of sine bars in conjuction with slip gauges, precautions and calibration of sine bars. Use of angle gauges, spirit level, errors in use of sine bars. Numericals. Principle and working of Micro-optic autocollimator. Circular Division: dividing head and circular tables, circular division by precision Polygons. Caliper Principle, Calibration of polygons. Numerical based on circular division. **Straightness and flatness**: Definition of Straightness and Flatness error. Determination of straightness error of straight edge with the help of spirit level and auto collimator. Determination of flatness error of a surface plate with the help of spirit level or auto collimator. Numericals.	**8**
Unit-4	**Screw Thread Measurement:** Errors in threads, Measurement of elements of screw threads – major diameter, minor diameter, pitch, flank angle and effective diameter (Two and three wire methods). Effect of errors in pitch and flank angles and its mathematical derivation. **Gear Measurement**: Measurement of tooth thickness – Gear tooth verniercaliper, Constant chord method, base tangent method and derivation of mathematical formulae for each method. Test plugs method for checking pitch diameter and tooth spacing. Measurement of Gear Pitch, Parkinson Gear Tester.Numericals.	**6**
Unit-5	**Machine Tool Alignment**: Machine tool tests and alignment tests on lathe. Alignment tests on milling machine. Alignment tests on a radial drilling machine.	**8**

	Interferometry: Principle of measurement, Interferometry applied to flatness testing, surface contour tests, optical flats, testing of parallelism of a surface with the help of optical flat. Quantitative estimate of error in parallelism, Flatness Interferometer, NPL Gauge length interferometer for checking the error in slip gauges. Numericals based on Interferometry.	
Unit-6	**Surface texture**: Introduction, different types of irregularities, standard measures for assessment and measurement of surface finish.	**6**
		42

Reference Book:	
1	Engineering Metrology", R.K. Jain, Khanna Publishers, Delhi. ISBN-13-9788174091536
2	Engineering Metrology, I.C. Gupta, Dhanpat Rai Publications, Delhi ISBN: Released: 9788189928452
3	Metrology for Engineers", F.W. Galyer & C.R. Shotbolt, "ELBS edition. ISBN-13: 978-0304318445
4	Fundamentals of Mechanical Inspection", R. Jenkins, McGraw Hill. (OCoLC) 600502978
5	"Fundamentals of Dimensional Metrology", C. Dotson ISBN-13: 9781418020620. Cengage Learning
6	A.S.T.M.E., "Handbook of Industrial Metrology", Prentice Hall. ISBN: 9783527406661

Course Outcomes

CO1	Understanding about Metrology, Principles of measurement, Sources of errors, Length Standards: Line standards, end standards and wavelength Standards, along with Slip gauges, its use and care as well as Limits, fits and tolerances
CO2	To understand the principle, types and application of Comparators along with their Characteristics, Limitation and Advantages & Disadvantages.
CO3	To understand the principle, types and instruments of Angular as well as Straightness and flatness.
CO4	To enable the students to understand about the parameters of Screw Thread and Gears, their Measurements and Errors.
CO5	To understand about various Machine tool tests and Alignment tests on Lathe, Milling machines and Drilling machines. Also about principle of Interferometry and its application in Metrology.
CO6	To understand different types of irregularities, standard measures for assessment and measurement of surface finish.

CO-PO/PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	2	2	2	3	2	3	2	3	2	-	-
CO2	3	2	3	2	2	3	2	3	2	2	3	3	3	-	2
CO3	2	3	3	2	3	2	2	2	2	3	2	3	2	-	2
CO4	3	3	3	3	2	3	3	2	3	2	2	3	2	-	2
CO5	2	2	3	2	3	2	3	2	2	2	2	2	2	-	2
CO6	3	3	3	2	2	2	2	3	3	2	3	3	2	-	2

ME415 Project Management										
L	**T**	**P**	Credit	Area		**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
3	0/1	2/0	4	DEC/GEC		15/25	25	20/25	40/50	-

Objectives: To enable the students to understand the basics of project management, project resource requirement, types of resources. To understand the concepts of project monitoring and post project reviews.

Syllabus		**Contact Hours**
Unit-1	**Introduction** Definitions, classifications, and scope of project management; project life cycle and uncertainty.	**6**
Unit-2	**Project planning** Scope, problem statement, project goals, objectives, success criteria, assumptions, risks, obstacles, approval process, projects and strategic planning.	**8**
Unit-3	**Project implementation** Project resource requirement, types of resources: men, materials, finance, resource distribution.	**8**
Unit-4	**Project monitoring** Evaluation, control, project network technique, planning for monitoring and evaluation, project audits, project management information system, Nature of project inventory, supply and transportation of materials, use of Material Requirement Planning. Project scheduling, PERT & CPM, project communication.	**6**
Unit-5	**Project team management** Recruitment, organizing, human resources: team operating rules, project organization, various forms of project organizations, project organization charting, project contracts, principles, compilation of contracts, practical aspects, legal aspects, global tender, negotiations, insurance.	**8**
Unit-6	**Project completion** Closing the project, types of project termination, strategic implications, project in trouble, termination strategies, evaluation of termination possibilities, termination procedures, post project reviews.	**6**
		42

Reference Book:	
1	Beenet P Lientz, Kathyn P rea, Project Management for 21st Centrury, - Academic Press, ISBN 12449983X, 2001.
2	Project Management –Dennis Lock, Gower Publishing Ltd; 9th Revised edition edition; ISBN 0566087693, 2007
3	David I Cleland, Project management, Mcgraw Hill International Edition, ISBN 0442221142,1988.
4	Gopalakrishnan, Project Management, Mcmillan India Ltd, ISBN 0333926218,1993

Course Outcomes

CO1	Ability to understand the basics of project management
CO2	Identification and formulation of various problems in project management
CO3	Selection of appropriate process/tool/techniques in project management
CO4	Application of knowledge in relevance to professional practice
CO5	Lifelong learning in technological world
CO6	Understand the concepts of demand forecasting and project management with relevant case studies.

CO-PO/PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	2	2	2	3	1	2	1	2	1	2	2	2	2
CO2	3	2	2	2	1	1	2	3	2	1	2	2	3	2	2
CO3	2	3	2	3	2	1	2	1	2	1	2	1	2	2	3
CO4	2	2	1	3	3	2	1	2	1	2	3	2	3	2	3
CO5	1	2	3	1	2	3	3	1	3	3	3	3	3	3	3
CO6	2	2	1	3	3	2	1	2	1	2	3	2	3	2	3

ME417 Robotics and Automation										
L	**T**	**P**	Credit	Area		**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
3	0/1	2/0	4	DEC/GEC		15/25	25	20/25	40/50	-

Objectives: To enable the students to understand the basics of robots, terms relating to industrial robots, types of resources. To understand the concepts of robot languages and programing.

Syllabus		**Contact Hours**
Unit-1	Introduction to Robotics, Classification of Robots, Characteristics of Robots, performance, advantages and disadvantages of a robot, industrial applications of a Robot.	**6**
Unit-2	Fundamentals of a Robot: Various system, structure and definition, terms relating to industrial Robots, basic terms related to Robot performance and Characteristics, Control volume of a robot.	**8**
Unit-3	Robot languages and programing.	6
Unit-4	Controlling the Robot systems: Introduction to drives, Mechanical, Hydraulic, Pneumatic, electric drives, feedback control	8
Unit-5	Sensing system for a robot: Introduction, types of sensors, machine vision, Artificial intelligence, Control techniques.	**7**
Unit-6	Robot safety: Introduction, potential safety hazards, safety planning check lists, safety guidelines, latest development in safety measurement.	**7**
	Total	**42**

Reference Book:	
1	Introduction to Robotics: Mechanics and Control, John j Craig, Pearson education, ISBN- 0201543613, 2005.
2	Robotics for Engineers, Y.Koren, McGraw Hill Publications, ISBN- 0070353999, 1985.

Course Outcomes

CO1	To make the students understand basics of robots and automation
CO2	To understand the basics of various methods, machines with respect to robotics and automation
CO3	To make the students understand different types of sensors
CO4	To make the students understand different types of configurations
CO5	To understand the importance of robotics and automation and their applications.
CO6	Application of robotics in industries.

CO-PO/PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	2	2	2	3	2	3	2	3	3	1	2	2	1	3
CO2	2	3	3	2	1	2	3	2	3	1	1	1	2	1	2
CO3	1	3	3	2	2	2	3	2	1	3	1	2	1	2	2
CO4	2	3	2	2	3	2	3	2	2	2	1	1	2	3	1
CO5	3	3	1	2	1	2	3	2	3	1	1	2	2	3	2
CO6	1	3	3	2	2	2	3	2	1	3	1	2	1	2	2

ME419 Computational Fluid Dynamics										
L	**T**	**P**	Credit	Area		**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
3	0/1	2/0	4	DEC/GEC		15/25	25	20/25	40/50	-

Objective: To enable the students to understand the introduction to CFD, mathematical behavior of partial differential equations. To understand concept of commercial codes (e.g. FLUENT).

Syllabus		**Contact Hours**
Unit-1	Introduction to CFD, Historical background, Impact of CFD	**6**
Unit-2	The Governing Equations of Fluid Dynamics Derivation, Discussion of physical meanings and Presentation of forms particularly suitable to CFD	**8**
Unit-3	Mathematical classification and physical Behavior of Partial Differential Equations: Elliptical, parabolic and hyperbolic equations. Impact on CFD.	6
Unit-4	Basic Aspects of Discretization: Taylor series expansion, Introduction to Finite Difference, Finite Elements and Finite Volume Methods. Detailed treatment of Finite Difference method, explicit and implicit methods, errors and stability analysis.	8
Unit-5	Grids with Appropriate Transformations, Adaptive grids and unstructured meshes. Lift reduction, down force generation and drag reduction. An introduction to the aerodynamics of airflows for cooling.	**7**
Unit-6	Commercial codes (e.g. FLUENT). Grid generation, techniques and application. Basic principles and concepts and the characteristics of wings and diffusers.	**7**
	Total	**42**

Reference Book:	
1	Computational Fluid Dynamics", John Anderson," McGraw- Hill Ltd.
2	Computational Fluid Dynamics", Tu, Elsevier.
3	Introduction to Computational Fluid Dynamics, Niyogi, Pearson Education, Delhi

Course Outcomes

CO1	Optimization manufacturing of hvac design, aerodynamics design, automobiles design, external building flows, fire/smoke management.
CO2	CFD analysis of velocity, pressure, temperature and chemical concentration allocation etc. helps engineers in understanding the problem appropriately and offers practical ideas for the best decision about the most flawless and productive designing.
CO3	CFD save cost and time, CFD is reliable.
CO4	Basics of Finite Difference, Finite Elements and Finite Volume Methods.
CO5	Grids with Appropriate Transformations Adaptive grids
CO6	Able to use commercial codes and software's

CO-PO/PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	1	2	2	1	1	1	1	2	2	1	3
CO2	3	3	2	2	2	2	2	1	1	1	1	3	3	2	2
CO3	3	3	3	2	2	2	1	1	1	1	1	2	2	1	3
CO4	3	3	3	3	2	2	2	1	1	1	1	2	3	1	2
CO5	3	3	3	3	3	2	2	1	1	1	1	3	3	2	3
CO6	3	3	3	3	3	2	2	2	1	1	1	2	3	2	3

ME421 Advanced Manufacturing Processes										
L	**T**	**P**	Credit	Area		**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
3	0/1	2/0	4	DEC/GEC		15/25	25	20/25	40/50	-

Course Objective: To familiarize the students with basics of advanced manufacturing processes. To impart knowledge about the basic principles of operation for each process and their applications. State various process parameters influencing the machining process.

Syllabus		**Contact Hours**
Unit-1	Introduction: mechanical advanced machining processes, need of advanced machining processes, hybrid processes Ultrasonic machining (USM): Introduction, mechanics of cutting, parametric analysis, process capabilities, applications.	**6**
Unit-2	Abrasive jet machining (AJM): Introduction, AJM setups, gas propulsion system, abrasive feeder, machining chamber, AJM nozzle, abrasive parametric analysis, process capabilities, applications.	6
Unit-3	Water jet machining: Introduction, process characteristics, process performance, applications. Abrasive Water jet machining: Working principle, parametric analysis, process capabilities and applications. Abrasive finishing process: Working principle, material removal and surface finish parametric analysis, process variables and applications.	8
Unit-4	Electro discharge machining (EDM): Introduction, Working principle, parametric analysis, process variables, process characteristics, applications, hybrid processes such as electro discharge grinding, diamond grinding, wire EDM, Laser beam machining: production of laser, working principle, types of laser, process characteristics and applications. Electron beam machining: Working principle, process parameter, process characteristics, applications. Ion beam machining: Working principle, process parameter, process characteristics, applications. Plasma arc machining: Working principle, Plasma arc cutting system, applications.	8
Unit-5	Electro-chemical machining: Working principle, ECM systems, parametric analysis, advantages and limitations, process performance, hybrid process such as EC grinding and chemical machining.	**7**
Unit-6	Ultra precision machining for higher accuracy and surface quality, micro machining, nano finishing and future trends in advanced machining processes.	**7**
	Total	**42**

Reference Book:	
1	Advanced machining process, Dr. V. K. Jain
2	Non traditional methods of manufacturing, shah &Pandey

Course Outcomes

CO1	The course aims to equip students with overview and the need of advanced manufacturing processes.
CO2	To comprehend working principle of advanced manufacturing processes based on energy used such as mechanical, thermal, and Kinetic energy.
CO3	To study parametric analysis of advanced manufacturing processes such as EDM, ECM, USM, AJM, AJWM.
CO4	To study the process variables on the performance of advanced manufacturing process such as metal removal and surface finish.
CO5	To study the capabilities and limitations of the advanced manufacturing processes and the guidelines for their selection of different materials.
CO6	To learn the working principle of hybrid advanced manufacturing techniques to enhance the manufacturability.

CO-PO/PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	2	2	2	2	1	2	3	1	2	3	3	2	1
CO2	1	2	3	1	2	1	3	1	2	2	3	1	2	1	3
CO3	2	3	2	1	1	3	1	2	1	3	1	2	2	1	2
CO4	1	2	3	2	1	2	3	2	2	1	1	3	3	2	1
CO5	2	1	1	2	1	2	1	2	1	3	3	1	3	1	2
CO6	1	2	3	3	2	1	2	1	1	2	3	2	3	1	3

ME423 Operations Research										
L	**T**	**P**	Credit	Area		**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
3	0/1	2/0	4	DEC/GEC		15/25	25	20/25	40/50	-

Objective: To allow students to develop the technical, analytic, and managerial skills necessary to perform the tasks successfully

Syllabus		**Contact Hours**
Unit-1	**Introduction:** Nature, Scope and Historical developments, Linear programming- Model formulation, Graphical and simplex methods, Duality, Degeneracy, sensitivity analysis.	**6**
Unit-2	**Transportation:** North-West corner rule, Least cost method, VAM, Methods to check the optimality, Assignment- Hungarian method and Sequencing models: Johnson Rule for n- job two-machine, n- job mmachine.	6
Unit-3	**Queuing theory:** Assumptions and applications of waiting line theory, M/M/1: /FCFS, M/M/K: /FCFS, M/M/K	8
Unit-4	**Game theory and its applications**: Pure and mixed strategy, dominance principle, Algebraic, arithmetic, and graphical methods to solve GT problems.	8
Unit-5	**Replacement models:** Replacement policy for the items that deteriorate over time, replacement policy for the items that deteriorate over time when time value of money is declining, replacement policy for the items that fails suddenly.	**7**
Unit-6	**Network Planning:** PERT, CPM, Project crashing, Shortest path problem, Maximum flow problem, Minimum **spanning tree problem, minimum cost flow problem, Resource levelling.**	**7**
	Total	**42**

Reference Book:	
1	Operations Research: Theory and Applications by J K Sharma, Macmillan, ISBN- 9789350593363, 2013.
2	Operations Research: An introduction by H A Taha, Pearson Education
3	Operations Research: Concepts and cases by F S Hiller and G J Liebermaan, TMH
4	Quantitative Technique in Management by N D Vohra, TMH

Course Outcomes

CO1	To identify and develop operational research models from the verbal description of the real system.
CO2	To understand the mathematical tools that are needed to solve optimization problems.
CO3	To use mathematical software to solve the proposed models
CO4	To understand the characteristics of different types of decision-making environments and the appropriate decision-making approaches and tools
CO5	To design new simple models to improve decision –making and develop critical thinking and objective analysis of decision problems
CO6	To develop a report that describes the model and the solving technique, analyse the results and propose recommendations in language understandable to the decision-making processes.

CO-PO/PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	2	3	2	2	3	3	3	3	3	3	3	2	2	3
CO2	3	3	1	1	3	1	3	1	3	3	1	3	3	2	2
CO3	3	2	2	2	1	2	1	2	1	2	1	2	2	1	3
CO4	2	1	1	1	1	1	1	1	3	2	2	2	2	3	1
CO5	2	1	1	3	3	3	3	2	2	1	1	1	3	1	3
CO6	3	1	2	2	2	2	2	3	3	3	3	3	3	3	2

ME425 Industrial Tribology										
L	**T**	**P**	Credit	Area		**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
3	0/1	2/0	4	DEC/GEC		15/25	25	20/25	40/50	-

Course Objective: To familiarize the students with basics of lubrication, wear &cost of friction. To impart in-depth knowledge of mechanisms of erosive and cavitations wear, hydrostatic lubrication, design of bearing, smart bearing and bearing with IOT.

Syllabus		**Contact Hours**
Unit-1	Introduction: Surface interactions, science of rubbing surface, general consideration of parameters involved, wear rate, modeling and solution of simple problems.	**6**
Unit-2	Material properties influencing interactions: Introduction, elastic properties, plastic deformation properties, relation between the strength and other properties of solids, chemical reactivity of surfaces, absorbed surface layer, Surface energy, relation between surface energy and hardness, Surface Interfacial Energies of Solids under engineering condition.	6
Unit-3	Surface Interaction: Size of real contact area and effect of surface energy, size of junction, rheologial properties, Wear in tribological joints - classification, calculation methods with allowance for stiffness, wear limits, reliability of joints, simple examples, detail study of manufacturing methods for highly reliable joints. Economic role of wear, measurement, types, and use of radiotracer techniques.	8
Unit-4	Adhesive wear: Mechanism, size, shapes of transferred and wear particles, quantitative laws, equilibrium calculation of fragments under different conditions, minimum load for loose particle formation, Quantitative expression for abrasive wear, of hardness and particle size on abrasive wear rate, surface fatigue wear, brittle fracture wear, corrosive wear with types.	8
Unit-5	Friction: Introduction, laws, function, properties of uncontaminated metals in air, outgassed metal surface, calculation of flash temperature using surface energy, stick-slip and its prevention.	6
Unit-6	Lubrication: Solid film lubrication, boundary lubrication with single and multiple penetration models, properties of lubricants, effectiveness of lubrication-intermediate temperature, behavior of a solid lubrication below melting point; effect of speed, load on lubrication. Lubricants, their properties lubrication technique in vacuum, lubricant coating and its stability. Theory of elastohydrodynamic lubrication film thickness, frictional stress heat flow & temperature, service life of roller bearings.	**8**
	Total	**42**

Reference Book:	
1	Engineering Tribology by Gwidon Stachowiak, Butterworth Heinemann, ISBN-0750673044, 2000.
2	Experimental Methods in Tribology by Gwidon Stachowiak, Elsevier, ISBN-0444515895, 2004.
3	Engineering Tribology by John Williams, Cambridge University Press, ISBN-0521609887, 2005.

Course Outcomes

CO1	The student can identify different areas of Industrial Tribology.
CO2	Be able to know the surface, properties of surface and related instruments
CO3	Understand the friction, friction theory and behaviour of metals and non-metals
CO4	Understand wear processes, wear theory, behaviour of metals and non-metals and different instruments
CO5	Be able to understand the lubricants, lubrication and instruments for measuring lubricant's properties.
CO6	Can find the applications of all the areas in day to day life

CO-PO/PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	1	2	2	1	1	1	1	2	2	1	3
CO2	3	3	2	2	2	2	2	1	1	1	1	3	3	2	2
CO3	3	3	3	2	2	2	1	1	1	1	1	2	2	1	3
CO4	3	3	3	3	2	2	2	1	1	1	1	2	3	1	2
CO5	3	3	3	3	3	2	2	1	1	1	1	3	3	2	3
CO6	3	3	3	3	3	2	2	2	1	1	1	2	3	2	3

ME427 Non-Conventional Energy Sources										
L	**T**	**P**	Credit	Area		**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
3	0/1	2/0	4	DEC/GEC		15/25	25	20/25	40/50	-

Course Objective: To familiarize the students with basics of non-conventional energy sources. To impart in-depth knowledge of geothermal energy resources, tidal and wave energy.

Syllabus		**Contact Hours**
Unit-1	**Introduction to Non-Conventional Energy Sources.** Overview of global energy demand and non-conventional energy potential; Advantages and limitations of non-conventional energy sources; Energy scenario in India and the world; Environmental and economic benefits of renewable energy systems	**6**
Unit-2	**Solar Energy Systems.** Solar radiation and its measurement; Solar photovoltaic (PV) systems: Types, working principles, and applications; Solar thermal systems: Solar water heaters, solar dryers, and solar cookers; Solar power plants: Parabolic troughs, solar towers, and Fresnel systems	6
Unit-3	**Wind Energy.** Wind Energy: Principles of wind energy conversion, wind turbines, wind resource assessment, and wind farms	8
Unit-4	**Geothermal Energy.** Geothermal Energy: Geothermal energy resources, technologies for electricity generation, and direct applications (space heating, agriculture). Environmental impacts and feasibility of wind and geothermal energy	8
Unit-5	**Bioenergy and Energy from Waste.** Biomass energy: Types of biomass and conversion technologies (combustion, gasification, pyrolysis). Biogas production: Anaerobic digestion process and applications. Biodiesel production: Feedstocks, transesterification process, and uses. Energy recovery from municipal and industrial waste	6
Unit-6	**Emerging Non-Conventional Energy Technologies.** Tidal and wave energy: Principles, devices, and challenges. Hydrogen energy: Production methods, storage, and fuel cells. Ocean thermal energy conversion (OTEC): Working principles and potential applications. Hybrid energy systems and their integration into smart grids	**8**
	Total	**42**

Reference Book:	
1	"Non-Conventional Energy Resources" by B.H. Khan, McGraw-Hill.
2	"Solar Energy: Principles of Thermal Collection and Storage" by S.P. Sukhatme and J.K. Nayak, Publisher: Tata McGraw-Hill
3	"Renewable Energy Resources" by John Twidell and Tony Weir, Publisher: Routledge
4	"Solar Engineering of Thermal Processes" by John A. Duffie and William A. Beckman, Wiley.
5	"Renewable Energy Engineering and Technology: Principles and Practice" by V.V.N. Kishore, TERI Press.
6	"Introduction to Renewable Energy" by Vaughn C. Nelson, CRC Press.
7	"Biogas Technology: Towards Sustainable Development" by K. M. Mittal, TERI Press.
8	"Hydrogen and Fuel Cells: Emerging Technologies and Applications" by Bent Sørensen, Academic Press.
9	"Energy from Waste" by Nickolas J. Themelis, Springer.

Course Outcomes

CO1	Understand the principles, significance, and potential of non-conventional energy sources in addressing energy challenges.

CO2	Analyze the technical and economic aspects of non-conventional energy systems such as solar, wind, and geothermal energy.
CO3	Apply knowledge of bioenergy systems, including biogas, biodiesel, and biomass combustion technologies.
CO4	Evaluate the role of emerging technologies like hydrogen energy, tidal, and wave energy systems in the global energy mix.
CO5	Design and assess non-conventional energy systems for practical applications with a focus on sustainability and environmental impact.
CO6	Applications of Non-Conventional Energy Sources

CO-PO/PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	1	2	2	1	1	1	1	2	2	1	3
CO2	3	3	2	2	2	2	2	1	1	1	1	3	3	2	2
CO3	3	3	3	2	2	2	1	1	1	1	1	2	2	1	3
CO4	3	3	3	3	2	2	2	1	1	1	1	2	3	1	2
CO5	3	3	3	3	3	2	2	1	1	1	1	3	3	2	3
CO6	3	3	3	3	3	2	2	2	1	1	1	2	3	2	3

ME429 Computer Integrated Manufacturing										
L	**T**	**P**	Credit	Area		**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
3	0/1	2/0	4	DEC/GEC		15/25	25	20/25	40/50	-

Objective: To enable the students to understand the fundamentals of computer integrated manufacturing. To understand fundamentals of basic concepts of CIM.

Syllabus		**Contact Hours**
Unit-1	NC/CNC/DNC terminology, Operations of NC/CNC machine tools. Control cycles in CNC machine tools and how do these reduce operator's activities, Central Processing Unit (CPU), Input Devices, Storage Devices, System Configuration, Feasible report to introduce CAM technology for the first time in the industry, advantages &limitations of using CNC technology.	**6**
Unit-2	Parameters for adaptation of CAM technology, Advantages and disadvantages of CAM, Part programming, Manual & CAP, APT& its statements/programming with suitable examples to machine the components on CNC lathe, CNC milling machine, CNC jig boring machine, etc, Parallel programming& its advantages, Post etc.	6
Unit-3	Canned cycles, linear/circular, parabolic interpolation, online/offline programming, unidirectional, bidirectional approach, point to point and continuous control, Buffer storage, adaptive control, Nesting, optipart, opti-route, precision sheet metal processing, CNC turret punch press, CNC press brake & its programming to machine the sheet metal components, Auto indexing, safety aspects in CNC machine tools. Tool length/ cutter compensation, Computer optimized manufacturing, etc	8
Unit-4	Reverse engineering, Reasons for reverse engineering, importance of reverse engineering, Process of reverse engineering, Applications of reverse engineering. Integration of reverse engineering with CAM, Flexible Manufacturing System, Elements of FMS, tool management systems, FMS control, Typical layouts of FMS, Benefits of FMS in the industries. Production planning and operation of FMS, Computer Aided Design, Concept and Description, Origin of CAD, Representations & Simulations, Various models of CAD, Analytical programs, Different models of CAD, Advantages of CAD & its limitations, etc.	8
Unit-5	CAPP, Types of CAPP, Group technology, Merit/ Demerits, Database management in the development of CAPP, CAD-CAM integration, Essential elements of CAPP, Future trends in CAPP, Importance of CAPP in CAM/CIM, etc. Introduction to Robots, its types, Laws of robotics, Symbolic modelling of robots, Robotic sensors, Configurations of robot, Applications of Robots in engineering industries.	6
Unit-6	Basic concepts of CIM, Evolution of CIM, Unmanned manufacturing, Elements of CIM, CIM implementation, CIM hardware and CIM software. Product development through CIM, Sequential engineering, Concurrent engineering, Comparison of sequential and concurrent engineering, implementation of concurrent engineering, concurrent engineering and information technology, Characteristics of concurrent engineering. Soft computing in CIM: Artificial neural networks/Artificial intelligence, Fuzzy, Fuzzy AHP Benefits of CIM, Lean manufacturing, comparison of lean manufacturing with conventional manufacturing, applications of lean manufacturing, etc.	**8**
	Total	**42**

Reference Book:	
1	Automation, Production system and computer intergrated manufacturing by Groover
2	Computer Aided Design and Computer Aided Manufacturing by Groover Zimmer
3	Computer Aided Manufacturing by P.N. Rao
4	NC/CNC Technology by Kundra, Rao, Tiwari
5	Craig J John, Introduction to Robotics: Mechanics and Control, Pearson education, ISBN- 0201543613, 2003.
6	Y.Koren , Robotics for Engineers, , McGraw Hill Publications, ISBN-0070353999,1985

Course Outcomes	
CO1	Explain the knowledge about role of computer and automation in manufacturing.
CO2	Describe the automation, types of automation and automation strategies.
CO3	Explain computer based integration between various functions - manufacturing, sales, design, and materials.
CO4	Describe the application of computer in CAPP, Production Management and ERP.
CO5	Explain the concept of group technology, FMS, concurrent engineering, Simulation in CIM systems
CO6	Applications of CIM in industries

CO-PO/PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	1	2	2	1	1	1	1	2	2	1	3
CO2	3	3	2	2	2	2	2	1	1	1	1	3	3	2	2
CO3	3	3	3	2	2	2	1	1	1	1	1	2	2	1	3
CO4	3	3	3	3	2	2	2	1	1	1	1	2	3	1	2
CO5	3	3	3	3	3	2	2	1	1	1	1	3	3	2	3
CO6	3	3	3	3	3	2	2	2	1	1	1	2	3	2	3

ME431 Optimization techniques										
L	**T**	**P**	Credit	Area		**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
3	0/1	2/0	4	DEC/GEC		15/25	25	20/25	40/50	-

Objective: To allow students to develop the technical, analytic, and managerial skills necessary to perform the tasks successfully

Syllabus		**Contact Hours**
Unit-1	**Introduction to Optimization -** Introduction, Engineering Applications, Problem Statement, Classification of optimization problems.	**6**
Unit-2	**Classical Optimization techniques -** Unconstrained Optimization: Optimizing Single- Variable Functions, conditions for Local Minimum and Maximum, Optimizing Multi- Variable Functions. Constrained Optimization: Optimizing Multivariable Functions with Equality Constraint: Lagrange Multipliers Method. Constrained Multivariable Optimization with inequality constrained: Kuhn-Tucker Necessary conditions, Kuhn –Tucker Sufficient Conditions.	6
Unit-3	**Non-Linear Programming-** One-Dimensional Methods: Elimination Methods, Interpolation Methods, Direct Root Methods; Quasi-Newton Method, Secant Method. Docotomous search method, Fabonacci method, Golden section method, Unconstrained Optimization Techniques: Direct search methods, Descent Methods. Constrained Optimizations: Direct and Indirect methods.	8
Unit-4	**Dynamic Programming:** Concept of Dynamic Programming, Multi stage Decision Process, Calculus Method and Tabular Method	8
Unit-5	**Integer Programming –** Branch and bound Method, Cutting Plane Method.	6
Unit-6	**Introduction to Advanced Optimization Techniques** – Genetic Algorithms (GA), Simulated Annealing, Particle Swarm Optimization (PSO), Ant Colony Optimization (ACO), Neural Network, Separable Programming, Stochastic Programming, Monte Carlo Simulation.	**8**
	Total	**42**

Reference Book:	
1	**Operations Research**, Taha, H. A., PHI
2	**Optimization of Engineering Design**, "Deb, K." PHI
3	**Operations Research**, "D.S. Hira, P. K. Gupta" S. Chand
4	**Optimization techniques**, "Rao" New Age international
5	**Introduction to optimal design,** Jasbir Singh Arora, McGraw Hill International

Course Outcomes

CO1	To learn the techniques and applications of Engineering optimization.
CO2	Analyze characteristics of a general linear programming problem.
CO3	Apply basic concepts of mathematics to formulate an optimization problem
CO4	Analyse various methods of solving the unconstrained minimization problem.
CO5	Analyze and appreciate variety of performance measures for various optimization problems.
CO6	Use of simulation software for multi objective optimization.

CO-PO/PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	1	2	2	1	1	1	1	2	2	1	3
CO2	3	3	2	2	2	2	2	1	1	1	1	3	3	2	2
CO3	3	3	3	2	2	2	1	1	1	1	1	2	2	1	3
CO4	3	3	3	3	2	2	2	1	1	1	1	2	3	1	2
CO5	3	3	3	3	3	2	2	1	1	1	1	3	3	2	3
CO6	3	3	3	3	3	2	2	2	1	1	1	2	3	2	3

ME404 Industrial Engineering										
L	**T**	**P**	Credit	Area		**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
3	0/1	2/0	4	DEC/GEC		15/25	25	20/25	40/50	-

Course Objective: To make students aware of industrial engineering concepts of work study and measurement, quality control and reliability etc.

Syllabus		**Contact Hours**
Unit-1	**Introduction:** Introduction, Definition and objectives of Industrial Engineering, Scope of Industrial Engineering, Production systems and their classifications; Productivity-Total and partial productivity, Reasons and remedy for poor productivity.	**6**
Unit-2	**Job analysis and Work Measurement Systems** Work System Design: Taylor's scientific management, Gilbreth's contributions; method study, micro-motion study, principles of motion economy; work measurement - stop watch time study, micro motion and memo motion, work sampling, standard data, PMTS; ergonomics; job evaluation, merit rating, incentive schemes, and wage administration; business process reengineering.	6
Unit-3	**Production Planning and Control** Types and characteristics of production systems, Objectives and functions of Production, Planning & Control, Routing, Scheduling and Operations scheduling, production scheduling, job shop scheduling problems, sequencing problems, scheduling tools and techniques, Loading, Dispatching and its sheets & Gantt charts.	8
Unit-4	**Quality Engineering** Quality concept and costs; statistical quality control, Concept of specification limits, statistical control limits, process capability, Process control and control charts for both attributes and variable data. Acceptance Sampling- Single and double sampling.	8
Unit-5	**Reliability and Maintenance** Reliability, availability and maintainability; distribution of failure and repair times; determination of MTBF and MTTR, reliability models; system reliability determination; Maintenance management and its objectives, Various types of Maintenance Planning, House Keeping, 5S concepts.	6
Unit-6	**Material Handling** Principles, functions, and objectives of Material Handling; Selection and classification of Material Handling Equipments; Relation of material handling with plant layout.	**8**
	Total	**42**

Reference Book:	
1	Industrial Engineering and Management; B. Kumar, Khanna Publication, ISBN-8174091963, 2011.
2	Introduction to work Study, International Labour Office, Geneva, 3rd edition, Oxford and IBH publishing Co. Pvt. Ltd, New Delhi, ISBN- 8120406028, 2008.
3	Industrial Engineering and Management, Pravin Kumar, Pearson Education, 1st edition, ISBN-9789332543560, 2015.

Course Outcomes

CO1	Ability to understand the productivity and work study
CO2	Ability to apply plant layouts and understanding the applications of material handling equipment.
CO3	Ability to apply the concept of inventory and supply chain management.
CO4	An understanding of job evaluation and merit rating
CO5	Explain various operations management Techniques
CO6	Solve operations management and project management problems

CO-PO/PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	1	2	2	1	1	1	1	2	2	1	3
CO2	3	3	2	2	2	2	2	1	1	1	1	3	3	2	2
CO3	3	3	3	2	2	2	1	1	1	1	1	2	2	1	3
CO4	3	3	3	3	2	2	2	1	1	1	1	2	3	1	2
CO5	3	3	3	3	3	2	2	1	1	1	1	3	3	2	3
CO6	3	3	3	3	3	2	2	2	1	1	1	2	3	2	3

ME406 Elastic and Plastic Behavior of Materials										
L	**T**	**P**	Credit	Area		**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
3	0/1	2/0	4	DEC/GEC		15/25	25	20/25	40/50	-

Objective: To familiarize the students with basics of state of stress and strain, in three dimensions, Yield criteria, forming processes, forging, rolling, wire drawing. To impart in-depth knowledge of real-life application Sheet metal forming operations, Sheet metal cutting operations like blanking, shearing and laser cutting and its force analysis, bending and spring back, die design for deep drawing and bending

Syllabus		**Contact Hours**
Unit-1	**Introduction:** Stress and strain tensor, three invariants, transformation rules, equilibrium equations, Study of stress-strain diagrams of various materials under states of tensile, compressive, shearing and bending stress.	**6**
Unit-2	**Basic theory of elasticity:** Constitutive law, Generalized Hooke's law, work of elastic deformation, plane stress and plane strain conditions, simple shear, elastic change in volume and shape, specific work of elastic deformation	6
Unit-3	**Fundamentals of plastic deformation:** General information about structure of metals, single crystal and its deformation, geometry and movement of dislocations, Burger's vectors, circuits and dislocation loops, deformation of metals: slip and twinning, effect of hot and cold working on properties of metals. Micro and macro hardness tests, Erichsen cupping test, Limit dome height test, forming limit diagram. **Elements of plasticity:** Flow curves, true stress-true strain, yielding criteria in metals, strain hardening and discontinuous yielding, combined stress states, yield locus, anisotropy in yielding, yield surface and normality, Octahedral shear stress and shear strain, plastic stress-strain relations.	8
Unit-4	**Fracture:** Study of ductile and Brittle fractures, Griffith theory of brittle fracture, ductile fracture, ductile - Brittle transition behaviour, notch effect and notch sensitivity, effect of hydrostatic pressure on fracture and methods of protection against fracture. Strain energy release rate, stress intensity factor, fracture toughness and design, plane strain toughness testing, plasticity corrections, Crack opening displacement, J-integral.	8
Unit-5	**Fatigue:** Stress cycles, the nature of fatigue: low cycle and high cycle fatigue, S-N curve, mechanism of fatigue, fatigue strength of metals and statistical nature of fatigue, effect of mean stress on fatigue, strain life equations, fatigue crack propagation, stress concentration, size and surface effects on fatigue, fatigue failure under combined stress, cumulative fatigue damage due to varying amplitude of stress, other factors affecting fatigue strength, local strain approach.	6
Unit-6	**Creep:** Time dependent mechanical behaviour, creep curve, design curves, Constant-temperature creep tests, mechanism of creep rupture: dislocation, diffusion and grain boundary sliding, deformation mechanism maps, activation energy for steady state creep, empirical relation for creep behavior, plastic flow rules for creep, metallurgical factors affecting creep behaviour, selection of creep resistant materials and applications.	**8**
	Total	**42**

Reference Book:	
1	Mechanical metallurgy, George E. Dieter, 1988, Mc Graw Hill, New York, ISBN-0071004068.
2	Metal forming- Mechanics and Metallurgy. Hosford, W.F., Cadell, R. M., 2007. Cambridge University Press, ISBN- 0521881218.

3	Dislocations and mechanical behaviour of materials, Shetty, M.N., 2013, PHI Learning, New Delhi, ISBN-9788120346383.

Course Outcomes

CO1	Describe the elastic and plastic behaviour from stress-strain curves for materials;
CO2	Recognize typical plastic yield criteria established in constitutive modeling;
CO3	Understand the physical interpretation of material constants in mathematical formulation of constitutive relationship;
CO4	Analyze theories of failure and design components for safe operation.
CO5	Develop constitutive models based on experimental results on material behavior.
CO6	Examine the properties of ideally plastic solid and apply the concepts of energy methods in solving structural problems.

CO-PO/PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	1	2	2	1	1	1	1	2	2	1	3
CO2	3	3	2	2	2	2	2	1	1	1	1	3	3	2	2
CO3	3	3	3	2	2	2	1	1	1	1	1	2	2	1	3
CO4	3	3	3	3	2	2	2	1	1	1	1	2	3	1	2
CO5	3	3	3	3	3	2	2	1	1	1	1	3	3	2	3
CO6	3	3	3	3	3	2	2	2	1	1	1	2	3	2	3

ME408 Combustion Generated Pollution										
L	**T**	**P**	Credit	Area		**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
3	0/1	2/0	4	DEC/GEC		15/25	25	20/25	40/50	-

Objective: To familiarize the students alternative fuels for IC engines, emissions and air pollution and Exhaust treatment devices. To impart in-depth knowledge about Thermal reactors and Gas chromatography.

Syllabus		**Contact Hours**
Unit-1	Engine fundamentals: Fuels, alternative fuels for IC engines, Type of hydro carbons. Gasoline specifications. Effect of Engine parameters on performance, fuel injection for SI engines, Engine vehicle road performance, road performance and fuel economy.	**6**
Unit-2	Emissions and air pollution: Automotive Emissions and their role in air pollution. Photo chemical smog. Chemistry of smog formation. Combustion in Homogeneous mixtures, emission formation. incomplete combustion, formation of hydro carbons, Carbon monoxide and oxides of nitrogen. Aldehyde emissions.	6
Unit-3	Influence of design and operating variables on gasoline engine exhaust emissions. Hydrocarbon Evaporative Emissions: Various sources and methods of their control. Canisters for controlling evaporative emissions. Emission control systems for gasoline engines: Blow by control closed PCV system design.	8
Unit-4	Exhaust treatment devices: Air injection into exhaust system.	8
Unit-5	Thermal reactors, Catalytic convertor. Stratified charge engines. Honda CVCC engine. Diesel engine combustion Emissions: Sources of emissions during combustion. Effect of air fuel ratio, speed, injection timing on performance and emission formation. D.I. and I.D.I engine emissions.	6
Unit-6	Methods of reducingg emissions, exhaust gas recirculation, smoke emission from diesel engines. Emission Instruments: Non- dispersive Infrared analyzer, Gas chromatography, flame ionization detector, Chemiluminescent analyser.	**8**
	Total	**42**

Reference Book:	
1	Combustion generated air pollution, Earnest S Starkman, Springer, ISBN-9780306305302.
2	Fundamentals of Air pollution engineering, Richard C. Hagan, Prentice Hall, ISBN-0133325371.
3	Air pollution threat & response, David Alym, Addison-Wesley Publication, ISBN-0201043556.

Course Outcomes

CO1	Recognise the ongoing role of combustion, both of fossil and bio-fuels, in providing a more sustainable energy source for society, and the environmental challenges
CO2	Summarise the mechanisms of combustion generated air pollution and the techniques
CO3	Measurements, modelling and scaling in understanding combustion
CO4	Recognise the safety and handling issues associated with combustion;
CO5	Explain the responsibility of engineers to the community in terms of providing a safe healthy environment
CO6	Controlling techniques to lower emissions.

CO-PO/PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	1	2	2	1	1	1	1	2	2	1	3
CO2	3	3	2	2	2	2	2	1	1	1	1	3	3	2	2
CO3	3	3	3	2	2	2	1	1	1	1	1	2	2	1	3
CO4	3	3	3	3	2	2	2	1	1	1	1	2	3	1	2
CO5	3	3	3	3	3	2	2	1	1	1	1	3	3	2	3
CO6	3	3	3	3	3	2	2	2	1	1	1	2	3	2	3

ME410 Advances in Welding & Casting										
L	**T**	**P**	Credit	Area		**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
3	0/1	2/0	4	DEC/GEC		15/25	25	20/25	40/50	-

Syllabus		**Contact Hours**
Unit-1	**CASTING DESIGN** Heat transfer between metal and mould — Design considerations in casting – Designing for directional solidification and minimum stresses - principles and design of gating and risering	**6**
Unit-2	**CASTING METALLURGY** Solidification of pure metal and alloys – shrinkage in cast metals – progressive and directional solidification — Degasification of the melt-casting defects – Castability of steel, Cast Iron, Al alloys, Babbit alloy and Cu alloy.	6
Unit-3	**RECENT TRENDS IN CASTING AND FOUNDRY LAYOUT** Shell moulding, precision investment casting, CO2 moulding, centrifugal casting, Die casting, Continuous casting, Counter gravity low pressure casting, Squeeze casting and semisolid processes. Layout of mechanized foundry – sand reclamation – material handling in foundry pollution control in foundry — Computer aided design of casting.	8
Unit-4	**WELDING METALLURGY AND DESIGN** Heat affected Zone and its characteristics – Weldability of steels, cast iron, stainless steel, aluminum, Mg, Cu, Zirconium and titanium alloys – Carbon Equivalent of Plain and alloy steels Hydrogen embrittlement – Lamellar tearing – Residual stress – Distortion and its control. Heat transfer and solidification - Analysis of stresses in welded structures – pre and post welding heat treatments – weld joint design – welding defects – Testing of weldment.	8
Unit-5	**RECENT TRENDS IN WELDING** Friction welding, friction stir welding – explosive welding – diffusion bonding – high frequency induction welding – ultrasonic welding – electron beam welding – Laser beam welding –Plasma welding – Electroslag welding narrow gap, hybrid twin wire active TIG – Tandem MIG- modern brazing and soldering techniques – induction, dip resistance, diffusion processes – Hot gas, wave and vapour phase soldering. Overview of automation of welding in aerospace, nuclear, surface transport vehicles and under water welding.	**8**
Unit-6	Overview of automation of welding in aerospace, nuclear, surface transport vehicles and under water welding.	6
	Total	**42**

Reference Book:	
1	ASM Handbook, Vol 15, Casting, ASM International, 2004, ISBN 978-0871707116
2	ASM Handbook vol.6, welding Brazing & Soldering, ASM International, 2003, ISBN 978-0871703828
3	Parmer R.S., Welding Engineering and Technology, Khanna Publishers,2002, ISBN9788174090287
4	Srinivasan N.K., Welding Technology, Khanna Tech Publishers, 2002, ISBN 8174091599
5	HEINE, LOPER & ROSENTHAL, Principles of Metal Casting, Tata McGraw Hill, 2001, ISBN 0070993483
6	Jain P.L., Principles of Foundry Technology, Tata McGraw Hill Publishers, 2003, ISBN 0070447608
7	Howard B. Cary, Scott C. Helzer, Modern Welding Technology, Pearson Prentice Hall Pvt Ltd., 2011, ISBN 0131836919
8	J. Piotrowski, W. Randolph, Robotic welding – A guide to selection and application, Society of Manufacturing, 1987, ISBN 0872632660
9	CORNU.J. Advanced welding systems – Volumes I, II and III, Springer Publishing, 2013, ISBN 3662110512
10	LANCASTER.J.F., Metallurgy of welding, Springer Publishing, 1987, ISBN 0046690107

Course Outcomes

CO1	Understand and explain the various moulding, core making and casting processes with their specific applications.
CO2	Design the gating and riser system and explain the melting process of steel, cast iron and non-ferrous metals.
CO3	Examine the defects, their causes and remedies for a casting and summarize the inspection and testing procedure of castings.
CO4	Explain the working principle, advantages, limitations, applications of various joining processes including advance processes and apply knowledge to select appropriate joining process based on the type of industrial application.
CO5	Discuss the weldability criteria of Steels, Cast Iron and Aluminium and explain different welding position and joint configurations.
CO6	Understand the various surface treatment processes and examine the welding defects and associated weld testing techniques.

CO-PO/PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	1	2	2	1	1	1	1	2	2	1	3
CO2	3	3	2	2	2	2	2	1	1	1	1	3	3	2	2
CO3	3	3	3	2	2	2	1	1	1	1	1	2	2	1	3
CO4	3	3	3	3	2	2	2	1	1	1	1	2	3	1	2
CO5	3	3	3	3	3	2	2	1	1	1	1	3	3	2	3
CO6	3	3	3	3	3	2	2	2	1	1	1	2	3	2	3

ME412 Supply Chain Management										
L	**T**	**P**	Credit	Area		**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
3	0/1	2/0	4	DEC/GEC		15/25	25	20/25	40/50	-

Objective: To understand the key considerations at the various stages involved in the supply of product in order to maintain the smooth flow from source to the point of consumption so that overall organizational performance may improve.

Syllabus		**Contact Hours**
Unit-1	**Introduction** Perspective of Supply Chain Management, Managing uncertainty, Key issue in supply chain management.	**6**
Unit-2	**Inventory Management and Risk Pooling** Inventory management, Classification of inventory, centralized versus Decentralized Warehousing and Risk pooling, Value of Information, Quantification of Bullwhip effect, Causes and remedies of Bullwhip effect.	6
Unit-3	**Resource planning** Aggregate Production Planning- Chase and leveling strategies, MRP, MRP-II, Agile manufacturing Systems	8
Unit-4	**Procurement and Outsourcing strategies** Introduction, outsourcing benefits and risks, Make/Buy decision, e-procurement, Vendor selection and quota allocation.	8
Unit-5	**Strategic Alliances** Introduction, third party logistics, Demand driven strategies, Distribution strategies- direct shipment, cross docking, transshipment, Supplier relationships management, Customer relationship management.	**8**
Unit-6	**International Issues in Supply Chain Management** Concepts in Globalization, Globalization forces, Risks and Advantages of International supply chains, Issues in International supply chain management, Regional differences in logistics.	6
	Total	**42**

Reference Book:	
1	Designing and Managing the Supply Chain: concepts, strategic and case studies by David Simchi-Levi, Philip kaminsky, Edith Simchi-Levi, Ravi Shankar, Tata McGraw-Hill, ISBN- 0072357568.
2	Supply Chain Management by Chopra S. and Meindl P., Pearson, ISBN- 8131789209, 2012.
3	Supply Chain Management: Text and Cases by ShahJanat, Pearson Education, ISBN- 8131715175, 2009.

Course Outcomes

CO1	Students will be able to understand the different types of uncertainties and issues in supply chain management.
CO2	Students will be able to know the importance of inventory management with concepts of risk pooling and Bullwhip effect in a supply chain
CO3	Students will have knowledge of resource planning to meet the fluctuating demand of the products and services in the market.
CO4	Students will have knowledge of sourcing, outsourcing and procurement of the materials
CO5	Students will have knowledge of supplier relationship management and integration with other supply chain partners.
CO6	Students will be able to know about globalization of supply chain activities and their requirement.

CO-PO/PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	2	3	2	2	3	3	3	3	3	3	3	2	2	3
CO2	3	3	1	1	3	1	3	1	3	3	1	3	3	2	2
CO3	3	2	2	2	1	2	1	2	1	2	1	2	2	1	3
CO4	2	1	1	1	1	1	1	1	3	2	2	2	2	3	1
CO5	2	1	1	3	3	3	3	2	2	1	1	1	3	1	3
CO6	3	1	2	2	2	2	2	3	3	3	3	3	3	3	2

ME414: Fracture Mechanics										
L	**T**	**P**	Credit	Area		**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
3	0/1	2/0	4	DEC/GEC		15/25	25	20/25	40/50	-

Objective: To familiarize the students with basics of Griffith's energy balance approach, the shape of the plastic zone for plane stress and plane strain cases, Stress intensity factors and plane strain fracture toughness. To impart in-depth knowledge of elastic plastic fracture mechanics and fatigue crack propagation and applications of fracture mechanics.

Syllabus		**Contact Hours**
Unit-1	**Introduction**: Introduction and overview Inter-disciplinary approaches in fracture mechanics, modes of deformation and failure, Griffith theory.	**6**
Unit-2	**Linear Elastic Fracture Mechanics**: Stress concentration in the vicinity of notches and cracks, concept of stress intensity factor (SIF), Stress intensity factor for different types of cracks and geometry. Irwin's stress intensity approach, fracture toughness.	6
Unit-3	**General Yielding Fracture Mechanics:** Crack tip plastic zones and its evaluation, Wall's crack opening displacement**.** Barenblatt and Dugdale's models.	8
Unit-4	**Evaluation of Fracture Mechanics Parameters:** Plane strain fracture toughness testing i.e., Kic Concepts of crack tip opening displacements (CTOD)	8
Unit-5	**J-Integral and fatigue crack:** J integral and its evaluation, application of J-integral. Mechanics of fatigue crack propagation.	**8**
Unit-6	**Fracture Safe Design Principles:** Fail-safe design. **Fractured surfaces:** Acquaintance with some common fracture surfaces of various materials, like steels, C.I, non ferrous alloys etc.	6
	Total	**42**

Reference Book:	
1	Prashant Kumar; 'Elements of Fracture Mechanics"; Tata McGraw- Hill Publishing Company Limited.
2	D. Breok; 'Elementry Fracture Mechanics"; Noordhoff International,1985
3	T.L. Anderson; 'Fracture Mechanics"; 3rd edition, Taylor & Francis, ISBN-0849316561, 2005.
4	Knott. J. F; "Fundamentals of Fracture Mechanics", John Wiley & Sons, Newyork.
5	Gdoutos. E. E; "Fracture Mechanics- An introduction"; Springer.
6	Ramesh. K; "e-Book on Engineering Fracture Mechanics"; IIT Madras

Course Outcomes

CO1	Develop basic fundamental understanding of the effects of crack like defects on the performance of Mechanical Engineering structures.
CO2	Select appropriate materials for engineering structures to ensure damage tolerance.
CO3	Employ modern numerical methods to determine critical crack sizes and fatigue crack propagation rates in engineering structures.
CO4	Classify the type of fracture and predict ductile to brittle transition.
CO5	Estimate fatigue crack growth using principles of fracture mechanics.
CO6	redict stress intensity factor, energy release rate and J-integral, computationally, as per ASTM standards.

CO-PO/PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	1	2	2	1	1	1	1	2	2	1	3
CO2	3	3	2	2	2	2	2	1	1	1	1	3	3	2	2
CO3	3	3	3	2	2	2	1	1	1	1	1	2	2	1	3
CO4	3	3	3	3	2	2	2	1	1	1	1	2	3	1	2
CO5	3	3	3	3	3	2	2	1	1	1	1	3	3	2	3
CO6	3	3	3	3	3	2	2	2	1	1	1	2	3	2	3

ME416 Nuclear Energy										
L	**T**	**P**	Credit	Area		**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
3	0/1	2/0	4	DEC/GEC		15/25	25	20/25	40/50	-

Objectives: To familiarize the students with basics of nuclear physics, reactor physics and reactor materials. To impart in-depth knowledge of waste management and radiation protection.

Syllabus		**Contact Hours**
Unit-1	Nuclear Physics: Atomic number and mass numbers, Isotopes, Nuclear energy and nuclear forces, Binding Energy, Nuclear Stability, Radioactivity, Nuclear reactions, Radioactive isotopes, Law of radioactivity, Interaction of radiation (alpha, beta, gamma) with matter, Interaction of neutrons with matter, Absorption radiative capture, Transmutation Fission, Cross section for nuclear reactions. Fission process, Mechanism of nuclear fission, fission cross section, fission products, Basic radio chemistry.	**6**
Unit-2	Reactor Physics: Neutron balance, Neutron diffusion, Diffusion equation, and its solution, Slowing down of neutrons, Showing down power and moderating ratio. Reactor theory: Multiplication factors, Four factor formula, One group critical equation, Age, Diffusion method, Non-leakage probabilities and effective multiplication factor, Multi group diffusion theory, Homogeneous and heterogeneous reactor systems, Time dependent reactor behaviour.	6
Unit-3	Nuclear Reactor Engineering: Types of reactors, Ordinary water moderated reactors (BWR, PWRO), Heavy water cooled and moderated reactors, Gas cooled reactors (HTGR, AGR), Fast reactors design, Construction and control of nuclear reactors.	8
Unit-4	Heat transfer in nuclear reactors: Heat transfer techniques in nuclear reactors, Design and operation, Thermal stresses, Reactor shielding.	8
Unit-5	Reactor materials: Nuclear fuels, Moderators, Coolants, Reflectors and structural materials. Reprocessing: Nuclear fuel cycle, Spent fuel characteristics, Reprocessing techniques, role of solvent extraction in reprocessing.	**8**
Unit-6	Waste management and radiation protection: Types of waste, Waste management philosophy and disposal, ICRP recommendations, Radiation hazards and their prevention, Radiation dose units. Status of nuclear technology in India: Indian nuclear power program, Nuclear reactors in India, India's commitment to nuclear nonproliferation.	6
	Total	**42**

Reference Book:	
1	Nuclear Reactor Engineering, S. Glasstone and A. Seronske, Van Nostrand –Reinhold, ISBN- 0442200579, 1963.
2	Nuclear Chemical Engineering, M. Bendict and T.A. Pigtor, McGraw Hill, ISBN-0070045313, 1981.
3	Basic Principles of Nuclear Science and Reactors, L. C. MerriteWiley Hill, ISBN-0070045313, 1981.
4	Introduction to Nuclear Reactor Physics, S. E. Liverhandt.

Course Outcomes

CO1	An understanding of nuclear energy fundamentals, nuclear fissions, and fission reactors.
CO2	Able to understand the neutron transport behavior.
CO3	An understanding of a nuclear steam supply system, nuclear safety, nuclear fuel cycle
CO4	Learn about radiation protection and ability to perform shielding calculations for a simple reactor system.
CO5	A general understanding of nuclear power plant systems, licensing, design, operation & maintenance, safety, and security.
CO6	Ability to perform a general design and nuclear safety analysis for a simple reactor system

CO-PO/PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	1	2	2	1	1	1	1	2	2	1	3
CO2	3	3	2	2	2	2	2	1	1	1	1	3	3	2	2
CO3	3	3	3	2	2	2	1	1	1	1	1	2	2	1	3
CO4	3	3	3	3	2	2	2	1	1	1	1	2	3	1	2
CO5	3	3	3	3	3	2	2	1	1	1	1	3	3	2	3
CO6	3	3	3	3	3	2	2	2	1	1	1	2	3	2	3

ME418 Operations & Manufacturing Strategy										
L	**T**	**P**	Credit	Area		**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
3	0/1	2/0	4	DEC/GEC		15/25	25	20/25	40/50	-

Objective: To allow students to develop the technical, analytic, and managerial skills necessary to perform the tasks successfully.

Syllabus		**Contact Hours**
Unit-1	**Productivity:** Production systems and their classifications; Productivity variables and measurement, Productivity-Total and partial productivity, Reasons and remedy for poor productivity.	**6**
Unit-2	**Work Study:** Work System Design: Taylor's scientific management, Gilbreth's contributions; method study, micro-motion study, principles of motion economy; work measurement - stop watch time study, micro motion and memo motion, work sampling, standard data, PMTS; job evaluation, merit rating, incentive schemes, and wage administration; business process reengineering, introduction to ergonomics and its applications.	6
Unit-3	**Production Planning and Control:** Types and characteristics of production systems Objective and functions of Production, Planning & Control, Routing, Scheduling and Operations scheduling, production scheduling, job shop scheduling problems, sequencing problems, scheduling tools and techniques, Loading, Dispatching and its sheets & Gantt charts.	8
Unit-4	**Quality Management:** Concepts of quality, total quality management, cost of quality; statistical quality control, Concept of specification limits, statistical control limits, process capability, Process control and control charts for both attributes and variable data. Acceptance Sampling- Single and double sampling, six sigma, ISO 9000 & ISO 14000.	8
Unit-5	**Resource Planning:** Enterprise resource planning (ERP), material required planning (MRP), manufacturing resource planning (MRP II), aggregate planning.	**8**
Unit-6	**Reliability and Maintenance:** Reliability, availability and maintainability; distribution of failure and repair times; determination of MTBF and MTTR, reliability models; system reliability determination; Maintenance management and its objectives, Various types of Maintenance Planning, House Keeping, 5S concepts.	6
	Total	**42**

Reference Book:	
1	Introduction to work Study; Oxford and IBH publishing Co. Pvt. Ltd, New Delhi
2	Industrial Engineering and Management; B. Kumar, Khanna Publication
3	Operation Management, Krajewski and Ritzwan, Pearson Education.
4	Work study and ergonomics, S.K. Sharma & Savita Sharma, Katson, Delhi.
5	Industrial Engineering & Management, Ravi Shanker, Galgotia Publication, Delhi

Course Outcomes

CO1	Understand the role of operations management in achieving organizational competitiveness.
CO2	Appreciate the concepts of lean production and maintenance management in operations.
CO3	Comprehend key decision areas of operations and analyze data for effective decision making in operations management.
CO4	Understand optimum allocation and efficient utilization of manpower, materials, equipment and technology at strategic and tactical levels in the organization
CO5	Develop and implement a production/operations strategy and integrate this strategy with the corporate, business and other functional strategies of both manufacturing- and service-oriented organizations.
CO6	Understand operations management concepts, techniques and models

CO-PO/PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	1	2	2	1	1	1	1	2	2	1	3
CO2	3	3	2	2	2	2	2	1	1	1	1	3	3	2	2
CO3	3	3	3	2	2	2	1	1	1	1	1	2	2	1	3
CO4	3	3	3	3	2	2	2	1	1	1	1	2	3	1	2
CO5	3	3	3	3	3	2	2	1	1	1	1	3	3	2	3
CO6	3	3	3	3	3	2	2	2	1	1	1	2	3	2	3

ME420 Materials Management										
L	**T**	**P**	Credit	Area		**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
3	0/1	2/0	4	DEC/GEC		15/25	25	20/25	40/50	-

Objective: The key objective of this course is to acquaint the students with Decision making for effective and efficient purchase, storage and flow of materials in manufacturing and service organizations; cost reduction techniques in prepurchase.

Syllabus		**Contact Hours**
Unit-1	Scope of materials management, integrated materials management, Reasons of materials management, relation with other functional areas of organization, Organizing for materials management, integrated materials management, conventional and modern approaches to organizing materials management	**6**
Unit-2	Classification, codification, Specification, standardization, simplification and variety reduction of materials, scope of materials management	6
Unit-3	Inventory problems, inventory policies, classification of inventory models, Static inventory models	6
Unit-4	Multi-item Budget Constraint model, Optimal Policy Curve Selective inventory management: ABC, VED, FSN analysis,	6
Unit-5	Inventory models: EOQ-ROP Model, Finite Replenishment Rate Model, Lot Size Model with Planned Backlogging, Sensitivity analysis of Lot Size System, Quantity discount model	**10**
Unit-6	Vendor development, Make-Buy decision, Store management, Future trends	8
	Total	**42**

Reference Book:	
1	Integrated materials management-A. K. Datta-PHI Learning, ISBN- 8120312511, 2009.
2	Purchasing and Supply Management-Dobbler, Burt D.N., McGraw Hill Education, 6th edition, ISBN-0071141383, 2004
3	Materials Management – P Gopalakrishnan – PHI Learning, ISBN- 8120300270, 2009
4	Purchasing And Materials Management – LeendersFearon Universal Book Stall
5	Purchasing AndInventory Control – K S Menon – WheelerPublishers
6	Materials Management – Varma M M – Sultan Chand And Sons

Course Outcomes

CO1	Able to learn the scope of materials and spare parts management in an organization.
CO2	Apply the key characteristics of the purchasing system.

CO3	Apply the policies of Inventory Management and Develop overall materials requirement plan.
CO4	Explain the ERP System for Materials management.
CO5	Understand the importance of warehouse and supplier development in materials management.
CO6	Apply the subject knowledge for e-commerce.

CO-PO/PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	1	2	2	1	1	1	1	2	2	1	3
CO2	3	3	2	2	2	2	2	1	1	1	1	3	3	2	2
CO3	3	3	3	2	2	2	1	1	1	1	1	2	2	1	3
CO4	3	3	3	3	2	2	2	1	1	1	1	2	3	1	2
CO5	3	3	3	3	3	2	2	1	1	1	1	3	3	2	3
CO6	3	3	3	3	3	2	2	2	1	1	1	2	3	2	3

ME422 Fuel Cell										
L	**T**	**P**	Credit	Area		**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
3	0/1	2/0	4	DEC/GEC		15/25	25	20/25	40/50	-

Objective: The key objective of this course is to acquaint the students with electrochemical energy, electrode kinetics and solid oxide fuel cells.

Syllabus		**Contact Hours**
Unit-1	**Introduction and Thermodynamics:** **Introduction:** Basic Operating Principles – Historical Highlights – Classification. **Thermodynamics:** Electrochemical Energy Conversion – Theoretical Efficiency – Electrochemical Energy Conversion – Factors Affecting Electrochemical Energy Conversion	**6**
Unit-2	**Electrode Kinetics:** Electrode Double Layer – Electrolyte Double Layer – Double Layer Models (Helmoltz Model, Gouy-Chapman Model, Stern Model, Grahame Model – Bockris, Devenathan and Muller Model, and Chemical Models)– Solid Metallic Electrode – Semiconductor Electrode –Specific Adsorption – Zero Potential	6
Unit-3	**Alkaline Fuel Cells & Phosphoric Acid Fuel Cells:** **Alkaline Fuel Cells:** Working Principle – Components – Modules and Stacks – Performance Characteristics (Power Density, Space Applications, Atmospheric Pressure Cells) – Limitations and R&D Challenges – System Issues – Ammonia as Fuel. **Phosphoric Acid Fuel Cells:** Cell Reactions – Electrodes (Stability of Catalysts, Electrode Fabrication – Fuel Cell Performance) – Stacks and Systems	8
Unit-4	**Solid Oxide Fuel Cells & Molten Carbonate Fuel Cells:** **Solid Oxide Fuel Cell:** Principle of Operation – Benefit sand Limitations – Cell Components (Electrolytes, Zirconia Systems, Ceria Based Electrolytes, Perovskite-Based Systems)– Cathode Materials – Anode Materials Interconnects –Fuel Reactions –Configurations and Performance Tubular, Monolithic, Planar) – Environmental Impact –Applications. **Molten Carbonate Fuel Cell:** General Principle – Components (Electrolyte and Matrix, Cathode and Anode Materials) – Electrode Reactions – Life Time	8
Unit-5	**Direct Methanol Fuel Cells & Proton Exchange Membrane Fuel Cells:** **Direct Methanol Fuel Cells:** Operating Principle– Noble Metal Issue – Electro-Oxidation of Methanol (Catalysts, Oxygen Electro-Reduction, Electrolyte, Non-Catalytic Aspects) - Methanol Crossover – Catalyst Optimization – Vapour Feed Versus Liquid Feed Cells. .	**8**
Unit-6	**Proton Exchange Membrane Fuel Cells:** Operating Principle (Membranes, Electrodes and Electrolysis, Optimization of Membrane and Electrode Assembly Impurities) – Technology Development (Single Cell and Stacks, Composite Plates) – Fuel Processing – Modeling Studies (Membrane, Electrode, Membrane-Electrode Assembly, Fuel Cell, Stack and System) – Technology Development and Applications	6
	Total	**42**

Reference Book:	
1	Viswanathan, B. and AuliceScibioh, M., Fuel Cells Principles and Applications, Universities Press (India) Pvt. Ltd., Hyderabad, 2006, ISBN:9781420060287 02871420060287
2	Hoogers, G., Edr., Fuel Cell Technology Handbook, Crc Press, Washington D. C., 2003, ISBN:9780849308772

Course Outcomes

CO1	Understand and identify different routes for hydrogen production and its storage.
CO2	Apply fundamentals of electrochemistry, thermodynamics, fluid mechanics, and heat and mass transfer to design different components of fuel cells and fuel cell systems.
CO3	Analyze and simulate the performance of different type of fuel cells.
CO4	Estimate and calculate various losses in fuel cells and propose corrective measures to reduce it.
CO5	Classify materials for electrodes and testing of different cells
CO6	Demonstrate the processing of fuels for the fuel cell

CO-PO/PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	1	2	2	1	1	1	1	2	2	1	3
CO2	3	3	2	2	2	2	2	1	1	1	1	3	3	2	2
CO3	3	3	3	2	2	2	1	1	1	1	1	2	2	1	3
CO4	3	3	3	3	2	2	2	1	1	1	1	2	3	1	2
CO5	3	3	3	3	3	2	2	1	1	1	1	3	3	2	3
CO6	3	3	3	3	3	2	2	2	1	1	1	2	3	2	3

ME424 Sustainable Energy Technologies										
L	**T**	**P**	Credit	Area		**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
3	0/1	2/0	4	DEC/GEC		15/25	25	20/25	40/50	-

Objective: The key objective of this course is to understand the basics of sustainable energy, solar energy system and wind energy systems.

Syllabus		**Contact Hours**
Unit-1	**Introduction to Sustainable Energy.** Global energy challenges and the need for sustainable energy technologies; Principles of sustainability and carbon-neutral strategies; Overview of renewable energy sources and their potential; Energy efficiency and demand-side management	**6**
Unit-2	**Solar Energy Systems.** Solar energy: Photovoltaic systems, solar thermal applications, and concentrated solar power (CSP)	6
Unit-3	**Wind Energy Systems** Wind energy: Aerodynamics, wind turbines, wind resource assessment, and offshore wind farms. Integration of solar and wind energy into power grid.	8
Unit-4	**Bioenergy and Waste-to-Energy Technologies.** Biomass conversion technologies: Combustion, gasification, and anaerobic digestion. Production of biofuels: Biogas, biodiesel, and bioethanol. Energy recovery from municipal solid waste and industrial waste. Environmental impact and economic feasibility of bioenergy systems	8
Unit-5	**Energy Storage and Hybrid Energy Systems.** Energy storage technologies: Batteries, thermal energy storage, compressed air energy storage (CAES), and hydrogen storage. Role of energy storage in renewable energy integration. Design and optimization of hybrid energy systems. Case studies: Hybrid systems for rural and urban applications	**8**
Unit-6	**Emerging Non-Conventional Energy Technologies.** Smart grids and digitalization in energy systems. Role of artificial intelligence and IoT in energy optimization. Innovations in tidal, wave, and geothermal energy technologies. Global and national energy policies for promoting sustainable energy. Future challenges and opportunities in sustainable energy	6
	Total	**42**

Reference Book:	
1	"Non-Conventional Energy Resources" by B.H. Khan, McGraw-Hill.
2	"Renewable Energy: Power for a Sustainable Future" by Godfrey Boyle, Oxford University Press.
3	"Energy and the Environment" by James A. Fay and Dan S. Golomb, Oxford University Press.
4	"Solar Energy: Principles of Thermal Collection and Storage" by S.P. Sukhatme and J.K. Nayak, Tata McGraw-Hill.
5	"Sustainable Energy: Choosing Among Options" by Jefferson W. Tester et al., MIT Press.
6	"Handbook of Renewable Energy Technology" by Ahmad Hemami, Wiley.
7	"Biomass to Renewable Energy Processes" by Jay Cheng, CRC Press.
8	"Energy Storage: Systems and Components" by Alfred Rufer, CRC Press.
9	"Smart Grid: Fundamentals of Design and Analysis" by James Momoh, Wiley-IEEE Press.

Course Outcomes

CO1	Understand the global energy scenario, the need for sustainability, and the role of sustainable energy technologies.
CO2	Analyze the principles and applications of renewable energy systems, including solar, wind, and biomass.
CO3	Evaluate advanced energy storage solutions for enhancing renewable energy integration.
CO4	Design hybrid energy systems and assess their technical, economic, and environmental viability.
CO5	Explore emerging trends in smart grids, AI-based energy management, and energy policy frameworks for sustainability.
CO6	Applications of Sustainable Energy Technologies

CO-PO/PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	1	2	2	1	1	1	1	2	2	1	3
CO2	3	3	2	2	2	2	2	1	1	1	1	3	3	2	2
CO3	3	3	3	2	2	2	1	1	1	1	1	2	2	1	3
CO4	3	3	3	3	2	2	2	1	1	1	1	2	3	1	2
CO5	3	3	3	3	3	2	2	1	1	1	1	3	3	2	3
CO6	3	3	3	3	3	2	2	2	1	1	1	2	3	2	3