Nagar Yuwak Shikshan Sanstha's

Yeshwantrao Chavan College of Engineering

(An Autonomous Institution affiliated to Rashtrasant Tukadoji Maharaj Nagpur University)

Hingna Road, Wanadongri, Nagpur - 441 110

Bachelor of Engineering

SoE & Syllabus 2014

7 & 8 Semester

Mechanical Engineering

Updated on June 2020

Nagar Yuwak Shikshan Sanstha's

Yeshwantrao Chavan College of Engineering

(An Autonomous Institution affiliated to Rashtrasant Tukadoji Maharaj Nagpur University)

B.E. SCHEME OF EXAMINATION 2014

(Revised Scheme of Examination w.e.f. 2020-21 onward)

SoE No. ME-101

Mechanical Engineering

Sl.No.	Sub Code	Subject	CONTACT HOURS L	T	P	Total	Credits	% Weightage MSEs*	TA**	ESE	ESE Duration
SEVENTH SEMESTER											
1	ME1447	Production Management	3	0	0	3	3	30	30	40	3 Hours
2	ME1448	Design Of Mechanical Drives	3	0	0	3	3	30	30	40	3 Hours
3	**Professional Elective - I**		4	0	0	4	4	30	30	40	3 Hours
	ME1401	PE-I: Tool Design									
	ME1402	PE-I: Material Handling Systems									
	ME1404	PE-I: Engineering Of Plastics									
	ME1405	PE-I: Project Evaluation & Management									
	ME1449	PE-I: Computational Fluid Dynamics									
	ME1456	PE-I: Advanced Manufacturing Techniques									
	ME1461	PE-I: Rapid Prototyping									
	ME1462	PE-I: Fuel Cells Technology									
	ME1463	PE-I: Data Structure and Algorithm									
4	**Professional Elective - II**		4	0	0	4	4	30	30	40	3 Hours
	ME1408	PE-II: Synthesis Of Mechanism									
	ME1409	PE-II: Finance & Cost Management									
	ME1410	PE-II: Renewable Energy System									
	ME1411	PE-II: Artificial Intelligence									
	ME1412	PE-II: Maintainance Management									
	ME1465	PE-II: Energy Management									
	ME1466	PE-II: Design For Manufacturing & Assembly									
	ME1467	PE-II: Quantitative Techniques									
	ME1468	PE-II: Database Management System									
5	**Professional Elective - III**		4	0	0	4	4	30	30	40	3 Hours
	ME1406	PE-III: Finite Element Methods									
	ME1417	PE-III: CIM									
	ME1419	PE-III: I.C. Engines									
	ME1421	PE-III: Refrigeration & Air Conditioning									
	ME1445	PE-III: Mechatronics									
	ME1469	PE-III: Refrigeration & Cryogenics									
	ME1476	PE-III: Machine Tool Design									
6	**Lab.:Professional Elective - III**		0	0	2	2	1		60	40	
	ME1407	**Lab. :** PE-III: Finite Element Methods									
	ME1418	**Lab. :** PE-III: CIM									
	ME1420	**Lab. :** PE-III: I.C. Engines									
	ME1422	**Lab. :** PE-III: Refrigeration & Air Conditioning									
	ME1446	**Lab. :** PE-III: Mechatronics									
	ME1470	**Lab. :** PE-III: Refrigeration & Cryogenics									
	ME1477	**Lab. :** PE-III: Machine Tool Design									
7	ME1433	Project Phase-I	0	0	4	4	4		60	40	
8	ME1434	Industrial Training / CRT	0	0	0	0	2		100		
Total			**18**	**0**	**6**	**24**	**25**				

*** MSEs = 3 MSEs of 15 Marks each will be conducted and marks of better 2 of these 3 MSEs will be considered for Continuous Assessment**

TA ** = for Theory : 20 marks on lecture quizzes, 8 marks on assignments, 2 marks on class performance

TA = for Practical : MSPA will be 15 marks each**

Chairperson		**Version**	**1.02**	**Applicable for AY 2019-20 Onwards**
Dean (Acad. Matters)		**Date of Release**	**June 2020**	

Nagar Yuwak Shikshan Sanstha's

Yeshwantrao Chavan College of Engineering

(An Autonomous Institution affiliated to Rashtrasant Tukadoji Maharaj Nagpur University)

B.E. SCHEME OF EXAMINATION 2014

(Revised Scheme of Examination w.e.f. 2020-21 onward)

SoE No. ME-101

Mechanical Engineering

Sl.No.	Sub Code	Subject	CONTACT HOURS L	T	P	Total	Credits	% Weightage MSEs*	TA**	ESE	ESE Duration
		EIGHTH SEMESTER									
1	ME1435	Automation In Production	3	0	0	3	3	30	30	40	3 Hours
2	ME1436	**Lab. :**Automation In Production	0	0	2	2	1		60	40	
3	ME1475	Optimisation Techniques	3	1	0	4	4	30	30	40	3 Hours
4	**Professional Elective - IV**		4	0	0	4	4	30	30	40	3 Hours
	ME1415	PE-IV: Vibration									
	ME1437	PE-IV: Industrial Fluid Power									
	ME1439	PE-IV: Cnc & Robotics									
	ME1441	PE-IV: Vehicle Engineering									
	ME1443	PE-IV: MIS									
	ME1478	PE-IV: Solar Energy and Utilization									
	ME1480	PE-IV: Design For Fatigue and Fracture									
	ME1485	**PE-IV: Pipe Design and Engineering**									
5	**Lab.: Professional Elective - IV**		0	0	2	2	1		60	40	
	ME1416	**Lab. :** PE-IV: Vibration									
	ME1438	**Lab. :** PE-IV: Industrial Fluid Power									
	ME1440	**Lab. :** PE-IV: Cnc & Robotics									
	ME1442	**Lab. :** PE-IV: Vehicle Engineering									
	ME1444	**Lab. :** PE-IV: MIS									
	ME1479	**Lab. :** PE-IV: Solar Energy And Utilization									
	ME1481	**Lab. :** PE-IV: Design For Fatigue And Fracture									
	ME1486	**Lab. : PE-IV: Pipe Design and Engineering**									
6	**Professional Elective - V**		4	0	0	4	4	30	30	40	3 Hours
	ME1451	PE-V: Stress Analysis									
	ME1452	PE-V: Design Of Experiments And Taguchi Methods									
	ME1453	PE-V: Value Engg.									
	ME1454	PE-V: Lean Sigma									
	ME1455	PE-V: Product Design And Development									
	ME1457	PE-V: Power Plant Engineering									
	ME1458	PE-V: Machine Tool Design									
	ME1459	PE-V: Industrial Safety									
	ME1460	PE-V: Advance Welding Techniques									
	ME1482	PE-V: Air Conditioning									
	ME1483	PE-V: Cryogenic Systems									
	ME1484	PE-V: Tribology									
7	ME1472	Comprehensive Viva Voce	0	0	0	0	3			100	
8	ME1473	Project Phase-II	0	0	8	8	8		60	40	
9	ME1474	Extra Curricular Activities	0	0	0	0	2		100		
		Total	**14**	**1**	**12**	**27**	**30**				

*** MSEs = 3 MSEs of 15 Marks each will be conducted and marks of better 2 of these 3 MSEs will be considered for Continuous Assessment**

TA ** = for Theory : 20 marks on lecture quizzes, 8 marks on assignments, 2 marks on class performance

TA = for Practical : MSPA will be 15 marks each**

Chairperson		**Version**	**1.04**	**Applicable for AY 2020-21 Onwards**
Dean (Acad. Matters)		**Date of Release**	**June 2020**	

7th Semester

ME1447	Production Management	L=3	T=0	P=0	Credits=3

Objective	Course Outcome
The course aims to develop an insight into working of production systems, their evaluation analysis and control. The overall objective is to learn to plan, design, execute or operate, control and measure the efficiency/ effectiveness of production systems.**[a,c,e,k]**	Students will develop (I)Ability to manage production system with cost and resource constraints..**[a,e,k]**
	(II)Ability to manage production systems to produce right quality goods and services as per the standards and specifications to meet delivery schedule with minimum resources and at the optimum level.. **[a,e,k]**
	(III) Ability to optimize the production system.. **[a,c,e,]**

Unit1 **[7 hrs]**
Work Study: Productivity, factors affecting productivity. Measurement of productivity. Work study and methods study: Definitions, objectives, steps in method study, Process charts, string diagram, motion study, micro motion study, SIMO Chart . **[a,e,k]**

Unit2 **[8 hrs]**
Work measurement: Objectives, definition, stop watch study, work sampling, PMTs, MTM & Work factor method
Value analysis and value Engineering:, Introduction, steps involved in value analysis. Applications in Manufacturing. **[a,e,k]**

Unit3 **[8 hrs]**
Plant Layout: Types of Plant Layout, Layout Functions and problems, Organization, Automated material handling, Concepts of AGVs, AS/RS and other automated devices. Design of integrated plant layout for product handling system. **[a,c,e]**

Unit4 **[7 hrs]**
Forecasting: Need for forecasting, classification of forecasting methods, like judgmental technique, time series analysis, least square method, moving average method, exponential smoothing method. **[a,e]**

Unit5 **[7 hrs]**
Production planning and control: Definition, objectives of PPC, functions of PPC, types of production, Inventory control, EOQ, Techniques in inventory control and associated problems. **[a,e,k]**

Unit 6 **[8 hrs]**
Process analysis and Cost Estimation:
Steps involved in manual production planning, Selection of process, analysis. Aims of Cost Estimation, Difference between cost and Estimation, Elements of cost: material, Product cost, Analysis of overhead expenses, Product cost estimation. **[a,e]**

Text books:				
1	Introduction to Work study	4th Edition (1992)	George Kanawaty	ILO
2	Motion and Time study	1st Edition (1980)	Barnes	Wiley
3	Ergonomics	1st Edition (1985)	Murell	Chapman & Hall
4	Production Planning and Control	2nd Edition (2006)	Jain & Agrawal	McGraw-Hill
5	Industrial Engg. And Project management	2nd Edition (2006)	Mart and Telsang	s. Chand
6	Plant layout and Material Handling	1st Edition (1977)	James Apple	Wiley, Technology & Engineering

7th Semester

ME1448	Design of Mechanical Drives	L=3	T=0	P=0	Credits=3

Objectives:	**Course Outcome:**	
To develop the concept of drive system and impart knowledge of various components of industrial drives. To enable the students in selecting proper drive system. To make the students capable of selecting proper gear drive and design the components of geared system. To emphasize the need of reducing cyclic fluctuations in speed by providing appropriate flywheel.To enable to take up small projects in design of haulage system.	(i)	The student will be able to apply the fundamentals of stress analysis and material science to design the mechanical drive.**[a,e]**
	(ii)	Student will be able to design the components of system for mechanical drives.**[a,e]**

Unit1

[8 hrs]

Flat belt drive: Types of belts & belt material, analysis of belt tension, condition for transmitting maximum power, design of flat belt, flat belt pulley.
V belt drive: Types of V-belt, analysis of V-belt tension, design of V belt pulley.**[a,e]**

Unit2

[7 hrs]

Chain Drive: Design of roller chain drive, types of chain, concept of chordal action, lubrication ,types of sprocket,
Rope drive: Introduction to haulage system, construction of rope, design of wire rope, sheave and drums Electric motor rating, their Characteristics, controls, selection motors. .**[a,e]**

Unit3

[8 hrs]

Gear drive: Review of Kinematics of gears & terminology, interference, tooth profiles, formative number of teeth etc. Bukingham equation, design of spur gear drive, helical gear drive.**[a,e]**

Unit4

[8 hrs]

Worm gear drive: Types and proportion of worm and worm gear, force analysis, beam strength of worm gear teeth, dynamic tooth load, wear load, thermal rating of worm gear, design of worm and worm gear.
Bevel gear drive: Types of bevel gear, proportions of bevel gear, force analysis of bevel gear drive design of bevel gear drive. .**[a,e]**

Unit5

[7 hrs]

Coupling: Types of shaft coupling, design of flange coupling, flexible bush coupling.
Flywheel: Coefficient of fluctuation of energy and Coefficient of fluctuation of speed, energy store in flywheel, stresses in flywheel, design of flywheel. .**[a,e]**

Unit 6

[7 hrs]

Bearing: Surface finish, friction wears, lubrication, oil seals, design of journal bearings for radial and thrust loads, selection of ball and roller bearing for radial and thrust loads. Failures of antifriction bearing, design of hydrostatic pocket type thrust bearing such as circular step thrust bearing, bearing housing. .**[a,e]**

7th Semester

ME1448	Design of Mechanical Drives	L=3	T=0	P=0	Credits=3

Text books:				
1	Mechanical Design of Machine	4th Edition (1965)	Maleev, Hartman	International Textbook Co.
2	Machine Design	3rd Edition (1968)	Black P.H	Tata McGraw Hill
3	Mechanical Engg. Design	8th Edition (2008)	Shigley	Tata McGraw Hill
4	Design Data book	1st Edition (2005)	Shiwalkar B.D	Central Techno Publication
5	Design of Machine Elements	Edition (Yr of publication)	Bhandari V. B	Publisher
6	Machine Design	2nd edition	Norton	McGraw publication

Reference books:				
1	Hand book of Machine Design	3rd Edition (2004)	Shiglay&Mischke	Tata McGraw Hill
2	Mechanical Engineering Hand book (Vol 1 & 2)	Vol 1: 12 Edition (1950) Vol 2: 11Edition	Kent	J.Wiley& Sons inc
3	PSG. Tech. Machine Tool Design Data Book	(1966)	CMTI	PSG College of Technology

7th Semester

ME1401	PE I : Tool Design	L=4	T=0	P=0	Credits=4

Objective	Course Outcome
To learn the mechanism of metal cutting and the design of metal cutting tools. Also to understand various press working operations along with tools to dies design.**[c,l]**	(I)Student will able to design of various tools needed for machining operations..[c,l]
	(II)Student can apply the concept of tool design, jigs and fixtures design & press work in machine operations..[c,l]

Unit1

[8 Hrs]

Design of single Point Cutting Tool ,Theory of metal Cutting Introduction, Mechanics of chip formation, Cutting tool materials, Single point cutting tool, Designation of cutting tools, ASA system, Importance of Tool angles, Orthogonal rake system, Classification of cutting tools, Types of chips, determination of shear angle, velocity relationship, force relations, Merchant's Theory, Cutting power, Energy consideration in metal cutting, Tool wear, Tool life, Tool life criteria, variable affecting tool life, Machine ability **[c,l]**

Unit2

[8hrs]

Form tools- Introduction, Types, design of form tools. Drills- Introduction, Types, Geometry, Design of drill. Milling cutters - Introduction, Types, Geometry, and Design of milling cutters**. [c,l]**

Unit3

[10hrs]

Press tool Design

Introduction, Press operations - Blanking, piercing, Notching, Perforating, Trimming, Shaving, Slitting, Lancing, Nibbling, Bending, Drawing, Squeezing. Press working equipment - Classification, Rating of a press, Press tool Equipment, arrangement of guide posts. Press selection, press working

Terminology, Working of a cutting die, Types of dies - Simple dies, inverted die, Compound dies, combination dies, progressive dies, Transfer dies, multiple dies Principle of metal cutting, strip layout, clearance, angular clearance, clearance after considering elastic recovery, cutting forces, method of reducing cutting forces, Die block, Die block thickness, Die opening, Fastening of die block, back up plate, Punch, Methods of holding punches, Strippers. Stoppers, Stock stop, Stock guide, Knockouts, Pilots. Blanking & Piercing die design - Single & progressive dies. **[c,l]**

Unit4

[10hrs]

Bending Forming & Drawing dies Bending methods - Bending Terminology, V- Bending, Air bending, bottoming dies, spring back & its prevention. Design Principles - Bend radius, Bend allowance, Spanking, width of die opening, Bending pressure. Metal flow during drawing, Design, Design consideration - Radius of draw die, Punch radius, Draw clearance, Drawing speed, Calculating blank size, Number of draws, Drawing pressure, Blank holding pressure. **[c,l]**

Unit5

[7 Hrs]

Forging Die Design: Introduction, Classification of forging dies, Single impression dies, Multiple Impression dies. Forging design factors - Draft, fillet & corner radius, parting line, shrinkage & die wear, mismatch, finish allowances, webs & ribs Preliminary forging operation - fullering, edging, bending, drawing, flattering, blacking finishing, cutoff. Die design for machine forging - determination of stock size in closed & open die forging. Tools for flash trimming & hole piercing, materials & manufacture of forging dies. **[c,l]**

Unit6

[10 Hrs]

Design of jigs & fixture: - Introduction, locating & clamping - principle of location, principle of pin location, locating devices, radial or angular location, V - location, bush location. Design principle for location purpose, principle for clamping purposes, clamping devices, design principles common to jigs & fixtures. Drilling Jigs: - Design principles, drill bushes, design principles for drill bushings, Types of drilling jigs - Template jig, plate type jig, open type jig, swinging leaf jig, Box type jig, channel type jig . Jig feet. Milling Fixtures: - Essential features of a milling fixtures, milling machine vice, Design principles for milling fixtures, Indexing jig & fixtures, Automatic clamping Devices. **[c,l]**

7th Semester

ME1401	PE I : Tool Design	L=4	T=0	P=0	Credits=4

.Reference books:

S.N.	Title of the book	Edition (Year of publication)	Author(s)	Publisher
1	"Tool design"	2001	Donaldson	TATA Mc-Graw Hill.
2	"Fundamentals of Tool design	1988	ASTME,	TATA Mc-Graw Hill.
3	"Fundamentals of Tool design"	1962	Pollock,	Reston Publishing Company
4	, "Fundamentals of Tool design"	1971	Kempster	Hall of India Pvt. Ltd
5	Computer aided fixture design	--	Rong , Yeming	Marcel Dekker

7th Semester

ME1402	PE I : Material Handling System	L=4	T=0	P=0	Credits=4

Objective	Course Outcome
To develop the awareness about principles and practices of material handling equipments. Study the different components design and applications of material handling devices.[c,e]	(I)The student will able to identify the need for material handling system. They will be able to select and design the system.[c,e]

Unit1 **[8 Hrs]**
Types of intraplant transporting facility, principles of material handling and classification of material handling equipments, selection of material handling equipment, hoisting equipment, screw type, hydraulic and pneumatic conveyors, general characteristics of hoisting machines, surface and overhead equipments, general characteristics of surface and overhead equipments and their applications. Introduction to control of hoisting equipments. **[c, e]**

Unit 2 **[10 Hrs]**
Component selection and design Flexible hoisting appliances like ropes and chains, welded load chains, roller chains, selection of chains, hemp rope and steel wire rope, selection of ropes, rope reeving arrangement and pulley blocks fastening of chains and ropes, different types of load suspension appliances, fixed and movable pulleys, different types of pulley systems, multiple pulley systems. Chain and ropes heaves and sprockets.**[c, e]**

Unit 3 **[7 Hrs]**
Load handling attachments, standard forged hook, hook weights, hook bearings, cross piece and casing of hook, crane grab for unit and piece loads, carrier beams and clamps, load platforms and side dump buckets, Electromagnetic lifting system, grabbing attachments for loose materials, crane attachments for handling liquid materials. **[c, e]**

Unit 4 **[10 Hrs]**
Arresting gear, ratchet type arresting gear, roller ratchet, shoe brakes and its different types like electromagnetic, double shoe type, thrusters operated, controlled brakes, shoe brakes, Electro-Hydraulic thrusters safety handles, load operated constant force and variable force brakes, Rope drum design and assembly, design of guides and column, **[c, e]**

Unit 5 **[8 Hrs]**
Different drives of hoisting gears like individual and common motor drive for several mechanisms, travelling gear, travelling mechanisms for moving trolleys and cranes on runway rails, mechanisms for trackless, rubber-tyre and crawler cranes, motor propelled trolley hoists and trolleys, rails and travelling wheels, slewing, jib and lifting gears. Operation of hoisting gear during transient motion, selecting the motor rating and determining braking torque for hoisting mechanisms, selecting the motor rating and determining braking torque for travelling mechanisms, slewing mechanisms, jib and lifting mechanisms. (Elementary treatment is expected)
[c, e]

Unit 6 **[7 Hrs]**
Cranes with rotary pillar, cranes with a fixed post, jib cranes with trolley, portal cranes with luffmg boom, cantilever cranes, cage elevators, safety devices of elevators, belt and chain conveyors and their power calculations, vibrating and oscillating conveyors, pneumatic and hydraulic conveyors, screw conveyors, hoppers, gates and feeders. Introduction to AGV's as new material handling device, use of robot for material handling. **[c, e]**

Text books:

S.N.	Title of the book	Edition (Year of publication)	Author(s)	Publisher
1	Materials Handling Equipment-	1964	N. Rudenko ,	Envee Publishers, New Dehli
2	Materials Handling Equipment-	1968	M.P. Alexandrov.	Mir publications

7th Semester

ME1404	PE I : Engineering of Plastics	L=4	T=0	P=0	Credits=4

Objective	Course Outcome
To familiarize students with : 1. Various Plastic materials, Their properties and applications 2. Different plastic processing techniques.**[c]**	(I)Students will be able to select the suitable plastic material for given application.**[c]** (II)Students will be able to select suitable plastic processing technique..**[c]**

Unit 1 **[7 Hrs]**
Chemistry and Classification of Polymers - Properties of Thermo Plastics - Properties of Thermosetting Plastics - Applications - Merits and Disadvantages.**[c]**

Unit 2 **[7 Hrs]**
Extrusion - Blow Molding – Casting – Thermo Forming – Rotomolding Study of molds **[c]**

Unit 3 **[8 Hrs]**
Compression and Transfer Molding - Injection Molding- study of compression and injection molding moulds **[c]**

Unit 4 **[8 Hrs]**
General Machining properties of Plastics - Machining Parameters and Their effect - Joining of Plastics -Mechanical Fasteners - Thermal bonding - Press Fitting. Testing of plastic **[c]**

Unit 5 **[8 Hrs]**
Fibers - Glass, Boron, Carbon, Organic, Ceramic and Metallic Fibers - Matrix Materials - Polymers, Metals and Ceramics. Open Mould Processes, Bag Molding, Compression Molding with BMC and SMC - Filament winding - Pultrusion - Centrifugal Casting - Injection Molding - Application of PMC's. **[c]**

Unit 6 **[7 Hrs]**
Solid State Fabrication Techniques - Diffusion Bonding - Powder Metallurgy Techniques - Plasma Spray,Chemical and Physical Vapor Deposition of Matrix on Fibers - Liquid State Fabrication Methods - Infiltration - Squeeze Casting - Rheo Casting - Compocasting - Application of MMCS. **[c]**

.Reference books:

S.N.	Title of the book	Edition (Year of publication)	Author(s)	Publisher
1	Product Design and Process Engineering	1995.	Harold Belofsky,	Hanser Publishers,
2	High Performance Polymers	**1991**	Bera, E and Moet	Hanser Publishers,
3	Plastics Extrusion technology	**1988**	F.Hensen,	
4	Injection Moulding Machines	**1983**	F.ohannaber	Hanser Publishers,
5	Polymer extrusion	**1990**	C.Rauwendaal,	Hanser Publishers,
6	Blow Moulding Handbook	**1989**	D.V.Rosatao,	Hanser Publishers,
7	Modern Plastics Moulding		E.B Seamour,	John Wiley.
8	Plastics Moulding	**1952**	John Dalmonte,	John Wiley.
9	Machining of Plastics	**1981**	Akira Kobyashi,	Mc-Graw Hill.
10	Composite Materials science and Engineering	**1998**	Krishan K.Chawla	Springer-Verlag, 1987.

7th Semester

ME1405	**PE I : Project Evaluation & Management**	**L=4**	**T=0**	**P=0**	**Credits=4**

Objective	**Course Outcome**
The course focuses on developing complete understanding of formulating a problem/project and finding possible solutions against the given constraints. The overall learning shall resolve project identification evaluating its technical and economical feasibility and developing skills for its planning, and establishing controls. Relevant techniques, writing skills and monitoring methods shall be dealt with in details.[**a,d,e,h,k]**	(I)The students will be able to use the concepts of monitoring and evaluation, appraise and determine best monitoring methods, appreciate evaluation in the context of developmental project work..[a,d,e,h,k]
	(II)The students will be able to carry out problem analysis, determine relevant indicators and data necessary for evaluation, prepare for and implement a monitoring and evaluation process, establish baselines and targets.. [a,d,e,h,k]

Unit1

[7 hrs]

Project Identification considering objectives and SWOT analysis, Screening of Project Ideas, Technical, Market, Financial, Socioeconomic and Ecological Appraisal of a project demand forecasting, secondary data, accuracy, confidence level, uncertainty.[**a,d,e,h,k]**

Unit 2

[7 hrs]

Technical feasibility : Process selection, Level of automation, plant capacity, acquiring technology, Appropriate technology plant location, Equipment selection & procurement, Govt. policies. Value analysis and project evaluation: .[**a,d,e,h,k]**

Unit 3

[9 hrs]

Economic feasibility: Cost of Project, working capital analysis, fixed cost, means of finance, estimation of sales & production price analysis, Break even point, Projected cash flow statements, projected balance sheet, projected profit & loss statement, projected cash flow, rate of return, Discounted payback period, cost benefit analysis, return after taxes. .[**a,d,e,h,k]**

Unit 4

[7 hrs]

Project Planning and Control: Work break down structure and network development. Basic Scheduling, Critical Path and four kinds of floats. Scheduling under probabilistic durations, Time Cost tradeoffs, CPM, PERT, Optimum project duration, resource allocation, updating .[**a,d,e,h,k]**

Unit 5

[7 hrs]

Project report: Preparation of project report, risk analysis, sensitivity analysis, methods of raising capital .[**a,d,e,h,k]**

Unit 6

[8 hrs]

Initial review, performance analysis , ratio analysis, sickness, project revival, Project Monitoring with PERT/Cost, Organizational aspects, Computer packages and Project Completion environ-mental & social aspects**.** .[**a,d,e,h,k]**

7th Semester

ME1405	PE I : Project Evaluation & Management	L=4	T=0	P=0	Credits=4

.Reference books:

S.N.	Title of the book	Edition (Year of publication)	Author(s)	Publisher
1	Projects	Seventh edition 2007	Prasanna chandra	Tata mc graw Hill publishing company Ltd.
2	CPM & PERT		L. S. Srinath	East West publisher
3	Projects	1963	P.K. Joy	Macmillon
4	Engineering Economy	Fifth edition	H. G Thuesen, W J Fabricky, G,J, Thuersen	Prentice-Hall
5	Finance series 'Project management' , Vol-I1 and Vol-III	2009	ICFAI	ICFAI,Press Hyderabad
6	Finance Management	Sixth edition 2010	M.Y.Khan	Tata McGraw hill
7	Financial Management	Fourth edition	Chandra, Prasanna	Tata McGraw-Hill Education, 1997
8	Engineering Economics	Eighth edition	G. J. Thuesen, Wolter J. Fabrycky	Prentice Hall, 1993

7th Semester

ME 1449	PE I : Computational Fluid Dynamics	L=4	T=0	P=0	Credits=4

Objective	Course Outcome
• To understand the applications of fundamental and advanced principles of fluid mechanics. • To be familiar with mathematical models for various CFD applications such as Navier-Stokes equations • To be familiar with the common numerical methods and understand how to estimate the numerical errors (verification), modeling errors (validation), and uncertainties for CFD.	(I) Student will be able to understand the various mathematical approaches and various CFD equations for various applications in Fluid dynamics and Heat transfer. (a,e,k,m)
	(II) Student will be able to understand the various CFD equations and basics of discretisation for various applications in Fluid dynamics and Heat transfer. (a,e,k,m)
	(III) Student will be able to be familiar with the common numerical methods and understand how to estimate the accuracy and errors in solving different problems in CFD. (a,e,k,m)

Unit1 **[7 hrs]** **Mathematical Preliminaries:** Numerical integration, Review of linear algebra, solution of simultaneous linear algebraic equations – matrix inversion, solvers – direct methods, elimination methods, ill conditioned systems, Gauss- Seidel method, successive over relaxation method. (a,e,m)(I,II).
Unit2 **[8 hrs]** **Equations of fluid dynamics:** Basic concepts Eulerarian and Lagrangian methods of describing fluid flow motion, acceleration and deformation of fluid particle, vorticity, Laws governing fluid motion, continuity, Navier – stokes & energy equations. Boundary layer equation, Euler equations, potential flow equations, Bernoulli's equation and vorticity transport equation. Initial and boundary conditions. Classification of equation of motions – hyperbolic, parabolic, elliptic. (a,e)(I)
Unit3 **[8 hrs]** **Grid Generation:** General principles of grid generation – structured grid's in two and three dimensions, differential equations based grid generation; Elliptic grid generation, algorithm, Grid refinement, Adaptive grids, Moving grids. Algorithms, CAD interfaces to grid generation. (a,e,k)(I,II)
Unit4 **[8 hrs]** **Finite Difference Discretisation:** Elementary finite difference coefficients, basic aspects of finite difference equations, steady and unsteady state heat conduction with FDM approach, consistency, explicit and implicit methods, errors and stability analysis. Stability of elliptic and hyperbolic equations. Finite difference applications in heat transfer – conduction, convection. (a,e,k,m)(I,III)
Unit5 **[8 Hrs]** **Finite Volume Method:** Introduction, Application of FVM in diffusion and convection problems, steady and unsteady state heat conduction with FDM approach, NS equations – staggered grid. (a,e,k,m)(I,III)
Unit6 **[6 Hrs]** SIMPLE algorithm. Solution of discretised equations using TDMA. Finite volume methods for unsteady problems – explicit schemes, implicit schemes. (a,e,k,m)(I,III)

7th Semester

ME1449	PE I : Computational Fluid Dynamics	L=4	T=0	P=0	Credits=4

.Reference books:

S.N.	Title of the book	Edition (Year of publication)	Author(s)	Publisher
1.	Computational Fluid Dynamics	1995	Anderson John D.	Mc-Graw Hill Corp.
2.	Introduction to Computational Fluid Dynamics : The Finite Volume Method	2nd Edition	Versteeg, H. K. and Malalasekara, W.	(Indian Reprint) Pearson Education.
3.	Numerical Heat Transfer and Fluid Flow	1962	S. V. Patankar,	McGraw-Hill
4.	Computational Methods for Fluid Dynamics		Ferziger J. H., Springer P. M.	Verlag Berling
5.	Computational Fluid Flow and Heat Transfer	2nd Edition	Sunderarajan M. K.	Narosa Publishing

7th Semester

ME1456	PE I : Advanced Manufacturing Techniques	L=4	T=0	P=0	Credits=4

Objective	Course Outcome
To develop the ability to understand & analyze different advanced manufacturing processes and different advanced manufacturing machines. **(a,c,k)**	(I)The Students will be able to understand and operate advanced production machines.. (a,c,k)
	(II)The Students will be able to understand advanced machining processes with applications. (a,c,k)

Unit 1 **[7 hrs]**
Non-traditional machines process: Need, classification & historical development. Abrasive machine and finishing operations, high speed grinding, creep feed grinding, belt grinding, hot and cold machining. **[a, c, k]**

Unit 2 **[8 hrs]**
Abrasive Jet Machine: Mechanics of AJM. Process parameter and characteristics ultrasonic machining mechanics, process parameter & control, effect of USM on materials, water jet machining. **[a, c, k]**

Unit 3 **[9 hrs]**
Electro – chemical machining: Electrochemistry of ECM, tool design, effect of variable on performance chemical milling, Chemical Engraving, Photo chemical machining, EC grinding, Electric discharge machining, machine surface finish & machining accuracy, electron beam. Laser beam and plasma arc machining **[a, c, k]**

Unit 4 **[6hrs]**
High energy rate forming process. Burnishing, dallising and other miscellaneous forming and finishing processes, electroforming. Thermoform High velocity forming, Vacuum forming, **[a, c, k]**

Unit 5 **[8 hrs]**
Unconventional welding techniques, laser, electron beam, plasma arc, atomic hydrogen, submerged arc, explosive welding techniques, electro slag welding and casting. **[a, c, k]**

Unit 6 **[7 hrs]**
Adhesive bonding, solid phase welding, technique such as ultrasonic welding, friction welding, recent development in welding, comparative analysis, economics and applications of nontraditional processes for machining, welding and forming.**[a, c, k]**

Reference Books:

S.N.	Title of the book	Edition (Year of publication)	Author(s)	Publisher
1	Manufacturing Science	2007	A. Ghosh & A. Mallik.	Ellis Horwood, 1986
2	Non Traditional Machining	2005	P.C. Paonoey & H. S. Shan.	Tata McGraw-Hill Education, 1980
3	New Technology		A Bhattacharya	
4	Advance machining process		V.K.Jain	Allied publisher

7th Semester

ME1461	PE-I : Rapid Prototyping	L=4	T=0	P=0	Credits=4

Objective	Course Outcome
To learn the Product Life Cycle. Study the process of Rapid prototyping and different Rapid Prototyping methods .[d,l]	(I) Student will learn basics of Rapid Prototyping.[d,l] (II)Student will learn the process of RP.[l] (III)Student will learn model slicing for RP [l] (IV)Student will learn Liquid and solid based RP systems [l] (V) Student will learn powder based RP system [l] (V) Student will learn RP tooling and manufacturing [d,l]

Unit 1 Introduction **[7 hrs]**
CAD-CAM and its integration, Development of CAD CAM., The importance of being Rapid, The nature of RP/T,The state of RP/T industry. Rapid Prototyping Defined. Time compression Technologies, Product development and its relationship with rapid prototyping. **[d,l]**

Unit 2 Process Chain for RP **[7 hrs]**
Data Preparation (Pre-processing), Part Building, Post Processing. CAD Model Preparation, Reverse Engineering and CAD model, Digitizing Techniques: Mechanical Contact Digitizing, Optical Non-contact Measurement, CT Scanning Method, Data Processing for Surface Reconstruction.
Data interface for Rapid Prototyping: STL interface Specification, STL data generation, STL data Manipulation, Advantages and limitations of STL file format. Open files. Repair of STL files. Alternative RP interfaces.
Part orientation and support generation: Factors affecting part orientation, various models for part orientation determination, the function of part supports, support structure design, Automatic support structure generation. **[d,l]**

Unit 3 Model Slicing and Contour Data Organization **[8 hrs]**
Model slicing and skin contour determination, Identification of external and internal contours, Contour data organization, Direct and adaptive slicing: Identification of peak features, Adaptive layer thickness determination, Skin contour computation. Tool path generation.
Part Building: Recoating, parameters affecting part building time, part quality.
Post Processing: Part removal, finishing, curing.
Other issues: Shrinkage, Swelling, Curl and distortion, Surface Deviation and accuracy, Build Style Decisions, **[d,l]**

Unit 4 LIQUID BASED AND SOLID BASED RP SYSTEMS **[8 hrs]**
Stereolithography Apparatus, Fused deposition Modeling, Laminated object manufacturing, three dimensional printing: Working Principles, details of processes, products, materials, advantages, limitations and applications - Case studies. **[d,l]**

Unit 5 POWDER BASED RP SYSTEMS **[8 hrs]**
Selective Laser Sintering, Direct Metal Laser Sintering, Three Dimensional Printing, Laser Engineered Net Shaping, Selective Laser Melting, Electron Beam Melting: Processes, materials, products, advantages, applications and limitations – Case Studies.. **[d,l]**

7th Semester

ME1461	PE-I : Rapid Prototyping	L=4	T=0	P=0	Credits=4

Unit 6 RAPID TOOLING AND MANUFACTURING [7 hrs]

Classification of RT Routes, RP of Patterns, Indirect RT: Indirect method for Soft and Bridge Tooling, Indirectmethod for Production Tooling, Direct RT: Direct RT method for Soft and Bridge Tooling, Direct method forProduction Tooling, Other RT Approaches. Rapid Manufacturing: Methods, limitations. **[d,l]**

BOOKS RECOMMENDED

1 Bjorke, Layer Manufacturing, Tapir Publisher. 1992.
2 Jacobs, PF (Ed), Rapid Prototyping and Manufacturing, Society of Manuf. Engrs, 1992.
3 Burns, M., Automated Fabrication: Improving Productivity in Manufacturing, 1993.
4 Jacobs, P.F. (Ed.), Stereo lithography and Other RP&M Technologies: From Rapid Prototyping to Rapid Tooling, Society of Manuf. Engrs. NY, 1996.
5 Chua C. k. and L. K. Fai, Rapid Prototyping: Principles and Applications in Manufacturing.
6 Gibson, I. (Ed.), Software Solutions for Rapid Prototyping, Professional Engineering Publications, London., 2002.

7th Semester

ME1462	PE-I: Fuel Cell Technology	L=4	T=0	P=0	Credit=4

Objective	Course Outcome

Unit I: Introduction to Fuel Cells
Brief history of fuel cells, Operating principles, Types of fuel cells- Solid Oxide Fuel Cell (SOFC), Alkaline Fuel Cell (AFC), Molten Carbonate Fuel Cell (MCFC), Phosphoric Acid Fuel Cell (PAFC), Fuel Cell Stack, Advantages, Limitations and Applications of Fuel Cell, Polarization curve for performance characterization of fuel cells, Representing various losses (Activation, Ohmic, concentration loss), Hydrogen Production, Storage and Transportation.

Unit II: Fuel Cell Thermodynamics
Heat Potential (Enthalpy of Reaction), Work Potential (Gibbs free energy), Reversible fuel cell voltage (Nernst equation), Fuel Cell Efficiency.

Unit III: Fuel Cell Electrochemistry
Electrochemical Reaction Basics, Faraday's law, Tafel equation, Butler – Volmer equation, Exchange Current.

Unit IV: Fuel Cell Charge Transport and Mass Transport
Ion Transport (Electrolyte), Electron Transport, Gas phase (single phase) mass transport in different fuel cell components (Diffusion layer, flow channels), Multiphase Mass Transport in fuel cell components , Fuel Crossover and Internal Currents, Heat generation and transport in fuel cell.

Unit V: Fuel Cell Characterization
In Situ Versus Ex Situ Characterization, Polarization Test, Electrochemical Impedance Spectroscopy, Linear Sweep Voltammetry, Cyclic Voltammetry, Current Interrupt, High frequency resistance.

Unit VI: Polymer Electrolyte Membrane Fuel Cell (PEMFC)
Components and Materials: Membrane, Catalyst Layer, Bipolar Plate, Current Collector, Water Management, Thermal Management, Direct Liquid Fuel Cell (DLFC), Advantage of Liquid Fuel over Gaseous Fuel, Different types of DLFC, Direct Methanol Fuel Cell (DMFC).

Textbooks/Reference Books
1. O'Hayre, R.P.,S. Cha, W. Colella, F.B.Prinz, Fuel Cell Fundamentals, Wiley, NY (2006).
2. J. Larminie and A. Dicks, Fuel Cell Systems Explained, 2nd Edition, Wiley (2003).
3. Matthew M. Mench, Fuel Cell Engines, Wiley (2008).
4. S. Srinivasan, Fuel Cells: From Fundamentals to Applications, Springer (2006)
5. X. Li, Principles of fuel cells, Taylor & Francis (2005).

7th Semester

ME1463	PE-I : Data Structure and Algorithm	L=4	T=0	P=0	Credits=4

Objective	Course Outcome
This Engineering course focuses on detail study of various data structures, the concept of Algorithm and programming for data structures used in computer environment. Also provides the learning of sorting and searching processes, non linear data structure	

.

Unit 1	Introduction to computer, Evolution of Computers, Classification of Computers, Applications of Computers, Advantages and Disadvantages of Computers, Components of a Computer System	**[7hrs]**
Unit 2	Introduction to data structures, abstract data types, array as an ADT, using one-dimensional arrays, arrays as parameters, character string operations, multi-dimensional arrays, structures and classes.	**[8 hrs]**
Unit 3	Stack and its Application, Definition and Examples, Primitive Operations, Recursion, Fibonacci sequence, Binary Search, Recursive Chains, Recursive Definition of Algebraic Expressions	**[8 hrs]**
Unit 4	Queues and Lists, the queues representation insert operation, priority queue, array implementation of a priority queue, linked lists, inserting and removing nodes from a list, linked implementation of stacks, linked implementation of queues, linked list as a data structure, non integer and non homogeneous lists, dynamic and array implementation of lists, simulation using linked lists simulation process, data structures, other list structures, circular lists, doubly linked lists , multiple linked lists	**[7 hrs]**
Unit 5	Trees, Binary Trees Operations, Applications Representations of Binary Tree. Internal and External Nodes, Implicit Array Representation of Binary Trees, Choosing a Binary Tree Representation, Binary Tree Traversals, Heterogeneous Binary Trees	**[7 hrs]**
Unit 6	Sorting:- Bubble sort, Quick sort, Selection and Tree Sorting, Straight Selection Sort, Binary Tree sorts, Heap sort, Insertion Sorts, Simple Insertion, Shell Sort Searching:- linear search, binary search, interpolation search, tree searching, inserting and deleting in a binary search tree	**[7 hrs]**

Books for Reference:

1. Langsam Y., Augenstein M. J. And Tenenbaum A. M., —Data Structures Using C and C++, Prentice Hall of India Pvt. Ltd.
2. Trembly J. P. And Sorenson P. G., —An Introduction to Data Structures with Applications, Tata McGraw Hill Pub. Co. Ltd.
3. Horowitz E. And Sahani S., —Fundamentals of Computer Algorithms, Galgotia Publications Ltd.

7th Semester

ME1408	PE II : Synthesis Of Mechanism	L=4	T=0	P=0	Credits=4

Objective	Course Outcome
To make the students understand various types of mechanisms and criterion used in their selection. To give detailed knowledge of type, number and dimensional synthesis of mechanisms. To introduce various graphical and analytical methods so as to enable students to design the mechanisms to meet kinematic needs. Introducing various optimization techniques for synthesis. **[a,e,k,l,m]**	(I)Students will be able to understand the fundamentals of mechanisms and machines.. **[a,e,k,l,m]**
	(II)Students will be able to formulate mathematical model for given mechanism. **[a,e,k,l,m]**
	(III)Students will be able to apply various graphical and analytical methods to design the mechanisms to meet kinematic needs.. **[a,e,k,l,m]**
	(IV)Students will be able to apply various optimisation techniques for synthesis. **[a,e,k,l,m]**

Unit 1

[7 hrs]

Introduction to kinematics, types of mechanism, kinematics synthesis, science of relative motion, tasks of kinematic synthesis with practical applications, Degree of freedom, class-I, class-II chain, Harding's notation, Grashof criterion, Grubler's criterion. **[a,e,k,l,m]**

Unit 2

[8 hrs]

Introduction to position generation problem, concept of pole, two &three position generation synthesis, pole triangle, Relationship between moving & fixed pivots, Four position generation, opposite pole quadrilateral, center point &circle point curve, Burmester's point. Matrix method for position generation problem, rotation matrix, displacement matrix. **[a,e,k,l,m]**

Unit 3

[7 hrs]

Introduction to function generation problem, co-ordination of input-output link motion, relative pole technique, inversion technique, overlay technique, graphical synthesis of quick return mechanisms for optimum transmission angle. Types of errors, accuracy points, cheby sher's spacing, frudenstein's equation with problems**.[[a,e,k,l,m]**

Unit 4

[8 hrs]

Introduction to path generation problem, synthesis for path generation with and without prescribed timing using graphical method. Coupler curves, cognate linkages, Robert's law of cognate linkages.
Complex number method for path generation problem 3 precision points. **[a,e,k,l,m]**

Unit 5

[7 hrs]

Synthesis for infinitesimally separated position, concept of polode and centrod, Euler's savery equation, inflection circle, Bobbilier and Hartman's construction**. [a,e,k,l,m]**

Unit 6

[8 hrs]

Optimal synthesis of planer mechanisms, powell's search method, least square method, penalty function. Introduction to spatial mechanisms, D-H notations, introduction to kinematic analysis of robot arm. **[a,e,k,l,m]**

.Reference books:

S.N.	Title of the book	Edition (Year of publication)	Author(s)	Publisher
1	Applied linkage synthesis	Fifth edition	Tao D.C.	New York, NY,
2	Advanced mechanism design	1984	Erdman A.G.; Sandor G.N	Prentice-Hall, 1984
3	Kinematics and mechanism design	Third edition 2010	Sue C.H; Radchiffe C.W	

7th Semester

ME1409	PE II : Financial & Cost Management	L=5	T=0	P=0	Credits=4

Objective	Course Outcome
•To develop in the engineering students the ability to analyze any engineering problem in a simple and logical manner and to apply a few well understood basic principles of Management to find its solution. •To be able to take a proper decision at proper time which will be beneficial in future. **[c,d,e,f,i,l**	1.(I)The student will have ability to decide the cost of the product **[c,d,e,f,i,l]**
	(II) The student will have the ability to Analyze the financial requirement. **[c,d,e,f,i,l]**
	(III) The student will have improved Decision making ability. **[c,d,e,f,i,l]**
	(IV) The student will have ability to take a proper decision on waste or scrap material. **[c,d,e,f,i,l]**

Unit 1 **[7 Hrs]**
Business Finance:
Need for finance, sources of finance (fixed and working capital), equity and preference shares, deposits from public, debentures, bonds, term loans, financial institutions in India, Financial statements and their analysis.
[c,d,e,f,i,l]

Unit 2 **[7 Hrs]**
Concept of Cost:
Concept of cost, classification of cost, direct and indirect , fixed and variable , semi variable, product and period, controllable and uncontrollable costs, opportunity costs , sunk cost, joint cost, prime cost, factory cost, cost of production, selling and distribution cost, administrative cost, cost of sales. **[c,d,e,f,i,l]**

Unit 3 **[7 Hrs]**
Cost ascertainment and cost reduction:
Concept of overhead, collection of overheads, allocation and appointment, absorption of overheads, absorption rates, under – over absorption , cost centers, cost units, cost statement sheet.
Areas of cost reduction, techniques, productivity. **[c,d,e,f,i,l]**

Unit 4 **[8 Hrs]**
Costing System:
Job costing, contract costing, cost plus contracts, batch costing, process costing, simple process costing, normal abnormal losses and gains, waste, scrap & spoilage, joint & byproducts, operating costing. **[c,d,e,f,i,l]**

Unit 5 **[8 Hrs]**
Cost Planning and Control:
Concept of budgeting, advantages and limitations, budgetary control, key factors, fixed and flexible budget.
Standard costing, selling of standards, variance analysis. **[c,d,e,f,i,l]**

Unit 6 **[8 Hrs]**
Decision Making:
Marginal costing, break even analysis, cost volume, profit analysis, application of costing to various decisions like make or buy, add or drop products, cost or process further, operate or shut down, replace or retain. **[c,d,e,f,i,l]**

7th Semester

ME1409	PE II : Financial & Cost Management	L=4	T=0	P=0	Credits=4

.**Reference books:**

S.N.	Title of the book	Edition (Year of publication)	Author(s)	Publisher
1	Principles and Practice of Cost Accounting	Fifth edition	N.K.Prasad	Pearson Education
2	Cost Accounting		Jawahar Lal	
3	Management Accountancy	Third edition2010	J. Batty	Tata Mc Graw Hill
4	Financial Management		Khan and Jain	
5	Financial Management	2007	Prasanna Chandra	Tata Mc Graw Hill
6	Engineering Economy	1973	Paul Degarmo	Macmillan, 1973
7	Cost Accounting	2008	B.K.Bhar	Academic publishers
8	Costing and finance managment	2012	Mrunalini Naik	Thakur publications

7th Semester

ME1410	PE II : Renewable Energy System	L=4	T=0	P=0	Credits=4

Objective	Course Outcome
To realize understand the importance of various renewable energy sources in this era of energy crisis. To study the theory of conversation of various renewable energy such thermal, electrical, etc. Apply thermodynamics cycles to above systems. To study Magneto Hydrodynamic systems. [a, c, e, m]	(I)Student will understand the renewable energy technologies, and there primary applications. [a, c, e, m]
	(II)Student will able to describe the challenges and problems associated with the use of various energy sources.. [a, c, e, m]
	(III)Student will be able to apply and use solar energy for specific applications.
	(IV) Better awareness of potential of wind energy, Biogas and micro hydroelectric systems. [a, c, e, m]

Unit 1 **[8 hrs]**
Solar Energy: Introduction, solar constant, spectral distribution of solar radiation, beam & diffuse radiation, measurement of solar radiation and measuring instruments. Solar radiation geometry, solar angles, estimation of average solar radiation, radiation as tilted surface, tilt factors. **[a, c, e, m]**

Unit 2 **[7 hrs]**
Solar flat plate collectors: Types of collectors, liquid flat plate collectors, solar air heaters, transmissivity of glass cove(system, collector efficiency, analysis of flat plate collector, fin efficiency, collector efficiency factor and heat removal factor, selective surfaces, evacuated collectors, novel designs of collector. **[a, c, e, m]**

Unit 3 **[8 hrs]**
Concentrating collectors: line focusing, point focusing and non focusing type, central receiver concept of power generations compound parabolic collector, comparison of flat & concentrating collectors. Applications of solar energy to water heating, space heating, space cooling, drying refrigeration, distillation, pumping. Solar furnaces, solar cookers, solar thermal electric conversion, solar photo- voltaics Solar energy storage, sensible, latent and thermochemical storage, solar pond **[a, c, e, m]**

Unit 4 **[7 hrs]**
Biogas: - Introduction, bio gas generation, fixed dome & floating drum biogas plants their constructional details, raw material for biogas production, factors affecting generation of biogas and methods of maintaining biogas, production, digester design considerations, fuel properties of biogas and utilisation of biogas Bio Mass :- Introduction, methods of obtaining energy from biomass, Incineration, thermal gasification, classification of gasifiers & constructional details chemistry of gasification fuel properties, applications of gasifiers. **[a, c, e, m]**

Unit 5 **[8 hrs]**
Wind and Ocean energy: -Power in wind, forces on blades, wind energy: Basic principle of wind energy conversion site selection consideration wind data and energy estimation, basic components of WECS Classification of WEC systems, savonius and darrieus rotars applications of wind energy.
Ocean energy: Introduction: - ocean thermal electric conversion open and closed cycle of OTEC, hybrid cycle, energy from tides basic principles of tidal power & components of tidal power plants, single & double basin arrangement estimation of tidal power and energy. Energy from ocean waves -energy availability, wave energy conversion devices. **[a, c, e, m]**

UNIT 6 **[7 hrs]**
Geothermal and MHD power generation :
Geothermal energy: Introduction, classification of geothermal systems vapour dominated, liquid dominated system, total flow concept, petrothermal systems, magma resources, applications of geothermal operational & environmental problems. Magneto Hydro Dynamic power generation: Introduction principles of MHD power generation, MHD open and closed systems, power output from MHD generators, design problems of MHD generation, gas conductivity, seeding **[a, c, e, m]**

7th Semester

ME1410	PE II : Renewable Energy System	L=4	T=0	P=0	Credits=4

Text books:				
S.N.	**Title of the book**	**Edition (Year of publication)**	**Author(s)**	**Publisher**
1	Energy Technology	3rd edition	Parulekar & Rao	Khanna Publishers
2	Non Conventional Energy Sources		G D Rai	Standard Publishers Distributors
Reference book				
1	Solar Energy	3rd edition	S.P. Sukhatme	Tata McGraw-Hill Education,
2	Solar Energy	3rd edition, 2006	John A. Duffie, William A. Beckman	Wiley
3	Solar energy engineering	2007	Jui Sheng Hsieh	Prentice-Hall,

7th Semester

ME1411	PE II : Artificial Intelligence	L=4	T=0	P=0	Credits=4

Objective	Course Outcome
•To learn about the automation of machines tools making the system intelligent. •Understanding the different techniques used for implementation of artificial intelligence.[a,b,j]	(I) The student will have ability to analyze the concept of NLP,Expert System and role of Knowledge base in Artificial Intelligence.**a,b,j]**
	(II) The student will have ability to understand the rule based System and rules for conflict resolution. **[a,b,j]**
	(III) The student will have ability to analyze the role of Knowledge Engineer and Domain Expert with the help of routine example.. **[a,b,j]**
	(IV) The student will have ability to analyze the NN/ANN applications in Mechanical Engineering. **[a,b,j]**
	(V) The student will have ability to apply the fundamentals of OOP in Artificial Intelligence. **[a,b,j]**
	(VI) The student will have ability to apply the concepts Semantic nets and Automated Learning.. **[a,b,j]**

Unit 1 **[7 hrs]**
Human and machine intelligence, Artificial Intelligence (AI), Programming in AI environment,. Natural Language processing (NLP) Architecture of an Expert system, Knowledge base, inference engine forward and backward chaining, Selection of inference mechanism. **[a, b, j]**

Unit 2 **[7 hrs]**
Introduction, to Rule Based System, Conflict Resolution, Advantages and Drawbacks of Rule Based Systems Clausal Form Logic; Rule Base Verification, Refinement and Validation **[a, b, c, d, j]**

Unit 3 **[9 hrs]**
Creating Knowledge Base, Knowledge Engineer and Domain Expert, Phases of Knowledge Engineering, Tools for Knowledge Engineering **[a, b, j]**

Unit 4 **[7 hrs]**
Neural network applications, artificial neural network models, NN applications in Cellular manufacturing and other areas of mechanical Engg. **[a, b, j]**

Unit 5 **[7 hrs]**
Fundamentals of OOP (Object oriented programming), creating structures and objects, object operations, invoking procedures, programming applications, Object oriented expert systems. **[a, b, j]**

Unit 6 **[8 hrs]**
Semantic nets, ruled systems for semantic nets, certainty factors, automated learning; **[a, b, j]**

7th Semester

ME1411	PE II : Artificial Intelligence	L=4	T=0	P=0	Credits=4

.**Reference books:**

S.N.	Title of the book	Edition (Year of publication)	Author(s)	Publisher
1	Designing Knowledge Based System	1985	Addis, T.R	Prentice Hall
2	Principles of Artificial Intelligence and Expert Systems Development	1988.	Rolston, D.W	McGraw Hill
3	Handbook of Expert Systems in Manufacturing	1991	Maus, R. and Keyes	McGraw Hill
4	A comprehensive guide to artificial intelligence and expert systems	1990	Robert Levine	McGraw-Hill, 1990
5	Artificial Intelligence	1991	Elain Rich	McGraw-Hill, 1991
6	Rule based expert systems	1990	Sasikumar, Ramani	
7	Design for Knowledge Based Systems	1978	Graham Winstanley	Galgotia Publications
8	Artificial Neural Networks	1992	Zurada	West, 1992
9	Neural Networks and Fuzzy Logic		V.B. Rao and H.V. Rao, "C^{++} :	BPB Publications

7th Semester

ME1412	PE II : Maintenance Management	L=4	T=0	P=0	Credits=4

Objective	Course Outcome
To Study (1)Functions of maintenance dept. (2)Types of maintenance policies (3)Various failures modes and their diagnosis (4)Various conditioned monitoring technique (5)Various types of maintenance costs & their estimation (6)Various techniques for measurement of maintenance work **(7)**Plan for maintenance of machines **[b,d]**	The student will be able to, (I)understand the maintenance function, its importance, types and organize the maintenance department..[d]
	(II)analyze the failure of a machine and plan the condition monitoring program for a machine ..[d]
	(III)Estimate repair and maintenance cost and evaluate maintenance performance..[b]
	(IV) Understand the maintenance needs of basic electrical and mechanical devices.,[d]

Unit I

[8 Hrs]

Objectives, scope, structure of maintenance organization and operating policies to guide management, policies with respect to work allocation, work force, intra and inter plant relation, material, finance and control.
Concept of life cycle maintenance ,optimization of total maintenance, analysis of productivity ,Reliability ,Maintainability, and Availability, **[d,]**

Unit II

[7 Hrs]

Maintenance policies, Preventive maintenance program, corrective maintenance guidelines, replacement policies-cyclic replacement, group replacement, standbys, economics of machine replacement, TPM,RCM and CMMS. **[d]**

Unit III

[7 Hrs]

Failure analysis:
General practice, failure classification , data collection, failure pattern recognition ,determination of replacement period, time between preventive maintenance checks. Use of various modern techniques to monitor the condition of machine to facilitate maintenance **[b, d]**

Unit IV

[8 Hrs]

Work measurement for maintenance:
Need for Work measurement ,various techniques for work measurement of direct and indirect labour. Work force requirement, location and size. **[d]**

Unit V

[8 Hrs]

Control and estimation of maintenance cost:
Job classification, various estimating techniques and its use.
Maintenance manual, plant performance improvement, Maintenance training program, Maintenance control indices and factor affecting them .Lubrication system-need ,design and implementation. **[a, d, m]**

Unit VI

[7 Hrs]

Maintenance of various mechanical and electrical equipments. **[d]**

7th Semester

ME1412	PE II : Maintenance Management	L=4	T=0	P=0	Credits=4

.**Reference books:**

S.N.	Title of the book	Edition (Year of publication)	Author(s)	Publisher
1	Maintenance engineering handbooks	2008	Mobley and Higgins	Mc-graw Hill
2	Guide to Complete Maintenance	1988.	Rolston, D.W	Heintzelment
3	Maintainability and maintenance management	1991	J. Patton	Maus, R. and Keyes
4	Operation research in Maintenance	--	Jarding	--
5	Introduction to reliability and maintainability Engineering.	--	Thomos Ebelling	Mc-graw Hill
6	Advanced operations management		R.P.Mohanty and S.G.Deshmukh	Pearson Education
7	Maintenance engineering and management		R.C.Mishra and K.Pathak	PHI Publications
8	Industrial Maintenance management		S.K.Shrivastava	S.Chand

7th Semester

ME1466	PE-II : Design for Manufacturing and Assembly	L=4	T=0	P=0	Credit=4

Objective	Course Outcome
To learn the Product Life Cycle. Study different design techniques, process selection, material selection.Study different design mechanizms like DFM, DFA,DFX. Study Rapid Prototyping.[d,l]	(I) Student will be able to design a new product.[d,l] (II)Student will be able to select proper materia and Processes.[l] (III)Student will learn criterias for DFM [l] (IV)Student will learn criterias for DFA [l] (V) Student will learn criterias for DFX [l] (V) Student will learn RP [d,l]

Unit 1 **[7 hrs]**
Importance of product design, types of design, product definition, product specification, Phases of product development: conceptual, embodiment and detailed design, product and technology development cycle, concept generation and evaluation methods. **[d,l]**

Unit 2 **[7 hrs]**
Material selection – Importance, classification, material performance characteristic, Selection criteria, Ashby Material selection chart, other constrain effect. Process selection – Impotence types of manufacturing processes and their classification, sources of information, selection criteria, **[d,l]**

Unit 3 **[8 hrs]**
DFM – Concepts, Design for Casting ,Design for Bulk deformation, Design for Sheet metal forming, Design for Machining, Design for Powder metallurgy, Design for Polymer processing **[d,l]**

Unit 4 **[8 hrs]**
DFA – Concepts, Assembly process- Top down and Bottom up, Mating criterias, Design for Welding ,Design for Brazing and Soldering, Design for Adhesive Bonding, Design for Polymer joining, Design for Heat Treatment . **[d,l]**

Unit 5 **[8 hrs]**
DFX - Design for Quality Benchmarking, Robust design, QFD and concurrent engineering. Introduction to green design. **[d,l]**

Unit 6 **[7 hrs]**
Product Development Cycle and Importance of Prototyping, Types of Prototypes, Principle and Advantages & Different Type of Generative Manufacturing Process, Viz, Stereolithography, FDM, SLS etc. Factors Concerning to RP: Consideration for Adoptions, Advantages, Accuracy and Economic Considerations **[d,l]**

Text books:

S.N.	Title of the book	Edition (Year of publication)	Author(s)	Publisher
1	Fourth Eye (Excellence through Creativity	1992.	KHANDWALLA P.N.;	Wheeler Publishing, Allahabad,
2	Product Design and Manufacturing	4th edition, 2007	A. K. Chitale and R. C. Gupta	PHI Pvt. Ltd., 2002 ,
3	Engineering Design	4th edition 2008	Dieter George E	McGraw Hill Pub. Company

7th Semester

ME1466	**PE-II : Design for Manufacturing and Assembly**	**L=4**	**T=0**	**P=0**	**Credit=4**

Reference Books:				
1	Product Design and Development	2003	Ulirich Karl T. and Eppinger Steven D	McGraw Hill Pub. Company
2	Handbook of Product Design for Manufacturing	1986	Bralla, James G.	McGraw Hill Pub. Company
3	I.P.R. Bulletins			TIFAC, New Delhi,
4	Creativity and innovation	2008	Harry Nystrom	John Wiley & Sons, 1979.
5	Managing technological innovation	4th edition	Brain Twiss	Pitman Publishing Ltd
6	New Product Planning		Harry B.Watton	Prentice Hall Inc.
7	Techniques in Reverse engineering and new product development.		Kevin Otto and Kristin wood.	Pearson Education

7th Semester

ME1467	**PE-II : QUANTITATIVE TECHNIQUES**	L=4	T=0	P=0	Credits=4

COURSE OBJECTIVES:-	**COURSE OUTCOME:-** Students will be able to apply
• To understand concept of different quantitative techniques that include linear programming, non linear programming ,dynamic programming and the students should be able to use different decision making theories**.**	• **CO-I:-** Use basic operation research techniques to formulate given situation as linear programming problem and solve by revised and two phase simplex method. **[a,k,m]** • **CO-II:- I**nteger programming problems and solve them with cutting plane methods, or branch and bound method. **[a,k,m]** • **CO-III:-** Dynamic programming by Bellman's principle of optimality for problem solving. **[a,k,m]** • **CO-IV:-** Quadratic programming for K.T. condition and Wolfe's modified simplex method. **[a,k,m]** • **CO-V:-** Game theory to analyze real world systems. . **[a,k,m]** • **CO-VI:-** Non-linear programming for different optimization techniques that are appropriate for solving realistic engineering problems.. **[a,k,m]**

Unit 1: Linear Programming [7 Hrs]
- Liner programming: formulation of problems, solution of LPP by revised simplex methods. Two phase simplex method, sensitivity analysis. **[a,k,m] (CO-I)**

Unit 2: Advanced Linear Programming [7 Hrs]
- Pure & mixed integer programming, Zero-one and Goal programming and its application. **[a,k,m] (CO-II)**

Unit 3: Dynamic Programming [7 Hrs]
- Dynamic programming: Decision tree. Bellman"s principle of optimality. Application in industry. **[a,k,m] (CO-III)**

Unit 4: Quadratic Programming [7 Hrs]
- Kuhn-tucker conditions, Wolfe's modified simplex method, Beale's method. **[a,k,m] (CO-IV)**

Unit 5: Game Theory [7 Hrs]
- Decision making, decision theory, game theory. **[a,k,m] (CO-V)**

Unit 6: Non Linear Programming [7 Hrs]
- Non-liner programming: Fibonacci and golden section search: Powells pattern search algorithm, complimentary Pivot algorithm, optimizations by geometric programming. **[a,k,m] (CO-VI)**

Text Books :-
1. Gupta ,Swaroop," Operation Research"
2. Hira , Gupta," Operation Research Techniques"

Reference Books:
1. Ravindran, Phillips Solberg , "OR Principles & Practice "
2. Hiller Libermen, "OR (Operation Research)"
3. Taha ,"OR (Operation Research) "
4. S.S. Rao , " Optimization Techniques".
5.Linear and non linear optimization, Griva, Nash, Sofer.

7th Semester

ME1468	PE-II : Database Management System	L=4	T=0	P=0	Credits=4

Objective	Course Outcome
This Engineering course focuses on detail study of various data structures, the concept of Algorithm and programming for data structures used in computer environment. Also provides the learning of sorting and searching processes, non linear data structure.	

Unit 1	Introduction to Databases and Transactions: database management system, purpose of database system, view of data, relational databases, database architecture, transaction management,	**[7hrs]**
UNIT 2	Data Models: The importance of data models, Basic building blocks, Business rules, The evolution of data models, Degrees of data abstraction.	**[8 hrs]**
UNIT 3	Database Design ,ER Diagram and Unified Modeling Language:- Database design and ER Model: overview, ER -Model, Constraints, ER-Diagrams, ERD Issues, weak entity sets, Codd's rules, Relational Schemas, Introduction to UML Relational database model: Logical view of data, keys, integrity rules. Relational Database design: features of good relational database design, atomic domain and Normalization (1NF, 2NF, 3NF, BCN, DKNF)	**[8 hrs]**
UNIT 4	Relational Algebra and Calculus: Relational algebra: introduction, Selection and projection, set operations, renaming, Joins, Division, syntax, semantics. Operators, grouping and ungrouping, Relational comparison. Calculus: Tuple relational calculus, Domain relational Calculus, calculus vs algebra, computational capabilities.	**[7 hrs]**
UNIT 5	Constraints, Views and SQL:- What is constraints, types of constrains, Integrity constraints, Views: Introduction to views, data independence, security, updates on views, comparison between tables and views SQL: data definition, aggregate function, Null Values, nested sub queries, Joined relations. Trigger	**[7 hrs]**
UNIT 6	Transaction management and Concurrency control, Lock based concurrency control (2PL, Deadlocks),Time stamping methods, optimistic methods, database recovery management.	**[7 hrs]**

Books for Reference:

1. Silberschatz and Galvin., —Database System Concepts
2. Henry F. Korth and Abraham Silberschatz, — Database System Concepts, McGraw-Hill International Editions Series
3. Ivan Bayross, SQL, PL/SQL the Programming Language of Oracle, Paperback – 1 Dec 2010
4. P.S. Deshpande, SQL & PL / SQL for Oracle

7th Semester

ME1406	PE III : FINITE ELEMENT METHOD	L=4	T=0	P=0	Credits=4

Objective	Course Outcome
To develop ability to analyze simple mechanical engineering problems. To understand and apply basic governing principals in logical manner to find solutions. [e]	(I)The students will be able to understand fundamentals of finite element method.[e]
	(II)The students will be able to analyse the Mechanical engineering problems[e]
	(III)The students will be able to find solutions for simple mechanical Engineering problems.. [e]

Unit 1 **[7 hrs]**
Fundamentals of stress & strain, stress & strain components, stress strain relationship, Elastic constants, plane stress, plane strain., differential equation of equilibrium, compatibility equations, boundary conditions, Saint Venant's principle. **[e]**

Unit 2 **[7 hrs]**
Fundamental concepts of FEM -' Historical background, Scope of FEM in Engg. Applications, Principle of minimum potential energy. Concept of Virtual work. Raleigh-Ritz method. FEM analysis procedure. Mathematical understanding required for FEM, Matrix algebra & operations, Eigen values & Eigen vectors. Methods for solution of simultaneous equations. like Gauss elimination. Matrix decomposition method.
Concept of discritization of body into elements. degrees of freedom, bandwidth, Basic types of 2-D & 3-D elements, displacement models, convergence requirements, shape function. Programming for above matrices.**[e]**

Unit 3 **[8 hrs]**
Finite element modeling and analysis of one dimensional problems:
Finite element modeling & analysis using Bar & Beam element -stiffness matrix, assembly, boundary conditions, load vector, temperature effects.
Two dimensional plane trusses-Local & Global coordinate system, element stiffness matrix, assembly, boundary conditions, load vector, force & stress calculations. Programming for simple bar and beam elements.**[e]**

Unit 4 **[8 hrs]**
Two dimensional problems using CST & LST -formulation of CST & LST elements, elemental stiffness matrix, assembly, boundary conditions, load vector. stress calculation. Temperature effect .
Axi-symmetric solids subjected to axi-symmetric loading -axi-symmetric formulation using CST ring, element, stiffness matrix, boundary conditions, load vector, calculation of stresses. Programming for simple 2-D problems using CST and LST elements. **[e]**

Unit 5 **[7 hrs]**
Introduction to Isoperimetric & Higher order elements. Introduction to Numerical Integration.
Introduction to dynamic analysis, formulation of mass matrix for one-dimensional bar element, free vibration analysis using one-dimensional bar element.
Torsion of prismatic bars using triangular elements. Programming for these elements. **[e]**

Unit 6 **[8 hrs]**
Application of commercial software for simple machine elements and interpretation of results. **[e]**

7th Semester

ME1406	PE III : FINITE ELEMENT METHOD	L=4	T=0	P=0	Credits=4

Text books:

S.N.	Title of the book	Edition (Year of publication)	Author(s)	Publisher
1	Introduction to Finite Elements in Engineering	4th edition 2011	Chandrupatla T.R; Belegundu AD	Pearson Education
2	Theory of Elasticity	2nd edition 1951	Timoshenko S.P	Tata McGraw-Hill Education
3	Concept and applications of Finite element Analysis	2nd edition revised, 2010	Cook RD	I. K. International Pvt Ltd
4	The Finite Element Method -A basic introduction for engineers	2nd edition	Griffiths D. W; Nethercot D.A	BSP Professional, 1983
5	Finite element methods	6th edition, 2005	O. C. Zienkiewicz, Richard Lawrence Taylor, Perumal Nithiarasu, J. Z. Zhu	Butterworth-Heinemann
6	Applied elasicity	--	Chi The Wang	Amazon
7	Finite to Infinite	--	--	Infinite seris

7th Semester

ME1407	**PE III : Lab. : FINITE ELEMENT METHOD**	**L=0**	**T=0**	**P=2**	**Credits=1**

7th Semester

ME1417	PE III : Computer Integrated Manufacturing	L=4	T=0	P=0	Credits=4

Objective	Course Outcome
To develop in the engineering students the ability to analyze any engineering problem in a simple and logical manner and to apply to its solution a few, well understood basic principles.**[a,b,d,h,k,lm]**	(I) The student will have ability to understand integration of business function with manufacturing planning and control..[a,b,d]
	(II) The student will have ability to apply fundamentals of robotics for industrial applications..[d,h,l]
	(III) The student will have ability to develop CNC programs for manufacturing applications.[a,b,k]
	(IV) The student will have ability to understand the process of Group technology for Flexible manufacturing system..[a,b,d,k,l]

Unit 1 **[7 hrs]**
Concept and scope of CIM, components of CIM, benefits, limitations.Basics of computer graphics NC basics, NC words, Manual part programming (NC part programming) Punch Tape, Tape Format CNC , DNC, APT programming Adaptive control, application. Tooling for CNC machine. **[a, b, d, h, k ,l]**

Unit 2 **[7 hrs]**
Introduction to Group Technology, Limitations of traditional manufacturing systems, characteristics and design of groups, benefits of GT and issues in GT. Part families , classification and coding , Production flow analysis , Machine cell design , Benefits **[a, b, d, h, k]**

Unit 3 **[8 hrs]**
Introduction & Components of FMS , Application work stations , Computer control and functions , Planning, scheduling and control of FMS , Scheduling , Knowledge based scheduling , Hierarchy of computer control , Supervisory computer Manufacturing data systems , data flow , CAD/CAM considerations , Planning FMS database **[a, b, d, h, k ,l]**

Unit 4 **[8 hrs]**
Industrial robotics Robot anatomy, Robot control, accuracy, repeatability, End Effectors Sensor, Introduction to robot programming, Robot application (Material handling processing assembly and inspection) introduction to robot Kinematics. **[a, b, d, h, k]**

Unit 5 **[10 hrs]**
Process Planning in the Manufacturing cycle , Process Planning and Production Planning Process Planning and Concurrent Engineering, CAPP, Variant process planning , Generative approach , Forward and Backward planning, Input format, Logical Design of a Process Planning , Implementation considerations ,manufacturing system components, Automated material handling systems, AS/RS, general considerations , selection, evaluation and control . Inspection and Quality control, CAQC, CMM types, working, applications Expert process planning **[a, b, d, h, k ,l]**

Unit 6 **[5 hrs]**
Totally integrated process planning systems, Integration of CNC robotics for CIM, Agile manufacturing, Nano Manufacturing. Simulation **[a, d, h, k ,l]**

7th Semester

ME1417	PE III : Computer Integrated Manufacturing	L=4	T=0	P=0	Credits=4

.Reference books:

S.N.	Title of the book	Edition (Year of publication)	Author(s)	Publisher
1	Systems Approach to Computer Integrated Design and Manufacturing	1996	Nanua Singh	John Wiley & Sons, 1996.
2	Automation, Production Systems and Computer Integrated Manufacturing	2002	Groover M.P	Prentice-Hall of India Pvt. Ltd., New Delhi, 2002
3	Handbook of Flexible Manufacturing Systems	1991	Jha, N.K	Academic Press Inc., 1991
4	Group Technology in Engineering Industry	1979	Burbidge, J.L	Mechanical Engineering pub. London, 1979.
5	G.T Planning and Operation, in The automated factory-HandBook: Technology and Management	1991	Askin, R.G. and Vakharia, A.J	Cleland, D.I. and Bidananda, B (Eds), TAB Books, NY, 1991.
6	Cellular Manufacturing Systems		Irani, S.A	Hand Book
7	Planning, design and analysis of cellular manufacturing systems	1995	Kamrani, A.K, Parsaei, H.R and Liles, D.H. (Eds)	Elsevier

7th Semester

ME1418	PE III : Lab. : Computer Integrated Manufacturing	L=0	T=0	P=2	Credits=1

Objective	Course Outcome
To develop in the engineering students the ability to analyze any engineering problem in a simple and logical manner and to apply to its solution a few, well understood basic principles.**[a,b,c,d,e,h,k,m]**	(I) The student will be able to develop CNC program ad carry out execution..[a,b,d,k,m]
	(II) The student will be able to apply fundamentals of Robotics for industrial applications..[a,b,k]
	(III)The Students will be able to use Group technology and various components of automated system to form flexible manufacturing system..[a,b,c,d,e,h,k,m]

List of Practical

1. Study of CIM. **[a, c, e, k]**
2. Study of CAD systems **[a, b, k ,m]**
3. Numerical control – Fundamental & Application **[a, b, e, k]**
4. CNC- Lathe – Features, Specification, & Part Program. **[a, b, ,m]**
5. CNC- Milling – Features, Specification, & Part Program. **[a, b, ,m]**
6. Group Technology. **[a, b, e ,m]**
7. FMS & CIM. **[a, b, e ,m]**
8. Computer Aided Process Planning. **[a, b, d, e ,m]**
9. Manual Part Programming. **[a, b, ,m]**
10. APT Part Programming. **[a, b, e ,m]**
11. Robots Fundamental and Applications **[a, b, ,m]**
12. AGVS- Fundamental and applications **[a, b, e ,m]**
13. CNC Lathe – Programming, Simulation & Actual Machining of Part.(Thread Cutting , Facing , Turning , Grooving etc.) **[a, b, ,m]**
14. CNC Milling – Programming , Simulation & Actual Machining of Part. (Profile Cutting , Various Interpolation , Pocketing , Mirroring etc.) **[a, b, e ,m]**
15. Programming , Simulation of Robot. **[a, b, e ,m]**

7th Semester

ME1419	PE III : I.C.Engines	L=4	T=0	P=0	Credits=4

Objective	Course Outcome
•To understand basic working cycles, construction and development of I.C. Engines. •To study the various systems related to I.C. Engines. •To study fuels, combustion process, pollution and its control of engines. •To carry out analysis of engine performance through mathematical approch **[a, b, h, m]**	(I) Students will be able to understand basics of I.C. Engines & its systems..**[b,h,m]** (II)Students will be able to understand combustion in I.C. Engines & its evaluation to improve the performance and reduce the pollution...**[b,h,m]** (III)Students will be able to formulate heat balance, power calculation and analyse performance characteristics of I.C. Engines..**[a,b,h,m]**

UNIT 1

[7 HRS]

Historical Perspective, Engines classification, Working cycles and operation, P-V, Valve Timing diagrams,
Engine components and their material .Engine cycle Energy Balance, various losses in the engine like Frictional losses, blow by losses, pumping loss etc. Engine system: Air supply, Fuel supply, lubrication systems, cooling systems and their importance. **[a,b,h,m]**

UNIT 2

[8 HRS]

I.C.Engines fuel and its desirable properties. Requirements of S.I and C.I. Engine fuel
Rating of I.C. engine fuels, Other fuel like CNG, LPG, Alcohols,
Air pollution from I.C.Engines and their control using EGR, Catalytic converters, particulate traps. **[a,b,h,m]**

Unit 3

[8 HRS]

Fuel supply systems for S. I. Engine: A-F mixture requirements, Basic principle, Simple Carburetor and systems like main metering, choke, idle, acceleration pump. Operating difficulties for carburetors. Petrol Injection SPFI., MPFI, Direct Gasoline Injection, Ignition system & components for S.I.Engine - Battery, Magneto & Electronic. **[a,b,h,m]**

Unit 4

[7 hrs]

Combustion in S. I. Engine: Stages of combustion with p-θ diagram. Factors affecting various stages of combustion. Abnormal combustion Pre ignition, Detonation and Knocking. HUCR, S.I.Engine combustion chamber. **[a,b,h,m]**

Unit 5

[7 HRS]

Fuel supply systems for C.I.Engine: Requirements of an ideal FI system, Types of Injection, Fuel injection pumps, fuel injectors and nozzles.
Combustion in C. I. Engines. Stages of combustion with p-θ diagram, Factors affecting various stages of combustion. Abnormal combustion Diesel Knock,
Supercharging and turbo charging in engine. **[a,b,h,m]**

Unit 6

[8hrs]

Engine performance Parameters. MEP, Torque ,speed, power, Specific fuel consumption and various efficiencies., Air measurement, Excess air and Volumetric efficiency, Measurement and Testing of friction power ,indicated power, Brake power, Fuel consumption, Air consumption, etc. Heat balance sheet calculation**[a,b,h,m]**

7th Semester

ME1419	PE III : I.C.Engines	L=4	T=0	P=0	Credits=4

.Reference books:

S.N.	Title of the book	Edition (Year of publication)	Author(s)	Publisher
1	Internal Combustion Engine Fundamentals	1988	John B. Heywood	McGraw-Hill
2	Internal Combustion Engines and Air pollution	1973	Edward F. Obert	
3	Internal Combustion Engines	2007	M. C. Mathur, R.D. Sharma.	McGraw-Hill
4	Internal Combustion Engines	2007	V. Ganesan	McGraw-Hill
5	Internal Combustion Engines	2010	V. M. Domkundwar	Dhanpat Rai & Co
6	Internal Combustion Engines	2012	R.K.Rajput	Laxmi publications (P) Ltd.

7th Semester

ME1420	PE III : Lab. : I.C. Engines	L=0	T=0	P=2	Credits=1

Objective	Course Outcome
•To study the basic cycles & various systems related to I.C. Engines through models,charts & animations. •To conduct an Engine trial for Engine performance evaluation. **[a, b, h, m]**	**(1)**(I)Students will be able to understand basic of I.C. Engines & its systems.**[d,i,m]** (II)Students will be able to formulate heat balance, power calculation and analyse performance characteristics of I.C. Engines..**[a,b,h,m]**

List of Practical

1. Demonstration to understand working of 2-S & 4-S Engines with its components. **[d,i,m]**
2. Demonstration the working of Lubrication & Cooling systems. **[d,i,m]**
3. Demonstration of fuel systems for S.I. engines (Carburattor/MPFI) **[d,i,m]**
4. Demonstration of fuel systems for C.I. engines. **[d,i,m]**
5. Determination of Air: Fuel ratio for Petrol Engine. **[a, b, h, m]**
6. Determination of Air: Fuel ratio for Diesel Engine**[a, b, h,m]**
7. Determination of BP/FP/IP of Engine. **[a, b, m]**
8. Heat balance sheet calculation. **[a, b, h, m]**
9. Visit to Automobile Industry/ workshop. **[a, b, h, m]**

7th Semester

ME1421	PE III : Refrigeration and Air Conditioning	L=4	T=0	P=0	Credits=4

Objective	Course Outcome
To familiarize with terminologies associated with refrigeration and Air conditioning. To understand principle of Refrigeration and Air conditioning systems.. TO understand basic and applied psychrometry. To understand air conditioning load calculations and duct design. To understand energy conservations and management [a,e,k,m]	(I)The students will be able to apply psychometric processes to live problems. [a,e,k,m]
	(II)The student will be able to analyze various types of refrigeration systems and apply as per requirement. [a,e,k,m]
	(III)The students will have fundamental knowledge of cryogenic systems suitable for advanced studies.. [a,e,k,m]

UNIT-I: PSYCHROMETRY [7 Hrs.]
Introduction, psychometric properties of air, psychometric chart, psychometric processes, bypass factor, apparatus dew point temperature. [a,e,k,m]

UNIT-II: ADVANCED PSYCHROMETRY: [8 Hrs.]
HUMAN COMFORT
Mechanism of body heat losses, factors affecting human comfort, effective temperature, comfort chart.
HEAT LOAD CALCULATIONS:
Data collection for load calculation, various components of heat load estimate, method of cooling load calculation. Application of psychrometry to various air-conditioning systems. RSHF, GSHF, ESHF, air washers, air coolers. [a,e,k,m]

UNIT-III [7 Hrs.]
AIR TRANSMISSION & DISTRIBUTION:
Principle of air distribution, types of grills & diffusers & their selection criteria, air alteration, types of air filters, distribution of air through ducts, pressure losses in ducts, methods of duct design, duct friction chart, air conditioning controls.
REFRIGERATION SYSTEMS:
Air cycle refrigeration, Applications in air refrigeration systems, Vortex tube, and thermoelectric refrigeration. [a,e,k,m]

UNIT-IV [8 Hrs]
REFRIGERATION:
Introduction, Definition, Applications.
STUDY OF SIMPLE VAPOUR COMPRESSION REFERIGERATION SYSTEM:
Analysis of simple vapour compression refrigeration system, effect of subcooling, superheating, polytropic compression & pressure drops on the performance of the system.
Refrigerants**:**
Nomenclature of refrigerants, refrigerant properties, mixture refrigerants, global warming potential & Ozone depletion potential, Montreal & Kyoto protocol, alternate refrigerants. [a,e,k,m]

UNIT-V [8 Hrs]
MULTISTAGE VAPOUR COMPRESSION REFRIGERATION SYSTEMS:
Multiple compressor & multiple evaporator systems, cascade refrigeration systems.
Study of equipments such as compressors, evaporators, expansion devices & controls defrosting methods (types & principle only). Testing & charging of refrigeration systems. [a,e,k,m]

UNIT-VI [7 Hrs]
STUDY OF VAPOUR ABSORPTION REFRIGERATION SYSTEM:
Introduction Ammonla-Water, Lithium bromide-water systems, three fluid refrigerators.
CRYOGENICS:
Introduction, Application of cryogenics, Joule- Thomson coefficient, inversion curve, methods of liquefaction of air. [a,e,k,m]

7th Semester

ME1421	PE III : Refrigeration and Air Conditioning	L=4	T=0	P=0	Credits=4

Text books:				
S.N.	**Title of the book**	**Edition (Year of publication)**	**Author(s)**	**Publisher**
1	Refrigeration & Air-conditioning	2000	Dr.C.P. Arora	Tata McGraw-Hill Education
2	Refrigeration & Air-conditioning	2005	Dr. P.L. Ballany	Khanna Publications
3	Refrigeration & Air-conditioning	2007	Dr. Manohar	New Age International
4	Refrigeration & Air-conditioning	2007	S.V. Domkundwar	Dhanpat Rai Company (P) Ltd
REFERENCE BOOKS:				
1	Refrigeration & Air-conditioning	1986	Stocker & Jones	McGraw-Hill
2	Principle of Refrigeration & Air-conditioning	1997	Roy J.Dossat	Prentice Hall
3	ASHRAE hand books	2003		ASHRAE
4	Air conditioning Principles & System. Energy approach	1989	E.G. Pita	Wiley
6	Basic Refrigeration& Air-conditioning	2005	P.N. Ananthnarayanan	Tata McGraw-Hill Education

7th Semester

ME1422	**PE III :** Lab. : Refrigeration & Air conditioning	**L=0**	**T=0**	**P=2**	**Credits=1**

Objective	**Outcome**
Students should able to carry out performance analysis of vapour compression refrigeration systems, air conditioning systems and cryogenics systems. **[a,b,k,m]**	**(1)** The student will be able to carry out performance analysis of vapour compression refrigeration systems.[a,b,k,m]
	(**2)** The student will be able to study various components of vapour compression refrigeration systems.[[a,b,k,m]
	(**2)** The student will be able to study miscellaneous refrigeration devices of vapour compression refrigeration systems.[[a,b,k,m]
	The student will be able to carry out performance analysis of air conditioning systems. [a,b,k,m]
	(**2)** The student will be able to study cryogenics systems.[[a,b,k,m]

PRACTICALS:
[Minimum seven experiments to be performed / demonstrated / studied]

1) Demonstration of use of various tools and equipments used by a refrigeration mechanic. [a,b,k,m]
2) Demonstration and study of various types of compressors. [a,b,k,m]
3) Demonstration and study of various condensers, evaporators, expansion devices used in refrigeration systems. [a,b,k,m]
4) Demonstration and study of various controls used in refrigeration and air-conditioning. [a,b,k,m]
5) Study of demonstration of miscellaneous refrigeration devices such as vortex tube. Thermoelectric Cooler, Cascade Refrigeration Unit etc. [a,b,k,m]
6) Study & demonstration of window air conditioner / packaged A/c / automotive/ A/c system. [a,b,k,m]
7) To perform experiments on vapour compression test rig to determine COP of the system. [a,b,k,m]
8) To perform experiments on Air-conditioning test rig. [a,b,k,m]
9) To perform experiments on air washer to evaluate its performance. [a,b,k,m]
10) Demonstration of charging a vapour compression refrigeration system. [a,b,k,m]
11) Report on visit to air-conditioning or cold storage plant or ice liquefaction plant. [a,b,k,m]
12) Visit to central A/c plant [a,b,k,m]
13) Exercises on computer assisted cooling load calculation. [a,b,k,m]
14) Exercises on computer assisted duct design. [a,b,k,m]
15) Study of Cryogenics System [a,b,k,m]

7th Semester

ME1445	PE III : Mechatronics	L=4	T=0	P=0	Credits=4

Objective	Course Outcome
(1)Understand the concept of Mechatronics (2)Develop the ability to understand the working of various electronically and computer control devices. (3)Concept development to bridge the existing gap between machines, Automation and Computer control system.**[a,b,c,i,j]**	(I) Students will be able to model various mechatronic systems..[a,b,c]
	(II) Students will be able to understand the working of various motors used in mechatronic systems..[a,b]
	Analyze the characteristics and use of various IC's.[a.b,i]
	(III) Student will be able to analyze the characteristics and use various IC's.a,b,j]
	(IV) Students will be able to analyze the internal hardware structure in Mechatronics Systems.[a,b,c,j]
	(V) Students will be able to understand the working of various integrated Systems..[a,b,i,j]
	(VI) Students will be able to apply concepts of Fuzzy Logic Control. .[a,b,i,j]

Unit 1 **[7 hrs]**
Introduction, sensors, actuators, modeling of systems. Recent trend of designing machine units along with electronic circuits for operation and supervision of mechanisms. Techniques of interfacing mechanical devices with computer hardware. **[a, b, i]**

Unit 2 **[8 hrs]**
Basic principles ,working and specific applications of armature and field controlled D.C. Motors, Variable voltage and variable frequency control of 3 phase and single phase Induction motors, speed control of synchronous motors, Different types of stepper motors-Constriction ,working and application. Position control of stepper motors.
[a, b, i]

Unit 3 **[8 hrs]**
Common and commercial I.Cs used for amplification, timing and digital indication.
Different types of actuators, working of synchro-transmitter and receiver set, Pressure to current (P/I) and I/P conversion. Electrical and hydraulic servomotors.
Design of solenoid plungers and pressure and force amplification devices. **[a, b, i, j]**

Unit 4 **[7 hrs]**
Add-on cards for sampling and actuation, 4-20 mA ports, AD-DA conversion, Peripheral interface organization, general layout of data bus and data transfer through serial and parallel modes of communication, schemes of computer networking and hierarchy in supervisory control. **[a, b, i, j]**

Unit 5 **[8 hrs]**
Study of various integrated systems by using block diagrams. Study of systems used in Ink Jet Printers, Photo copying, Washing Machines, IC Engine fuel injection system etc **[a, b, c, i]**

Unit 6 **[7 hrs]**
General philosophy of Artificial Neural Network simulations, Fuzzy logic for operation and control of mechatronic systems. **[a, b, d, e, i]**

7th Semester

ME1445	PE III : Mechatronics	L=4	T=0	P=0	Credits=4

Text books:

S.N.	Title of the book	Edition (Year of publication)	Author(s)	Publisher
1	Introduction to Mechatronics and Measurement Systems	2007	Michael B.Histand and David G. Alciatore	Tata McGraw-Hill Education
2	Mechatronics	2007	Bradley, D.A., Dawson, D, Buru, N.C. and Loader, AJ.,	Chapman and Hall, 1991
3	Microprocessor Architecture, Programming and Applications	2002	Ramesh.S, Gaonkar	Prentice Hall
4	Understanding Electro-Mechanical Engineering, An Introduction to Mechatronics	1996	Lawrence J.Kamm	John Wiley and Sons
5	Introduction to Microprocessors for Engineers and Scientists	2004,	Ghosh, P.K. and Sridhar	PHI Learning Pvt. Ltd.

7th Semester

ME1446	PE III : Lab. : Mechatronics	L=0	T=0	P=2	Credits=1

Objective	Course Outcome
(1)Understand the concept of Mechatronics (2)Develop the ability to understand the working of various electronically and computer control devices. (3)Concept development to bridge the existing gap between machines, Automation and Computer control system.[a,b,c,i,j]	(I)The student will be able to use various motors, Switches, Timers & Flip-flops and various IC's..[a,b,i] (II)The student will be able to carry out interfacing of various mechanical and electronic equipments..[a,b,c,j]

List of Practical (Minimum 10 Experiments)

1. Verification of P, P+I, P+D, P+I+D control actions.[a,b,c,I,j]
2. Demonstration on XY position control systems. .[a,b,c,I,j]
3. Demonstration on linear conveyor control system. .[a,b,c,I,j]
4. Demonstration on rotary table positioning systems. .[a,b,c,I,j]
5. Demonstration on different switches and relays. .[a,b,c,I,j]
6. Analysis of control system using software like MATLAB/SIMULINK or equivalent. .[a,b,c,I,j]
7. Development of ladder diagram/programming PLC for level control, position control or any other mechanical engineering application. .[a,b,c,I,j]
8. Demonstration on A/D and D/A converters. .[a,b,c,I,j]
9. Demonstration on Flip Flops and Timers. .[a,b,c,I,j]
10. Demonstration on Application of Op – Amp circuits. .[a,b,c,I,j]
11. Demonstration on Data acquisition system. .[a,b,c,I,j]
12. Demonstration on Microcontrollers. .[a,b,c,I,j]

7th Semester

ME1469	PE-III : Refrigeration & Cryogenic	L=4	T=0	P=0	Credit=4

Objectives	Outcome
I)To explain and analyse VCRS system II) To study about vapour absorption and other refrigeration system III) To explain about cryogenic technology	COI- student will be able to understand and analyse vapour compression refrigeration system [a,e,k]
	COII- student will be able to explain construction ,working of different components and use of different refrigerant in VCRS [a,c,h]
	COIII- student will be able to explain different vapour absorption and other refrigeration system [a,h]
	COIV- student will be able to analyse multistage VCRS system [a,e,k]
	COV- student will be able to explain and analyse air refrigeration system.[a,e,k]
	COVI- student will be able to explain and analyse different methods of production of ultra low temperature. [a,d.k]

UNIT I Vapor Compression Refrigeration system
Introduction to refrigeration, applications of refrigeration, development of simple saturated Vapour compression refrigeration cycle, effect of change in evaporator and condenser pressure, effect of pressure drops, polytropic compression, sub cooling, superheating. **[a,e,k]**

UNIT II Components of Vapor compression system
Various components used in refrigeration system like compressors, condensers, evaporators, expansion devices, cooling towers, control use in refrigeration system
Refrigerants
Types and classification, properties and nomenclature, environment friendly refrigerants. **[a,c,h]**

UNIT III Other refrigeration systems
Vapor absorption systems (NH3- H20, LiBr- H2O) , Electrolux refrigeration system, steam jet refrigeration systems, thermoelectric refrigeration, vortex tube refrigeration. **[a,h]**

UNIT IV Multistage Refrigeration systems
Working and analysis of multistage systems multiple evaporator and multiple compressor systems. **[a,e,k]**

UNIT V Air refrigeration systems
Gas cycle refrigeration, reversed Brayton /Joules/Bell Coleman cycle, aircraft refrigeration, simple cycle, boot strap cycle, reduced ambient air cycle, regenerative cycle. **[a,e,k]**

UNIT VII Cryogenics
Introduction and applications of cryogenics, cascade refrigeration, Joules Thomson effect, methods of air liquification, Linde's and Claude's cycle . cryogenic insulation. **[a,d,k]**

Recommended Books:
1. Dossat Roy J.; Principles of Refrigeration, 4th Ed.; Pearson Education Asia Publication
2. Arora C.P.; Refrigeration and Air conditioning, 2nd Ed.; Tata Mc Graw Hill Publication
3. Ballaney P.L.; Refrigeration and Air conditioning; Khanna publishers
4. Prasad Manohar; Refrigeration and Air conditioning, 2nd Ed.; New edge Publication
5. Arora, Domkundwar; A course in Ref. &Air Conditioning, 7th Ed.; Dhanpat Rai Publications.
6. Pita Edward G.; Air conditioning principles and systems, 4th Ed.; Prentice Hall
7. ASHRAE handbook and CARRIER hand book.

7th Semester

ME1470	Lab: PE-III : Refrigeration & Cryogenic	L=0	T=0	P=2	Credit=1

Objectives	Course Outcome
I) To carry out performance analysis and study of components, used in VCRS II) To explain about vapour absorption refrigeration system III) To visit different refrigeration plant.	CO I- The student will be able to carry out the trial on Refrigeration trainer and evaluate their performance.[a,b,k,m]
	CO II- The student will be able to study of expansion devices used in VCRS [a,c,k]
	CO III- The student will be able to study of condenser ,evaporators and cooling tower used in VCRS [a,c,k]
	CO IV- The student will be able to study of vapour absorption refrigeration system [a,c,k]
	CO V - The student will be able to study of controls used in VCRS system [a,c,k]
	CO VI- student should visit and understand the refrigeration system used for cold storage, ice plant and production of ultra low temperature.

List of experiment

1. Experiment on Determination of COP of Refrigeration trainer [a,b,k,m]
2. Trial on ice-plant test rig [a,b,k,m]
3. Study of expansion devices used in vapour compression refrigeration system [a,c,k]
4. Study of condensers and cooling towers used in vapour compression refrigeration system [a,c,k]
5. Study of evaporators used in vapour compression refrigeration system [a.c.k]
6. Study of vapour absorption refrigeration system [a,c,k]
7. Study of electrolux refrigeration system [a,c,k]
8. Study of controls used in refrigeration system [a,c,k]
9. Visit to air liquefaction plant [a,d,k]
10. Visit to cold storage [a,c,k]
11. Visit to Industrial cooling tower [a,c,k]
12. Visit to ice plant [a,c,k]

7th Semester

ME1476	PE-III : Machine Tool Design	L=4	T=0	P=0	Credit=4

Objective	Course Outcome
To develop in the engineering students the ability to analyze any engineering problem in a simple and logical manner and to apply to its solution a few, well understood basic principles. This subject consists of application of scientific principles, technical information & creative thinking for the development of a new or improved machine tools, to perform desired machining operation with maximum efficiency. **[a,e,k,l]**	(I)The student will be able to design Gear boxes (II)The student will be able to design machine tool structure (III) The student will be able to design guide ways and power screws (IV) The student will be able to design spindles (V) The student will be able to test machine tools (VI) The student will be able to understand control system of machine tools

UNIT 1 **[7Hrs]**

Introduction to Machine tool drives & Mechanisms, Working & auxiliary motions in machine tools, Parameters defining the working motions of a machine tool; Machine tool drives, Hydraulic Transmission & its elements, Mecll.'U1ical Transmission & its elements, General requirements of machine tool design, layout of machine tool.**[a, e,k,l]**

UNIT 2 **[8 Hrs]**

Regulation of speed & feed rates - Aim of speed & feed regulation, Stepped regulation of speed -Various laws of stepped regulation, Selection of range ratio, Standard values of Geometric progression Ratio & guidelines for selecting proper value, break up of speed steps; Structure diagrams & their analysis, Speed classification. Design of feed box, machine tool drives using multiple speed motors, Special cases of gear box design -speed box with overlapping speed steps, speed box with a combined structure, speed box Wit11 broken geometric progression, General recommendation for developing the Gearing diagram, determining the Number of teethes of gears, Classification of speed & feed boxes. Electromechanical system of Regulation, Friction, Pressure and Ball Variation, Epicyclic Drive . **[a, e,k,l]**

UNIT 3 [7Hrs]

Machine Tool Structure - Functions of machine tool structures & their requirements, Design criteria for machine tool structU1.es, Materials of machine tool structures, Static &Dynamic stiffness, Profiles of machine tool structures, Factors affecting stiffness of machine tool structures & methods of improving it; Basic design procedure of machine tool structures -design for strength, design for stiffness. Design of Beds, Column, housings, Bases & Tables, Cross Rails, Arms, Saddles, Carriages, Rams. **[a, e,k,l]**

UNIT 4 [8Hrs]

Design of Guide ways & Power Screws - Functions & types of guide ways, Design of Sideways - Shapes, materials, methods of adjusting clearances. Design Criteria & Calculations for sideways, Design for wear resistance, Design for stiffness. Guide ways operating under liquid friction conditions -Hydrodynamic & Hydrostatic sideways, Design of Aerostatic sideways, Design of Antifriction Guide ways, Combination guide ways, protecting devices for sideways.

Design of Power Screws -Sliding friction power screws, Rolling friction Power Screws. **[a, e,k,l]**

UNIT 5 ***[7Hrs]***

Design of Spindles & Spindle Supports Functions of spindle unit & requirements, Materials of spindles, design calculations of spindles – Deflection of spindle axis due to bending, deflection of spindle axis due to compliance of spindle supports, optimum spacing between spindle supports deflection due to compliance of the Tapered Joint permissible deflection & design for stiffness. Antifriction bearings -Preloading of antifriction bearing. Sliding bearings - Sleeve bearings, hydrodynamic journal bearing, and air -lubricated bearings**.** [a, e,k,l]

7th Semester

ME1476	PE-III : Machine Tool Design	L=4	T=0	P=0	Credit=4

UNIT 6 **[8Hrs]**

Testing & Control of Machine Tools

a) Testing: Objects and procedure for Acceptance Test, Instrumentation for acceptance, Accuracy of machine tools, and accuracy of work pieces.

b) Control systems: Electrical control, push button control, directional control relays, electrical brakes, automation in feed mechanism

c) Hydraulic control: positional control, power pack for lubrication system in hydraulic drive.

d) Control system for gear sliding and feed mechanism (open loop or close loop) for NC/CNC machine using stepper motor or DC motor. **[a, e,k,l]**

Text books:

S.N.	Title of the book	Edition (Year of publication)	Author(s)	Publisher
1	Machine Tool Design	2007	N. K. Mehata	Tata McGraw-Hill, 1984
2	Principles of Machine Tools	2011	Gopal Chandra Sen, Amitabha Bhattacharyya	New central book agency
3	Design Of Machine Tools	5th edition 2008	Basu, Pal	Oxford and IBH Publishing, 2008
4	Principles of Machine tools		Sen and Bhattacharya	New central book agency

7th Semester

ME1477	Lab.: PE-III : Machine Tool Design	L=0	T=0	P=2	Credits=1

Objective	Course Outcome
To develop in the engineering students the ability to analyze any engineering problem in a simple and logical manner and to apply to its solution a few, well understood basic principles. This subject consists of application of scientific principles, technical information & creative thinking for the development of a new or improved machine tools, to perform desired machining operation with maximum efficiency. **[a,e,k,l]**	(I)The student will be able to design Gear boxes (II)The student will be able to design machine tool structure (III) The student will be able to design guide ways and power screws (IV) The student will be able to design spindles (V) The student will be able to test machine tools (VI) The student will be able to understand control system of machine tools

List of Practical (Minimum 10 Experiments)

1. Introduction to Machine Tool Design
2. Gear box design
3. Design of Beds, Column, housings, Bases & Tables
4. Design of, Cross Rails, Arms, Saddles, Carriages, Rams
5. Design of Guide ways
6. Design of Power Screws.
7. Design of Spindles
8. Design of Spindle Supports.
9. Testing of Machine Tools.
10. Study of Machine Tool controls.

7th Semester

ME1433	Project Phase-I	L=0	T=0	P=4	Credits=4

Objective	Course Outcome
The objective is to prepare the student to examine any design or process or phenomenon fron all angles.This will encourage and develop the process of independent thinking and team working in them and expose them to the needs of industry and society The group of students (not more than 4) will work under the guidance of the faculty member on the project work .It is expected to carry out literature survey for their project work and finalized the methodology and schedule of project. Each student from the project batch shall present [(1st Preliminary and 2nd Progress) using audio visuals, aids] the seminar of about 10 to 15 minute duration on their project methodology. Seminar delivery will be followed by question – answer session. The batch of the students shall also require to submit a progress report of minimum 3 pages before 2nd seminar .The seminar committee (minimum 3 members) shall be constituted for the purpose of evaluating seminar. [d,e,g,j,k,l]	1.(I)The student will able to understand various facets of engineering problems.**d]**
	(II)The student will able to communicate his ideas with others. **[g]**
	(III)The student will able to identify various solutions to engineering problems.. **[e]**
	(IV)The student will able to understand the need to update knowledge.. **[j]**
	(V)The student will able to use latest techniques to find solutions.. **[k,l]**

S.No	Rubrix
I	Objective and literature survey
II	Innovativeness,Presentation and reasoning skill
III	Working & fabrication,experinentation
IV	Presentation of result and discussion

7th Semester

ME1434	Industrial Training / CRT	L=0	T=0	P=0	Credits=2

Objective	Course Outcome
To work in an industry for understanding- 1.Nature of work 2.Different machines used 3.Different technologies used 4.Work culture **5.** Various problems exist in Industry. **[e,h,m]**	1.(I)The student will able to understand nature of work environment in industry..[h]
	(II)The student will able to understand working of different machines and processes..[m]
	(III)The student will able to understand various problems associated with industry..[e]

S.No	Rubrix
I	Know edge and details of Industry
II	Technical Content in report
III	Technical report presentation
IV	Innovation in content
V	Evaluation on the basis of question answer

TRAINING: The student shall undergo training in an industry for minimum period of one month duration during summer vacation after completion of 6th Semester. They will be required to prepare and submit a comprehensive report on the training undergone by them. They will have to submit a certification of completion of training from the industry at the time of joining 7th Semester. They will have to face or undergo a viva-voce by a committee of teachers during 7th semester.

8th Semester

ME1435	Automation In Production systems	L=3	T=0	P=0	Credits=3

Objective	Course Outcome
To develop in the engineering students the ability to analyze any engineering problem in a simple and logical manner and to apply to its solution a few, well understood basic principles.[a,b,c,d,h,k,l]	(I)The Students will be able to interpret advanced automated systems.[a,b,h,k]
	(II)The Students will be able to develop and understand CNC machine programming and its execution.[a,b,k]
	(III)The Students will be able to understand System integration of automated system such as flexible manufacturing system..[a,b,c,d,h,k,l]

Unit 1 **[7 hrs]**

Automation- Definition, types, reasons for automating, arguments for and against automation. Types of production, functions in manufacturing, Organization and information processing in manufacturing.

Automated Flow 'Lines- Methods of workpart transport, Transfer mechanisms, Buffer storage. Analysis of flow lines- General terminology and analysis, analysis of transfer lines without storage, partial automation, automated flow lines with storage buffers, manual assembly lines. Line Balancing Problem, Methods of line balancing. Automated Assembly Systems- Types, parts delivery system**[a, b, d, h, l]**

Unit 2 **[8 hrs]**

Numerical Control Production Systems- Basic concepts, coordinate system and machine motion- Types of NC systems- Point to point, straight cut and continuous path. Machine control unit and other components, Tape and tape readers.

NC part programming- Punched tape and tape formats, NC words, methods of part programming, manual part programming: APT programming, Direct numerical control. Computer numerical control. Adaptive control. Applications and economics of NC. **[a, b, c, k ,l]**

Unit 3 **[8 hrs]**

Industrial Robotics- Introduction, robot anatomy, robot control systems, accuracy and repeatability and other specifications, end effectors, sensors, introduction to robot programming, safety monitoring.

Robot applications- Characteristics of robot applications, work cell layout, robot applications in material handling, processing, assembly and inspection. **[a, c, d, h, l]**

Unit 4 **[7 hrs]**

Automated material handling & storage-Conveyor systems : Roller conveyer , Skate wheel conveyer, Belt conveyers, Chain conveyers, Slat conveyers , Overhead trolley conveyers , Infloor towline conveyers, Cart on track conveyers .

Automated Guided Vehicle Systems -

Types: - Driverless trains, AGVS pallet trucks, AGVS unit-load carriers. Vehicle guidance & Routing, Traffic control & safety, System management, Analysis of AGVS systems, AGVS applications.

Automated Storage & Retrieval System -

Types :- Unit load AS/RS , mini load AS/I{S , man on board AS/RS , automated item retrieval system, deep lane AS/RS -Basic components & special features of AS/RS , Carousel storage systems , Work in process storage, quantitative analysis. **[a, b, c, d , l]**

Unit 5 **[7 hrs]**

Automated inspection & Group technology:- Automated inspection principles & methods -100% automated inspection, off -line & on -line inspection, distributed inspection & final inspection; Sensor technologies for automated inspection , coordinate measuring machines -con~tructiol1 , operation & benefits; Machine vision -image aquisition & digitigation, image processing & analysis, interpretation,

machine vision applications; Other optical inspection methods -Scanning laser systems , linear allay devices, optical tringulation techniques. Introduction to Group Technology. **[a, b, d, k ,l]**

Unit 6 **[7 hrs]**

Computer aided manufacturing -Manufacturing planning, manufacturing control ; Computer integrated manufacturing ; Flexible manufacturing systems -Components, Types of systems, FMS layout configuration computer functions, data files, system reports, FMS benefits.

Computer aided process planning: Retrieval CAPP systems, generative CAPP systems, benefits of CAPP . Shop floor control. Computer Process Control. **[a, c, d ,l]**

8th Semester

ME1435	Automation In Production systems	L=3	T=0	P=0	Credits=3

Text books:				
S.N.	**Title of the book**	**Edition (Year of publication)**	**Author(s)**	**Publisher**
1	Automation, production System & CIMS	Third edition (2007)	M P, Groover PHI	Prentice Hall
2	CAD/CAM	Fifth edition (2008)	Zimmers & Groover PIll	Pearson Education India
Reference Books:				
1	Numerical Control And Computer Aided Manufacturing	13th edition (2007)	Rao, N K Tiwari, T K Kundra	Tata McGraw-Hill Education
2	Computer Control of Manufacturing Systems	2005	Koren	Mcgraw Hill

8th Semester

ME1436	Lab. : Automation In Production	L=0	T=0	P=2	Credits=1

Objective	Course Outcome
To develop in the engineering students the ability to analyze any engineering problem in a simple and logical manner and to apply to its solution a few, well understood basic principles.[a,b,c,d,e,h,k,m]	(I)The Students will be able to develop the CNC programs and execute..**[a,b,d,k,m]**
	(II)The Students will be able to understand fundamentals of robotics engineering and its industrial application..**[a,b,k,]**
	(III)The Students will be able to use Group technology and various components of automated systems to form flexible manufacturing system.. **[a,b,c,d,e,h,k,m]**

Practicals:

1) Performance, Simulation on lathe (atleast two Complex Geometric) **[a, b, e, k ,m]**
2) Performance, Simulation on CNC milling (atleast two Complex Geometries) **[a, d, h, m]**
3) Practice Programming on Manual Part Program **[a, b, c, m]**
4) Practice Programming on APT **[a, b, e, k ,m]**
5) Case Study on Automated System of any Industry. **[a, b, k ,l]**
6) Performance/ Practical on Robot. **[a, b, k ,l]**
7) Part Coding and Group Technology **[a, d, h ,l]**
8) Study of FMS**[a, b, c, k ,l]**
9) Study of Automated material handling **[a, b, e ,l]**
10) Study of Automated inspection **[a, d, h ,l]**

8th Semester

ME1475	Optimisation Techniques	L=3	T=1	P=0	Credits=4

OBJECTIVES

The course aims to develop the engineering - analysis capability for engineering-problems using basic statistical tools and techniques. Detailed treatment of various data analysis and handling technique leading to complete understanding and modeling the processes including its optimization is envisaged in this course.

COURSE OUTCOME:-	
(I)	Use basic operations research techniques for solving linear programming problems. Learn to formulate and solve real-world problems as linear programs, CPM, PERT for better decision –making.
(II)	Solve transportation Models and Assignment Models.
(III)	Understand the characteristics of different types of decision-making environments and the appropriate decision making approaches and tools to be used in each type.

Unit 1 **[7 hrs]**

Introduction of operation research. LP Formulations, Graphical method for solving LP's with 2 variables, Simplex method, Duality theory in linear programming and applications, Integer linear programming, dual simplex method.**[a,k, m]**

Unit 2 **[7 hrs]**

Transportation model,Assignment model (Maximization and minimization problem), Travelling Salesman Problem by branch and bound method**[a, k, m]**

Unit 3 **[8 hrs]**

Dynamic Programming: Basic Concepts, Bellman's optimality principles, Dynamics programming approach in decision making problems, optimal subdivision problem.

Sequencing Models: Sequencing problem, Johnson's Algorithm for processing n jobs through 2 machines, Algorithm for processing n jobs through 3 or more machines, Processing 2 jobs through n machines.**[a, k, m]**

Unit 4 **[8 hrs]**

Project Management: PERT and CPM : Project management origin and use of PERT, origin and use of CPM, Applications of PERT and CPM, Project Network, Diagram representation, Critical path calculation by network analysis and critical path method (CPM), Determination of floats, Construction of time chart and resource labeling, Project cost curve and crashing in project management, Project Evaluation and review Technique **[a, k]**

Unit 5 **[7 hrs]**

Replacement Models and Economic Equivalence: Concept of equivalence interest rate, present worth, economic evaluation of alternatives, group replacement models. **[a, k]**

Unit 6 **[8 hrs]**

Waiting line situations, Queuing Theory M/M/1models (No derivations expected),Monte- Carlo simulations, Inventory Models:Probabilistic and Deterministicmodel, EOQ.**[a, k]**

8th Semester

Me1475	Optimisation Techniques	L=3	T=1	P=0	Credits=4

Text books:

S. N.	Title of the book	Edition (Year of publication)	Author(s)	Publisher
1	Introduction to Operation Research, Computer Oriented Algorithmic approach	2007	Gillet B.E	Tata McGraw Hill Publising Co. Ltd. New Delhi.
2	Operations Research	Third edition 2008	P.K. Gupta & D.S. Hira	S.Chand& Co.
3	Operations Research: Theory and Applications	Second edition 2002	J.K. Sharma	Mac Millan
4	Operations Research	2006	S.C. Sharma	Discovery Publishing House
5	Optimization Theory and Application	Second edition 2010	S.S. Rao	Halsted Press
6	Operations Research - An Introduction	Ninth Edition 2010	Tata Hamdy	Prentice Hall of India Pvt. Ltd., New Delhi.

8th Semester

ME1415	PE IV : Vibrations	L=4	T=0	P=0	Credits=4

Objective	Course Outcome
To develop in students fundamentals knowledge of vibrations. To familiarize with energy methods for multi degree freedom systems. To impart, knowledge of vibration of continuous systems and applications of factor in vibration analysis. TO impart knowledge of use of FFT in vibration analysis for condition monitoring purpose [b,e]	(I) The student will have ability to analyze various types of Vibrations..[b,e] (II) The student will have ability to measure Vibrations and carryout its analysis..[b,e]

Unit 1 **[7 hrs]**
Free body diagram, free & forced vibration, un damped and damped single degree of freedom systems subjected to harmonic and other periodic excitations. Impulse response, convolution integral and response to arbitrary excitation. Vibration isolation and transmissibility. Solution using laplace transform, Runga kutta method, structural damping.**[b,e]**

Unit 2 **[7 hrs]**
Energy method applied to multi degree freedom system. Lagranges equation. Generalized mass formulation of mass , damping and stiffness matrix and its numerical solutions . Vibration absorber, conservative and non conservative systems. Geared rotor system, Influence Coefficients and flexibility matrix of bending vibration of beam and multi-disc rotor. Mode shapes and orthogonality principle. **[b,e]**

Unit 3 **[8 hrs]**
Numerical techniques for M.d.o.f. systems. Matrix iteration method. Holzer's method for torsional vibration. Dunkeleys method for critical speed determination of multi disc rotor. Rayleigh quotient sweeping matrix method for determination of all the natural frequencies and mode shapes. Rayleigh Rit method. Modal matrix and expansion theorem. Free and forced response by modal analysis. **[b,e]**

Unit 4 **[8 hrs]**
Vibration of continuous system. Axial vibration of rod, bending vibration of beam and torsional vibration of shaft. Hamiltons principle and derivation of equation of motion, Rayleigh quotient. Modal co-ordinates and modal forces. Free and forced response through modal analysis. **[b,e]**

Unit 5 **[8 hrs]**
Vibration pickup, seismometers, accelerometer, proximity probe spectrum analyzer, FET & DFT (DiscreteFT), torsional, Vibration measurement, Digital vibration measurement, philosophy of vibration. condition monitoring. **[b,e]**

Unit 6 **[7 hrs]**
Introduction to Finite element method in vibration of continuous system. Natural frequencies and mode shape computation for simple rod and beam problem.**[b,e]**

.Reference books:

S.N.	Title of the book	Edition (Year of publication)	Author(s)	Publisher
1	Theory of vibration	2001	Thomson W.T	Prentice hall
2	Elements of vibration analysis	1986	Meirovitch L	McGraw-Hill Science/Engineering/Math; 2 Sub edition (January 1, 1986)
3	Mechanical vibration	1984	Rao J.S.;Gupta K	Wiley Eastern, c1984
4	Theory of vibrations	1983	Morse TSE; Hinkle	New Delhi: CBS Publishers, 1983.
5	Advanced theory of vibration	1992	Rao J.S	Wiley, 1992
6	Vibration condition Monitoring of Machines	2000	Rao J.S	Alpha Science International Limited, 2000
7	Random vibration		Gandall & Mark	

8th Semester

ME1416	PE IV : Lab. : Vibration	L=0	T=0	P=2	Credits=1

Objective	Course Outcome
To do Experimentation on Types of Vibrations. To do analysis of Vibration of different systems and machines using different methods And through Instrument. [b,e]	(I) The student will have ability to do analyze different types of Vibrations..[b,e]
	(II) The student will have ability to measure Vibrations and carry out its analysis..[b,e]

List of Practical

1. To determine transmissibility of single degree freedom system using load cells and exciter.**[b,e]**
2. To Study the Transverse Vibrations of Cantilever Beam and to determine the frequency or period of Vibration (oscillation) theoretically and actually by experiment.**[b,e]**
3. To determine natural frequency of Torsional vibration of geared system.**[b,e]**
4. To Study the forced vibration of equivalent spring mass System.**[b,e]**
5. Study and determination of modes shapes for two degree and three degree freedom systems. .**[b,e]**
6. To Study the Free Vibration of two rotor and three rotor System and to determine the natural frequency of vibration theoretically & experimentally. .**[b,e]]**
7. To verify the Dunkerley's Rule. .**[b,e]**
8. Determination of Whirling of shaft. .**[b,e]**
9. To study the effect of damping on natural frequency and plot frequency response curves at various damping coefficient. **[b,e]**
10. To determine vibration parameters (Amplitude Velocity acceleration for machines using FFT.**[b,e]**
11. To diagnose faults in simple machines like pumps motor gearbox using FFT. .**[b,e]**
12. To remove dynamic unbalance using FFT. .**[b,e]]**

8th Semester

ME1437	PE IV : INDUSTRIAL FLUID POWER	L=4	T=0	P=0	Credits=4

Objective	Course Outcome
1. .To introduce and understand the simple fluid power systems and to realize its importance in the world of automation and power transmission. 2. To study various fluids, filters and seals for hydraulic systems 3. To study various components of fluid power systems. 4. To understand the language and symbols associated with fluid power components & systems. 5. To design and analyze fluid power systems. **6.** To identifying fluid power maintenance, troubleshooting and safety practices. **[a,b,c,e,g,k,l]**	Students will be able to: (I)To understand and apply fluid power laws and principles [a,e,g,l] (II)Students will be able to understand the basic fluid power hardware system components.. [a,b,c,e,l,m] (III)Students will be able to interpret and draw hydraulics and pneumatics system drawings..[a,g,k,l] (IV)Students will be able to design, analyze, use, maintain, carryout troubleshooting, and establish safety procedures of Fluid Power systems..[a,b,c,k,l]

Unit 1

[8 hrs]

Fluid power systems: Components, advantages, applications in the field of M/c tools, material handling, hydraulic presses, mobile & stationary machines, clamping & indexing devices etc. **Transmission of power at static & dynamic states**. Pascal's Law, continuity equations,
Types of Hydraulic fluid petroleum based, synthetic & water based. Properties of fluids. Selection of fluids, additives, effect of temperature & pressure on hydraulic fluids.
Seals, sealing materials, selection of seals.
Filters, strainers, sources of contamination of fluid & its control.
JIC symbols/ISO Symbols for hydraulic & pneumatic circuits. **[a, e, g,k,l]**

Unit 2

[7 hrs]

Pumps: Types, classification, principle of working & constructional details of vane pump, gear pumps, radial & axial plunger pumps, power and efficiency calculations, characteristic Curves, selection of pumps for hydraulic power transmission.
Accumulators & Intensifiers: Types & functions of accumulators & intensifiers, applications, selection & design procedure. **[a,c,k,e,l]**

Unit 3

[8 hrs]

Control Of Fluid Power: Necessity of pressure control directional control, flow control valves,
Pressure Control Valves: Principle of pressure control valves, direct operated, pilot operated, relief valves, pressure reducing valve, sequence valve & methods of actuation of valves.
Flow Control Valves: Principle of operation, pressure compensated, temperature Compensated flow control valves, meter in & meter out flow control circuits, bleed off circuits.
Direction Control Valves: Check valves, types of D.C. valves:- Two way two position, four way three position, four way two position valves, open center, close center, tandem center valves, method of actuation of valves, manually operated, solenoid operated, pilot operated etc **[a,c,e,k,l]**

Unit 4

[7 hrs]

Actuators: Linear & Rotary actuators.
Hydraulic motors: Types, vane, gear piston, radial piston.
Theoretical torque, power & flow rate hydraulic motor performance.
Hydraulic Cylinders: Types of cylinder & mountings, calculations of piston velocity, thrust under static & dynamic applications. Design consideration for cylinders. **[a, c,e, k, l]**

8th Semester

ME1437	PE IV : INDUSTRIAL FLUID POWER	L=4	T=0	P=0	Credits=4

Unit 5

[7 hrs]

Design Of Hydraulic Circuits:
Meter in meter out circuits. Pressure control for cylinders, Flow divider circuits, etc. Circuit illustrating use of pressure reducing valves, sequencing valve, counter balance valves, unloading valves with the use of electrical controls, accumulators etc. Hydraulic circuit analysis.
Maintenance, trouble shooting & safety precautions of Hydraulic Circuits.
Hoses & Pipes: Types, materials, pressure drop in hoses/pipes, valves and fittings.
Hydraulic piping connections. **[a, b, c, e,g,k, l]**

Unit 6

[8 hrs]

Pneumatics: Introduction to pneumatic power sources, e.g. reciprocating & rotary compressors, roots-blower etc. **Comparison** of pneumatics with Hydraulic power transmission. **Air preparation units**, filters, regulators & lubricators. **Actuators**, linear, single & double acting, rotary actuators, air motors, **Pressure Regulating Valves**, **Directional Control Valves** two way, three way & four way valves, solenoid operated, push button; & lever control valves. **Flow Control Valves**. Check valves methods of actuation, mechanical, pneumatic & electrical etc.
Pneumatic circuits for industrial applications & automation. **[a, b, c, e, g,k, l]**

Text books:			
Title of the book	**Edition (Year of publication)**	**Author(s)**	**Publisher**
Introduction to Fluid Power	2002	James L Johnson	**Delmar Thomson Learning**
Fluid Power With Applications	6th	Anthony Esposito	PEARSON Prentice Hall
Industrial Hydraulics	3rd or above	J.J. Pipenger & T. G. Hicks	McGraw Hill Co.
Pneumatic Systems: Principles and Maintenance	16th (2006)	S. R. Majumdar	Tata McGraw-Hill Education
Reference Books:			
Power pneumatics	(2007)	Michael J. Pinches	Prentice Hall
Vickers manuals on Industrial Hydraulics	3rd edition or above	Vickers	Vickers, 1996
Hydraulics & Pneumatics	4th edition	Harry L. Stewart	Industrial Press
Fluid Power Design Handbook	3rd edition	Franklin D. Yeaple	Marcel Dekker, 1996

8th Semester

ME1438	PE IV : Lab. : INDUSTRIAL FLUID POWER	L=0	T=0	P=2	Credits=1

Objective	Course Outcome
• Develop an understanding of basic principles of simple fluid power & systems. • Study & Select the proper hydraulic /pneumatic component for an application. • Read & understand the language and symbols associated with fluid power components & systems. • Design, assemble and analyze basic fluid power circuits. • Troubleshoot and maintain the hydraulic /pneumatic components and systems. • Understand & follow the safety and precaution norms in fluid power lab. **[a,b,c,e,g,k,l]**	(I) Student will be able to use the appropriate safety precautions. [a,b,c,e,g,k,l] (II) Student will be able to differentiate, install, and maintain the different types of hydraulic and pneumatic pumps, valves, motors and actuators. [a,b,c,e,g,k,l] (III) Student will be able to understand, install and maintain Hydraulic/Pneumatic circuit. [a,b,c,e,g,k,l]

Practical: - Minimum eight practical to be conducted /studied

Note: Demonstrations shall be carried out on Hydraulic and Pneumatic Kit

1) Study of JIC/ISO symbols for Hydraulics and Pneumatics .{a,b,c,e,g,k,l]
2) Demonstration of hydraulic pumps used in hydraulic systems.{a,b,c,e,g,k,l]
3) Demonstration of Actuators used in Fluid Power systems.{a,b,c,e,g,k,l]
4) Demonstration of various valves used in Fluid Power systems.{a,b,c,e,g,k,l]
5) Demonstration of accumulators and Intensifiers used in Fluid Power systems.{a,b,c,e,g,k,l]
6) Demonstration of different flow control methods used in Fluid Power systems.{a,b,c,e,g,k,l]
7) Demonstration of various hydraulic circuits (three to four applications) .{a,b,c,e,g,k,l]
8) Demonstration of various industrial hydraulic circuits (another three to four applications) .{a,b,c,e,g,k,l]
9) Demonstration of FRL unit used in pneumatic systems. .{a,b,c,e,g,k,l]
10) Demonstration of valves used in pneumatic systems. .{a,b,c,e,g,k,l]
11) Demonstration of industrial pneumatic circuits (three to four app.) .{a,b,c,e,g,k,l]
12) Study of hydraulic fluids used in hydraulic systems.{a,b,c,e,g,k,l]
13) Study of hydraulic seals used in Fluid Power systems.{a,b,c,e,g,k,l]
14) Study of Contamination Control of Hydraulic Fluids. .{a,b,c,e,g,k,l]
15) Design report of a hydraulic or pneumatic system using manufacturer's catalogue.{a,b,c,e,g,k,l]

8th Semester

ME1439	PE IV : CNC and Robotics	L=4	T=0	P=0	Credits=4

Objective	Course Outcome
To understand the need and process of automation in industry. Study the Computer Numerically Controlled machines and Robots, their components, functions, functions, programming and applications.[k,m]	(I)Student will be able to understand construction of CNC machines & Robots..[k,m]
	(II)Student will be able to prepare a program for making components using CNC machines..[k,m]
	(III)Student will be able to operate CNC machines & Robots..[k,m]

Unit 1 **[7 hrs]**
Concepts of NC, CNC, DNC. Classification of CNC machines, MCU architecture and functionality, Machine configurations, Types of control, CNC controller's characteristics, Interpolators**. [k,m]**

Unit 2 **[8 hrs]**
Qualified, semi qualified and preset tooling, tooling system for Machining centre and Turning centre, work holding devices, of CNC Machines.
Programming CNC machines, Part print analysis and Process planning, Advanced Programming features , Canned cycles. APT part programming CAD/CAM, Parametric Programming.**[k,m]**

Unit 3 **[8 hrs]**
Manual part programming for CNC turning, milling and machining center. Wire EDM machines. Computer assisted part programming techniques, Conversational and Graphics based software, Solid based part programming. Freeform surface machining. Simulation and Verification of CNC programs, Adaptive CNC control techniques. Integration of CNC machines for CIM. **[k,m]**

Unit 4 **[7 hrs]**
Robotics, Basic concepts , Robot configurations , Basic robot motions , Types of drives , Applications
Transformations and kinematics, Vector operations, Translational transformations and Rotational transformations , Properties of transformation matrices,
Homogeneous transformations and Manipulator, Forward solution, Inverse solution, Introduction to robot dynamics.
Controls, Control system concepts, Analysis, control of joints, Adaptive and optimal control. **[k,m]**

Unit 5 **[8 hrs]**
End effectors, Classification, Mechanical, Magnetic, Vacuum, and Adhesive, Drive systems, Force analysis and Gripper design**.**
Robot programming, Methods, Languages ,Computer control and Robot Software – Programming Languages, Robot application (Assembly, inspection, material handling, processing) **[k,m]**

Unit 6 **[7 hrs]**
Sensory devices, Non optical and optical position sensors, Velocity and Acceleration, Range, Proximity, touch, Slip, Force, Torque. Machine vision, Image components , Representation , Hardware , Picture coding , Object recognition and categorisation Integration of Robots with CNC machines for CIM. **[k,m]**

Text books:

S.N.	Title of the book	Edition (Year of publication)	Author(s)	Publisher
1	Robot Engineering An Intergrated approach	2004	Klafter R.D., Chmielewski T.A. and Negin M	Springer

8th Semester

ME1439	PE IV : CNC and Robotics	L=4	T=0	P=0	Credits=4

Reference :				
1	CNC Technology and Programming	2003	Krar, S., and Gill	Industrial Press Inc
2	An Introduction to CNC Machining	1991	Gibbs, D.	Industrial Press
3	Computer Numerical Control Concepts and Programming	1991	Seames, W.S.	Thomson Learning EMEA, Limited
4	Computer Numerical Control for Machining	1993	Lynch, M	McGraw-Hill
5	Computer Control of Manufacturing Systems	2005	Koren Y	Tata McGraw-Hill Education
6	Robotics control, sensing, vision, and intelligence	2004	Fu K.S., Gonzalez R.C., and Lee C.S.G.	Tata McGraw-Hill Education
7	Robotics Technology and Flexible Automation	2001	Deb S.R	Tata McGraw-Hill Education
8	Introduction to Robotics Mechanics and Control	2008	Craig J.J	Pearson Education India

8th Semester

ME1440	PE IV : Lab. : CNC and Robotics	L=0	T=0	P=2	Credits=1

Objective	Course Outcome
To understand the need and process of automation in industry. Study the Computer Numerically Controlled machines and Robots, their components, functions, functions, programming and applications.[k,m]	(I)Student will be able to understand construction of CNC machines & Robots. [k,m]
	(II)Student will be able to prepare a program for making components using CNC machines.. [k,m]
	(III)Student will be able to operate CNC machines & Robots. [k,m]

List of Practical

1) Demonstration on Automation through development in NC machines. **[K,m]**
2) Numerical control – Fundamental & Application. **[K,m]**
3) Manual Part Programming. **[K,m]**
4) APT Part Programming. **[K,m]**
5) CNC- Lathe – Features, Specification, & Part Program. **[K,m]**
6) CNC Lathe – Programming, Simulation & Actual Machining of Part. **[K,m]**
7) **[a, b ,e ,i, j, k, l, m]** (Thread Cutting, Facing, Turning, Grooving etc.) **[[K,m]**
8) CNC- Milling – Features, Specification, & Part Program. **[a, b ,e ,i, j, k, l, m]**
9) CNC Milling – Programming, Simulation & Actual Machining of Part. **[K,m]**
   (Profile Cutting, Various Interpolation, Pocketing, Mirroring etc.)
10) Robots Fundamental and configurations. **[K,m]**
11) Robots Applications **[K,m]**
12) Programming, Simulation of Robot. **[K,m]**
13) Problems on Robot kinematics. **[K,m]**

8th Semester

ME1441	PE IV: Vehicle Engineering	L=4	T=0	P=0	Credits=4

Objective	Course Outcome
The main objective of the syllabus to understand basic knowledge about Automobile systems which are used in the regular vehicle. The modernization in automobile is also included to understand recent trend in the field.**[d,i,k]**	(I) Student should understand basic operations of Automobile engine and power transmission systems.**[d,i,m]**
	(II) Student should understand basic operations various control system in automobile.**[d,i,m]**
	(III) Student should understand electrical system and various safety equipments automobile.**[d,i,m]**

UNIT-1: **[8 hrs]**
- Introduction, Automobile history and development and classification. Vehicles layout.
- Various engine system and components
- Introduction to Fuel supply system: for Petrol and Diesel Engine.
- Engine cooling and lubrication systems., **[d,i,m]**

UNIT-2: **[8 hrs]**
- Resistance to vehicle motion: Air, Road and gradient resistance and power calculation.
- Clutch – Necessity, requirements of a clutch system. Types of Clutches: Single & multi plate clutch, Diaphragm clutch and centrifugal clutch.
- Gear box: Necessity of gear box, working principle, Classification: Sliding mesh, constant mesh, synchromesh, synchromesh and Transfer case gear box, Gear Selector mechanism, lubrication and control. Introduction to Automatic Transmission **[d,i,m]**

UNIT-3: **[8 hrs]**
- Transmission system: Propeller shaft, Universal joint, constant velocity joint, Hotchkiss drive, torque tube drive.
- Differential - Need and working. Differential lock.
- Rear Axles and Front Axles.
- Wheel and Tyres: tyres specification, factors affecting tyre performance. **[d,i,m]**

UNIT-4: **[8 hrs]**
- Steering systems, principle of steering, steering linkages, steering geometry and wheel alignment, steering gear box and its types.
- Suspension systems – Function, conventional and Independent suspension System, shock absorber
- Brakes - Drum and Disc brakes, Comparison, Mechanical, hydraulic (Master and wheel cylinder), Air brakes.**[d,i,m]**

UNIT-5: **[8 hrs]**
- Electrical systems: Battery construction. Specification. Operation of Batteries. Charging of battery, Alternator.
- Starting system, Battery Ignition and magneto ignition systems, Lighting, Horn, Side indicator, wiper. and other electrical systems.**[d,i,m].**

UNIT-6: **[8 hrs]**
- Automobile air-conditioning,
- Panel board instruments .
- Overhauling, Engine tune up.
- Recent Advances in automobiles such as ABS, Power Steering, Collision avoidance, Navigational aids etc. **[d,i,m]**

Reference books:

S.N.	Title of Book	Edition	Authors	Publication
1	Automotive Technology		H.M.Sethi	Tata McgraHill
2	Automobile Engineering-I & II	First Edition - 2010	P.S.Gill	S.K.Kataria & sons
3	Automobile Engineering	First Edition - 2015	Dr.D.S.kumar	S.K.Kataria & sons
4	Automotive Mechanics		Joseph Heitner	
5	Automotive Engines		W.H. Crouse	

8th Semester

ME1442	PE IV : Lab. : Vehicle Engineering	L=0	T=0	P=2	Credits=1

Objective	Course Outcome
The main objective of the syllabus to understand working of Automobile systems like power development, transmission & controls etc which are used in the regular vehicle..**[d,i,k]**	(I)Student will be able to understand and identify various components and its assembly and de-assembly in vehicle .**[d,i,m]**
	(II)Student will be able to understand and identify various operating system in automobiles. .**[d,i,m]**

List of Practical: Minimum eight practical to be conducted

1. Demonstration to understand vehicle layout and important constituents of four wheel ,two-wheel & four-wheel drive vehicle. **[d,i,m]**
2. Demonstration to understand various components and working of 2S & 4S Engine. **[d,i,m]**
3. Demonstration to understand working of single plate/Multiplayer/Diaphragm automobile clutch. **[d,i,m]**
4. Demonstration of synchromesh gearbox with gear shifting mechanism. **[d,i,m]**
5. Demonstration of final drive and differential. **[d,i,m]**
6. Demonstration of working Hydraulic braking system and comparison with other braking system. **[d,i,m]**
7. Demonstration to undersatnd front wheel steering geometry and steering mechanism. **[d,i,m]**
8. Demonstration to understand suspension system and working of shock absorber. **[d,i,m]**
9. Demonstration of various components of battery and working of its charging system. **[d,i,m]**
10. Demonstration of vehicle starting system(Kick start and Self start). **[d,i,m]**
11. Demonstration to understand working principle of Electric horn, Brake light and side indicator. **[d,i,m]**
12. Visit to workshop to understand wheel balancing. **[d,i,m]**
13. Visit to servicing station for vehicle maintenance, repairs and report. **[d,i,m]**

8th Semester

ME1443	PE IV : Management Information Systems	L=4	T=0	P=0	Credits=4

Objective	Course Outcome
•To focus on the integration of computer systems with the overall goals set by an organization. • To learn the development and management of information technology tools for assisting executives and the general workforce in performing any tasks related to the processing of information MIS and business systems are especially useful in the collation of business data and the production of reports to be used as tools for decision making.[**a ,b, c, e, h, i, j, k]**	(I) Student will be able to analyze the system..[**a ,b, c, e, h, i, j, k]** (II) Student will be able to improve the decision making. . [**a ,b, c, e, h, i, j, k]** (III) Student will be able to use various MIS tools.. [**a ,b, c, e, h, i, j, k]**

Unit 1 **[7 hrs]**
Introduction to MIS;
System & Its components, System Concepts, system control, Types of systems, Date & Information, Nature and scope, Character Function & Applications, system life cycle design. **[a, b, c, e]**

UNIT 2 **[7 hrs]**
System Analysis: System planning, Information Gathering, Structure Analysis tools, Feasibility Study, cost/benefit analysis. **[a ,b, c, e, h, i, j, k]**

UNIT 3 **[7 hrs]**
System Design: Stages of system Design, Input/output & form design, Database Design, Design Documentation.
[a, b, h, i, j, k]

UNIT 4 **[7 hrs]**
SYSTEM IMPLEMENTATION & EVALUATION :
System testing, Implementation Detailed evaluation, System maintenance. **[a, b, i, j, k]**

UNIT 5 **[7 hrs]**
DECISION SUPPORT SYSTEM :
Concepts & Philosophy of DSS, Deterministic System, Artificial Intelligence(AI), knowledge Based Expert system(KBES). **[a, b, i, j, k]**

UNIT 6 **[7 hrs]**
MIS TOOLS & PACKAGES/AREAS OF MIS
ERP(Enterprise Resource Planning)
SCM(Supply Chain arrangement)
CRM(Customer Relation argt.)
Concept of data ware housing and data mining. **[a, e, f, g, h]**

Reference books:

S.N.	Title of the book	Edition (Year of publication)	Author(s)	Publisher
1	MIS	2002	WS Jawadekar	Tata McGraw-Hill
2	MIS	2006	D. P. Goyal	Macmillan
3	System Analysis and Design	1985	Elias M. Awad	R.D. Irwin
4	System Analysis and Design	2004	Donald Yeales.	Financial Times Prentice Hall

8th Semester

ME1444	**PE IV : Lab. : Management Information Systems**	**L=0**	**T=0**	**P=2**	**Credits=1**

Objective	**Course Outcome**
•To focus on the integration of computer systems with the overall goals set by an organization. • To learn the development and management of information technology tools for assisting executives and the general workforce in performing any tasks related to the processing of information MIS and business systems are especially useful in the collation of business data and the production of reports to be used as tools for decision making. [**a ,b, c, e, h, i, j, k]**	(I) Student will be able to analyze the system..[**a ,b, c, e, h, i, j, k]** (II) Student will be able to improve the decision-making [**a ,b, c, e, h, i, j, k]** (III) Student will be able to use various MIS tools.. [**a ,b, c, e, h, i, j, k]**

PRACTICALS :

1. Inventory control, [a ,b, c, e, h, i, j, k]
2. MRP, [a ,b, c, e, h, i, j, k]
3. Office Automation by using: MS-Access [a ,b, c, e, h, i, j, k]
4. Visual Basic, [a ,b, c, e, h, i, j, k]
5. Oracle or any other database Languages. [a ,b, c, e, h, i, j, k]

8th Semester

ME1478	PE-IV : Solar Energy & Utilization	L=4	T=0	P=0	Credits=4

Unit1 Basics of solar energy [7hrs]
Brief History of solar energy &utilization, Various approaches of utilizing solar energy, Blackbody radiation, Relation between radiation field energy density and radiation spectrum, Planck's formula in energy unit, Maximum spectral density, Planck's formula in wavelength unit, Wien displacement law, Stefan - Boltzmann law, Photoelectric effect, Einstein's theory of photons, Einstein's derivation of the black-body formula.

Unit2 Solar radiation, measurement and estimation [8hrs]
History of solar energy utilization, basic definitions, Solar radiation and modeling, Empirical equations for predicting the availability of solar radiation, Measurement of global, direct and diffuse radiation, Radiation computations on inclined surfaces, Angstrom's turbidity, Solar chart, Standard radiation scale, Measurement of solar radiation, Solar energy measuring instruments, Pyranometer, Pyrheliometer, Sunshine recorder, Estimation of average solar radiation, Ratio of beam and total radiation on tilted surface of that on horizontal surface.

Unit3 Concentration of solar energy [7hrs]
Three types of imaging optics: trough or linear collectors, central receiver with heliostats, and parabolic dish concentrator with on -axis tracking, Solar thermal electricity is using Stirling engine or Ranking engine, Solar photovoltaic with concentration.

Unit4 Solar Thermal systems: [7hrs]
Liquid Flat, Plate collector, air heater and concentrating collector, Solar pond, Solar distillation, Solar drying. Thermal storage. Solar Passive Architecture Passive heating and cooling of Buildings. Solar Cooking, Distillation, Desalination, Solar Drying, Solar Chimney.

Unit5 Solar cells: [8Hrs]
Formation of a PN–junction, Space charge and internal field, Quasi - Fermi levels, The Shockley diode equation, Structure of a solar cell, The solar cell equation, Fill factor and maximum power, Various electron, hole-pair recombination mechanisms, Crystalline silicon solar cells, Thin film solar cells: CIGS, Cite and silicon - Tandem solar cells, Dye - sensitized solar cells, Organic solar cells. Photovoltaic applications: battery charger, domestic lighting, street lighting, water pumping etc., solar PV power plant, Net metering concept.

Unit6 Storage of solar energy: [8Hrs]
Types of Energy Storage, Thermal Storage, Simple water and rock bed storage, pressurized water storage system, Electrical Storage, Fundamental concept of batteries, measuring of battery performance, charging and discharging of a battery, storage density, energy density, and safety issues. Types of batteries, Chemical Storage, Fuel Cell, History of Fuel cell, Principles of Electrochemical storage, Types, Hydrogen oxygen cells, Hydrogen air cell, Hydrocarbon air cell, alkaline fuel cell, detailed analysis, advantage and drawback of each type, hydro-storage.

.Reference books:

S.N.	Title of the book	Edition (Year of publication)	Author(s)	Publisher
1.	Solar Energy Utilization	2010	Rai, G.D.	Khanna Publishers, N. Delhi
2.	Solar Energy	3rd Edition, 2008	Sukhatme S.P.,	Tata McGraw Hills P Co.
3.	Solar Energy Thermal Process	2007	Duffie, J.A., and Beckman	John Wiley and Sons, NewYork,
4.	The Physics of Solar Cells	2003	Nelson	Imperial College Press
5.	Solar Energy: Principles of Thermal Collection and Storage	3rd Edition, 2008	S Sukhatme and J Nayak	Tata McGraw Hill,

8th Semester

ME1479	**Lab. : PE-IV : Solar Energy & Utilization**	**L=3**	**T=0**	**P=0**	**Credits= 1**

List of Experiments

1. Solar Radiation Measurements
2. **Flat Plate Solar Water Heater**
3. **Flat Plate Solar Air Heater**
4. **Flat Plate Collector with Reflector**
5. Parabolic Tube Collector
6. Evacuated Tube Collector
7. **Solar Cookers**
8. Thermal Storage System
9. **Study on Solar Cell Characteristics**
10. **Testing of SPV Standalone Systems**
11. **Testing of SPV system with tracking unit**
12. **Performance Evaluation of SPV**

8th Semester

ME1485	PE-IV: Pipe Design and Engineering	L=4	T=0	P=0	Credits=4

Objective	Course Outcome
• The student should be able to acquire elementary knowledge of Piping Design and Engineering. • To impart the knowledge on selection of components for piping design • To impart the knowledge about selection of equipment for piping design • To impart basic knowledge on piping Engineering flow diagram and process system • To impart basic knowledge to Designing & engineering of Piping Diagram • To impart knowledge on ASME Engineering and pressure design	After completion of this course, Students will be able to **I.** Describe the basic concepts of Piping design and Engineering **II.** Apply the basic concepts involved in selection of components and equipment in piping design. **III.** Apply the knowledge of design and engineering for preparation of process diagram and piping diagram **IV.** Describe the application of international standards for piping design

Unit 1 **[8 hrs]**

Fundamentals of Piping Design and Engineering

Introduction to piping designing & engineering, Evolution of piping, Manufacturing methods, Piping materials and selection, Pipe dimensioning, Schedule numbers, Common piping abbreviations, Major organizations for standards, Commonly American code in piping ASME/ANSI, Common abbreviations.
[CO-I]

Unit 2 **[8 hrs]**

Basic Piping components

Type of Fittings - elbows, weld tee, stub in, couplings, reducers, weld cap, screwed and socket welded fittings, Pipe nipples, flanged fittings and use of fittings, Type Flange -Types, P-T ratings and facings, Gaskets, bolts and nuts, Major Valves - Types, Materials operations, applicability, codes and specifications. **[CO-II]**

Unit 3 **[6 hrs]**

Piping Equipment

Horizontal vessels/accumulators, fractionation columns, pumps, heat exchangers, re-boiler, air cooled heat exchanger, cooling towers, heaters/boilers, storage tanks, fractional distillation process andvendor data drawings, Prepare layout of Different type lights.**[CO-II]**

Unit 4 **[7 hrs]**

Piping Engineering flow diagram and process system

Uses of flow diagrams, process flow diagrams, mechanical flow diagrams, utility flow diagrams, piping symbols, line symbols, valve symbols, piping isometrics, general arrangement drawings- sections/elevations/ detail drawings, plot plan procedures, Purpose of P&ID'S, study of P&ID'S, stages of development of P&ID'S, symbols usage according to industrial practices, Purpose of P&ID in process industrial/plants. **[CO-III]**

Unit 5 **[8 hrs]**

Designing & engineering of Piping Diagram

Plant Co-ordinate Systems, Site Plans, Unit Plot Plan, Equipment Location Drawing, Foundation Location Drawing, Pipe Rack Spacing, Drawing pipe in the rack, pipe insulation shoes, pipe guides, field supports, dummy supports, hanger rods, spring hangers, pick-up pipe supports, plant utilities, control valve manifolds, utility stations, sewer and underground piping system.**[CO-III]**

Unit 6 **[8 hrs]**

ASME Engineering and pressure design

Pipe wall thickness calculations, operating pressure, design pressure, operating & design temperature ,max allowable operating pressure, Pressure design of Pipe, elbows, mitre bends, reinforcement pad calculation for branch connections, flanges, blanks, expansion joints and gaskets. **[CO-IV]**

CO	Co contain	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
I.	Describe the basic concepts of Piping design and Engineering	3		3			3								
II.	Apply the basic concepts involved in selection of components and equipment in piping design.			3			3							2	
III.	Apply the knowledge of design and engineering for preparation of process diagram and piping diagram			3			3							2	
IV.	Describe the application of internationsl standards for piping design			3			3							2	

Reference books:

1	Piping Handbook	07th Edition (2010)	Mohinder L Nayyar	McGraw-Hill Publishing
2	Offshore engineering an Introduction	1995	Angus Mather	Witherby & Company Ltd.
3	Handbook of piping design	1st Edition (2010)	G. K. Sahu	New age International
4	The fundamentals of piping Design	1st Edition (2007)	Peter Smith	Gulf Publishing Company

8th Semester

ME1479	Lab. : PE-IV : Piping Design and Engineering	L=3	T=0	P=0	Credits= 1

Objective	Course Outcome
• The student should be able to acquire elementary knowledge of Piping Design and Engineering. • To impart the knowledge on selection of components for piping design • To impart the knowledge about selection of equipment for piping design • To impart basic knowledge on piping Engineering flow diagram and process system • To impart basic knowledge to Designing & engineering of Piping Diagram • To impart knowledge on ASME Engineering and pressure design	After completion of this course, Students will be able to **I.** Describe the basic concepts of Piping design and Engineering **II.** Apply the basic concepts involved in selection of components and equipment in piping design. **III.** Apply the knowledge of design and engineering for preparation of process diagram and piping diagram **IV.** Describe the application of international standards for piping design

List of Practical

A set of 8 Experiments from following list to be performed.

1. Study of Fundamentals of Piping Design and Engineering using AVEVA PDMS Software.
2. User interface Basics about AVEVA PDMS Software.
3. Displaying modeled element.
4. Working with 3D Views.
5. Attributes, positioning and orientation. .
6. General Utilities. .
7. Introduction to model editor
8. Introduction to Aveva primitives for piping design.
9. Drafting Features – Automatic Drawing production
10. Draft explorer and viewing control along with draft Hierarchy
11. Dimensioning the drawing – Equipment, piping and structural arrangement

8th Semester

ME1451	PE V : STRESS ANALYSIS	L=3	T=0	P=0	Credits=4

Objective	Course Outcome
To develop in the engineering students the ability to analyze any engineering problem in a simple and logical manner and to apply to its solution a few, well understood basic principles of stress analysis.[c,e]	(I)The students will able to prepare mathematical model of general stress analysis problem. [c,e] (II)Students will be able to obtain stress distribution using analytical as well as experimental methods. [c,e] (III) Student will be able to design and carry out improvement in exiting design. [c,e]

Unit 1 **[7 hrs]**
Two Dimensional Problems in. Cartesian Coordinate system -Fundamentals of stress & strain, stress-strain relationship, Elastic constant, plane stress, plane strain., differential equation of equilibrium Boundary conditions, Saint Venant's principle, compatibility equation. **[c,e]**

Unit 2 **[7 hrs]**
Airys stress function. Stress analysis of cantilever subjected to concentrated load at its end and simply supported beam subjected to uniformly distributed load.
Two dimensional problems in polar coordinate systems -General equations of equilibrium in polar coordinate compatibility equation. **[c,e]**

Unit 3 **[7 hrs]**
Stress distribution about symmetric. axis, stress analysis of cylinder subjected to ~ internal & external pressure, Pure bending of curved beams, effect of hole on the stress distribution in plates, Stress analysis of rotating circular disk. **[c,e]**

Unit 4 **[8 hrs]**
Introduction to various methods of stress analysis like grid techniques, brittle coating method, Moire fringe method etc.
Two Dimensional Photo elasticity - Introduction to basic optics related to photo elasticity, stress optic law, plane & circular polariscope arrangements, diffusion and lens type polariscope .Effect of stressed model in plane & circular polariscope, Isoclinic & Isochromatics, stress trajectories, calibration of photo elastic material (determination of fringe constant). Various photoelastic materials and their properties, Casting of photo elastic models, Tardy's and other compensation technique. Separation techniques like, shear difference, oblique incidence & electrical analogy. **[c,e]**

Unit 5 **[8 hrs]**
Strain gage technique for stress & strain analysis -Introduction to electrical resistance strain gages, gage . factor, bridge circuit, bridge balance, output voltage of Wheatstone bridge, balancing of bridge, temperature compensation, various bridge configurations, bonding of strain gages to the specimen, determination of principle strains & stresses using strain rosettes. Environmental effects on performance of strain gages, Strain gages response to dynamic strains, Effect of lead wires. Introduction to Strain measurement on rotating components, Static & Dynamic Strain Measurement introduction to semiconductor gages, high temperature strain gages & self-temperature compensated gages. Introduction to Commercial strain indicators. **[c,e]**

Unit 6 **[7 hrs]**
Introduction to fatigue and fracture mechanics. **[c,e]**

8th Semester

ME1451	PE V : STRESS ANALYSIS	L=3	T=0	P=0	Credits=4

Text books:				
S.N.	**Title of the book**	**Edition (Year of publication)**	**Author(s)**	**Publisher**
1	Theory of Elasticity	2nd edition	Timoshenko S.P;	Tata McGraw-Hill Education, 1951
2	Experimental Stress Analysis	3rd edition	Dally ;Riley	McGraw-Hill, 1991
3	Experimental Stress Analysis	1982	Ray T.K.	S. Chand,
4	Experimental Stress Analysis	1984	Srinath L.S	Tata McGraw-Hill Publishing Company Limited, 1984
5	Vol - I and Vol – II."Theory of photoelasticity	2009	Max Mark Frocht	Pergamon Press, 1969
6	Applied elasicity	--	Chi The Wang	Amazon

8th Semester

ME1452	**PE V : Design of Experiments and Taguchi methods**	**L=4**	**T=0**	**P=0**	**Credits=4**

Objective	**Course Outcome**
The course aims to develop the engineering - analysis capability for engg-problems using basic statistical tools and techniques. Detailed treatment of various data analysis and handling technique leading to complete understanding and modeling the processes including its optimization is envisaged in this course. (a,e,l)	(I)Students will be able to develop engineering analysis capability with basic statistical tools and techniques.. [a,e,l]
	(II) Students will be able to implement different optimization techniques. [a,e,l]

Unit 1 **[7 Hrs]**
Frequency Distribution & Histograms, Probability & its Distribution, Measures of Central Tendency & Distribution, Presentation of Statistical Data. Importance and significance of statistics in an engineering industry.
[**a,e,l]**

Unit 2 **[8 Hrs]**
Confidence intervals, Hypothesis Testing, Correlation, Liner & Multiple Repression Analysis, Signification Testing, Introduction to minitav[**a,e,l]**

Unit 3 **[7 Hrs]**
Full & fractional factorial experiments, analysis of variance, Latin squares, response surface methology, [**a,e,l]**

Unit 4 **[7 Hrs]**
Group Method of Data Handling, shainin variable search technique, Regression equation in matrix form. [**a,e,l]]**

Unit 5 **[8 Hrs]**
Taguchi techniques, concept of six sigma, DoE and six sigma, Six sigma implementation. [**a,e,l]**

Unit 6 **[8 Hrs]**
Industrial application of Taguchi technique, orthogonal arrays, OA selection, DoE with Taguchi and comparison with conventional DoE. [**a,e,l]**

Text books:

S.N.	**Title of the book**	**Edition (Year of publication)**	**Author(s)**	**Publisher**
1	Experimental Design	1950	Cochran & Cox	Wiley,
2	Taguchi Techniques in Quality Engineering	2nd edition	Phillip J. Ross	McGraw-Hill, 1996
3	Statistical Analysis for Engineers and Scientist	2010	Barnes	McGraw-Hill, 1994
4	Introduction to Probability and Statistics	4th edition 2003	Milton	McGraw-Hill,
5	Engineering Statistics	2nd edition	Bowker & Liberman	Prentice-Hall, 1972

8th Semester

ME1453	PE V : Value Engineering	L=4	T=0	P=0	Credits=4

Objective	Course Outcome
To familiarize students with : 1. Philosophy of Value Analysis / Value Engineering , its importance and application 2. The various steps involved in systematic implementation of Value Analysis / Value Engineering **[d,l]**	(I)Students will be able to improve the value of given product/system using Value Analysis / Value Engineering techniques. **[d.l]**

Unit 1 **[7 hrs]**
Introduction to Value Engineering (V.E.) and Value Analysis, Quantitative definition of Value, Use Value and Prestige Value, Estimation of product quality/performance, Types of Functions. **[e, g, l]**

Unit 2 **[7 hrs]**
Life Cycle of a Product, Product life cycle Management, Methodology of V.E., **[f, h, m]**

Unit 3 **[8 hrs]**
Relationship between Use Functions and Esteem Functions in product design, Functional Cost and Functional Worth, Effect of value improvement on profitability, Aims of VE systematic Approach [**c, i, l]**

Unit 4 **[8 hrs]**
Introduction to V.E. Job plan / Functional Approach to Value Improvement, Various phases and techniques of the job plan **[a, j, m]**

Unit 5 **[8 hrs]**
Factors governing project selection, Life Cycle Costing for managing the Total Value, Concepts in LCC, Present Value concept, Annuity concept, Net Present Value, Pay Back period, Internal rate of return on investment (IRR), Examples and illustrations. **[b, k, l]**

Unit 6 **[7 hrs]**
Creative thinking and creative judgment, False material, labor and overhead saving, System Reliability, Reliability elements in series and parallel, Decision matrix, Estimation of weights and efficiencies, Sensitivity analysis, Utility functions, Fast diagramming, Critical path of functions, DARSIRI method of value analysis, Purchase price analysis. **[a, c, d, m]**

Reference Books

S.N.	Title of the book	Edition (Year of publication)	Author(s)	Publisher
1	Value Engineering	1962	L.D.Miles	Materials Management International,
2	Getting more at less cost	1995	Jagannathan	Tata McGraw-Hill Publishing Company Limited,
3	Value Engineering		Tufly	
4	Value Engineering	3rd edition	Donald Parker	
5	Value Engineering	4th edition 1984	Zimmerman	City of Tulsa, 1984

8th Semester

ME1454	PE V : Lean Sigma	L=4	T=0	P=0	Credits=4

OBJECTIVES	Course Outcome
• The course aims to develop a broad understanding of Lean/Six Sigma principles. • It focuses on build capability to implement Lean/Six Sigma initiatives in manufacturing as well as service operations will also help the capability to operate with awareness of Lean/Six Sigma at the enterprise level.[a,b,c,d,e,f,h,k,l,m)	(I)The students will able to manage the industrial resources more efficiently.. [a,b,c,d,e,f,h,k,l,m) (II)The students will be able to reduce wastage, cost and at the same time improve efficiency through use of various lean techniques. [a,b,c,d,e,f,h,k,l,m) (III)The students will be able to design, optimise and innovate six sigma.. [a,b,c,d,e,f,h,k,l,m)

UNIT 1 **[8 hrs]**
Business process, Quality management, Need and significance of LS, COQ, COPQ, LS implementation, LS culture, Team roles and function, benefits. **[c, d, f, l]**

UNIT 2 **[8 hrs]**
Six sigma essentials, SS tools, DMAIC methodology, case studies and applications.**[a, b, e, m]**

UNIT 3 **[8 hrs]**
Statistical applications and methods using Minitab Software, cases and problems.**[a, b, k, l]**

UNIT 4 **[7 hrs]**
Process capability, Gage R & R,MSA, ANOVA,HYPOTHESIS testing, DOE, process characterization. **[b, k, l]**

UNIT 5 **[7 hrs]**
Lean manufacturing concepts, Lean means speed, efficiency, waste time and cost reduction.
Lean Tools and Techniques-VSM,7 waste,5S,Kanban,Poka-yoke,Kaizen,TPM,SMED,Pull vs Push, JIT, single piece flow. **[a, c, h]**

UNIT 6
Design for Six Sigma, (DFSS)- need and significance, DMADV methodology, DFSS tools, Product and process optimization, innovations, TRIZ, case studies and applications.**[a, b, k, m]**

S.N.	Title of the book	Edition (Year of publication)	Author(s)	Publisher
Test Books :				
1	Getting started in Six-sigma		Michel C Thomset	John Wiley and Sons
2	Six Sigma for every one		George Eclees	John Wiley and Sons
3	Transactinal Six sigma nad Lean servicing		Betsi Harris Ehrlich	St.Lucie Press
4	Six sigma for small business		Greg Brue	Ep- Entrepreneur press
5	Six sigma for Quality and productivity promotion	2003	Sung H.	Park Asian Productivity organization

8th Semester

ME1454	PE V : Lean Sigma	L=4	T=0	P=0	Credits=4

Reference Books				
1	Six sigma and Beyond- Vol I to VII		D. S Stamalatis	St. lucie Press
2	Demystifying Six Sigma	2003	Alan Lasson	AMCON(American management Association)
3	The Six sigma Way	2003	P.Pande R Nenman & R.Cavanagh	Mc GraHill
4	Lean Production Simplified: A plain- Language Guide to the World's Most powerful Production System	2002	Dennis, Pascal	New York: Productivity Press, ISBN: 1563272628
5	Lean Six sima		Michel L George	Mc GraHill
6	Design for Six Sigma		Kai Yang,Basen El-Haik	Mc GraHill
7	Design for Lean Six sigma			

8th Semester

ME1455	PE V : PRODUCT DESIGN AND DEVELOPMENT	L=4	T=0	P=0	Credits=4

Objective	Course Outcome
To understand the Product Life Cycle. Study different design techniques, product development phases, process selection, material selection and costs associated with PDD.[d,l]	**(I) Student will be able to design a new product.[d,l]**
	(II)Student will be able to select proper material..[l]
	(III)Student will be able to select proper manufacturing process [l]
	(IV)Student will be able to Estimate and Decide Cost.[d,l]
	(V) Student will be able to Implement product Development.[d,l]

Unit 1 **[7 hrs]**
Importance of product design, types of design, product definition, product specification, Phases of product development: conceptual, embodiment and detailed design, product and technology development cycle, concept generation and evaluation methods. **[d,l]**

Unit 2 **[7 hrs]**
Material selection – Importance, classification, material performance characteristic, Selection criteria, Ashby Material selection chart, other constrain effect. **[d,l]**

Unit 3 **[8 hrs]**
Process selection – Impotence types of manufacturing processes and their classification, sources of information, selection criteria, Material and Process selection Methods- Expert systems, Computer Database Approach, Performance indices, decision matrix, AHP and fuzzy approach, introduction to material and process selection software **[d,l]**

Unit 4 **[8 hrs]**
Benchmarking, integrated product design and development, DFM, DFA, DFX, Early supplier involvement, robust design, QFD and concurrent engineering. Introduction to green design. **[d,l]**

Unit 5 **[8 hrs]**
Mathematics of Time Value of Money, Cost Comparison, Depreciation, Taxes, Inflation, Profitability of Investment and Investment Decision Analysis Sensitivity Analysis. Methods of Cost Estimates. Industrial Engineering Approach, Parametric Approach, Introduction to Assembly Modelling, Top-Down and Bottom-Up Approaches of AM, Mating Conditions, Representation Schemes, Generations of Assembly Sequences **[d,l]**

Unit 6 **[7 hrs]**
Product Development Cycle and Importance of Prototyping, Types of Prototypes, Principle and Advantages & Different Type of Generative Manufacturing Process, Viz, Stereolithography, FDM, SLS etc. Factors Concerning to RP: Consideration for Adoptions, Advantages, Accuracy and Economic Considerations **[d,l]**

Text books:

S.N.	Title of the book	Edition (Year of publication)	Author(s)	Publisher
1	Fourth Eye (Excellence through Creativity	1992.	KHANDWALLA P.N.;	Wheeler Publishing, Allahabad,
2	Product Design and Manufacturing	4th edition, 2007	A. K. Chitale and R. C. Gupta	PHI Pvt. Ltd., 2002 ,
3	Engineering Design	4th edition 2008	Dieter George E	McGraw Hill Pub. Company

8th Semester

ME1455	PE V : PRODUCT DESIGN AND DEVELOPMENT	L=4	T=0	P=0	Credits=4

Reference Books:				
1	Product Design and Development	2003	Ulirich Karl T. and Eppinger Steven D	McGraw Hill Pub. Company
2	Handbook of Product Design for Manufacturing	1986	Bralla, James G.	McGraw Hill Pub. Company
3	I.P.R. Bulletins			TIFAC, New Delhi,
4	Creativity and innovation	2008	Harry Nystrom	John Wiley & Sons, 1979.
5	Managing technological innovation	4th edition	Brain Twiss	Pitman Publishing Ltd
6	New Product Planning		Harry B.Watton	Prentice Hall Inc.
7	Techniques in Reverse engineering and new product development.		Kevin Otto and Kristin wood.	Pearson Education

8th Semester

ME1457	PE V : Power Plant Engineering	L=4	T=0	P=0	Credits=4

Objective	Course Outcome
1.To study the basics of power generations systems. 2.To study conventional & non-conventional power plants. 3.To study the combined operations of different power plants. 4.To study Power load analysis & Economic analysis of power generations systems. **[a,c,d,e,h,j,k,l]**	(I) Student will be able to understand the various systems of thermal power plant (Steam and Gas) [a,d,h,j,l]
	(II) Student will be able to understand hydraulic power plants. [a,d.l]
	(III) Student will be able to undertake power load analysis & Economic analysis of power generations systems.[a,c,e,l]
	(IV) Student will be able to understand nuclear power plat and safety aspect.[a,h]
	(V) Student will be able to understand basics of combine cycle and Non conventional power generations systems.[a,d,h,j,l]

Unit 1 **[7 Hrs]**

THERMAL POWER PLANT- I

Introduction to thermal power plants and power plant layouts.
Fuel characteristics, handling, storage, preparation & firing methods. Ash & dust collection and handling.
Boiler: classification, general arrangement, details of different components and system like draught system, steam turbine systems, condenser, cooling towers, water treatment, Waste Disposal-Present practices, environmental hazards and other social aspects**.** [a,d,h,j,l]

Unit 2 **[8 Hrs]**

THERMAL POWER PLANT- II

Gas Turbine Power Plant: -Introduction, power plant layouts, Open cycle, close cycle power plants. Various components and systems. Methods to improve efficiency. Reheat and Regeneration cycle and their combinations
Diesel Electric Power Plant: - Introduction, Outline, type of engines, different components, performance, plant layout. Comparison with other power plant. Introduction to captive power plant.(To study the practical aspect ot power plant,the visit to nearby power plant shall be arrange for the students) **.** [a,d,h,j,l]

Unit 3 **[7 Hrs]**

HYDROELECTRIC POWER PLANT.

Hydrology: - Rainfall, Runoff, Hydro graph, flow duration curve, mass curve.
Hydroelectric power plant: - Site selection, classification of hydroelectric power plant, general arrangement, details of different components, turbine selection, models & model testing, governing.
Comparison with other power plant. **.[** a,d,l]

Unit 4 **[8 Hrs]**

POWER PLANT ECONOMICS

Load Analysis - Fluctuating Load on power plants, Load curves, various terms & definition, peak load, effect of fluctuating load.
Economic Analysis: - Cost of electric energy, load division, and. Tariff methods for Electrical Energy. **[a, c, e, l]**

Unit 5 [8 Hrs]

NUCLEAR POWER PLANT

Introduction to Nuclear Engineering, Global scenario, prominent installations worldwide, present & proposed nuclear plant in India.
Nuclear Reactors: - Types of reactors, PWR, BWR, CANDU, Gas cooled, liquid metal cooled, Breeder reactor. Operational requirements and difficulties, site selection for location of a nuclear power station Nuclear Waste Disposal-Present practices, environmental hazards and other social aspects.
Comparison with other power plant. **.[a, h]**

8th Semester

ME1457	PE V : Power Plant Engineering	L=4	T=0	P=0	Credits=4

Unit 6 **[7 Hrs]**

COMBINED OPERATION OF DIFFERENT POWER PLANTS

Combined operation: - Need division, combination of different plant & their coordination, advantages.

NON CONVENTIONAL POWER GENERATION SYSTEMS

Introduction to Non Conventional power Generation Systems

Geo-Thermal Power Plant, Tidal Power Plant, Wind Power Plant, Solar Power Plant

Global scenario, prominent installations worldwide present & proposed plant locations. **.[a, d, h, j, l]**

.Text books:

S.N.	Title of the book	Edition (Year of publication)	Author(s)	Publisher
1	Power Plant Engineering	2002	Domkundwar.	Dhanpat Rai & Co.

.Reference books:

S.N.	Title of the book	Edition (Year of publication)	Author(s)	Publisher
1	Power Plant Engineering	2007	Vopal & Slortzki	
2	Power Plant Engineering	1984	M.M. Wakil	TATA Mc-Graw Hill.
3	Power Plant Engineering	2008	P. K. Nag	TATA Mc-Graw Hill.
4	Power Plant Engineering	2005	R. K. Rajput	TATA Mc-Graw Hill.

8th Semester

ME1458	PE V : Machine Tool Design	L=4	T=0	P=0	Credits=4

Objective	Course Outcome
To develop in the engineering students the ability to analyze any engineering problem in a simple and logical manner and to apply to its solution a few, well understood basic principles. This subject consists of application of scientific principles, technical information & creative thinking for the development of a new or improved machine tools, to perform desired machining operation with maximum efficiency. **[a,e,k,l]**	((I)Students will be able to analyze components of machine tools.. **[a,e,k,l]** (II)Students will be able to design various components of machine tool like machine bed, machine drive and structure etc.. **[a,e,k,l]**

UNIT 1 **[7Hrs]**

Introduction to Machine tool drives & Mechanisms, Working & auxiliary motions in machine tools, Parameters defining the working motions of a machine tool; Machine tool drives, Hydraulic Transmission & its elements, Mecll.'U1ical Transmission & its elements, General requirements of machine tool design, layout of machine tool.**[a, e,k,l]**

UNIT 2 **[8 Hrs]**

Regulation of speed & feed rates - Aim of speed & feed regulation, Stepped regulation of speed -Various laws of stepped regulation, Selection of range ratio, Standard values of Geometric progression Ratio & guidelines for selecting proper value, break up of speed steps; Structure diagrams & their analysis, Speed classification. Design of feed box, machine tool drives using multiple speed motors, Special cases of gear box design -speed box with overlapping speed steps, speed box with a combined structure, speed box Wit11 broken geometric progression, General recommendation for developing the Gearing diagram, determining the Number of teethes of gears, Classification of speed & feed boxes. Electromechanical system of Regulation, Friction, Pressure and Ball Variation, Epicyclic Drive . **[a, e,k,l]**

UNIT 3 [7Hrs]

Machine Tool Structure - Functions of machine tool structures & their requirements, Design criteria for machine tool structU1.es, Materials of machine tool structures, Static &Dynamic stiffness, Profiles of machine tool structures, Factors affecting stiffness of machine tool structures & methods of improving it; Basic design procedure of machine tool structures -design for strength, design for stiffness. Design of Beds, Column, housings, Bases & Tables, Cross Rails, Arms, Saddles, Carriages, Rams. **[a, e,k,l]**

UNIT 4 [8Hrs]

Design of Guide ways & Power Screws - Functions & types of guide ways, Design of Sideways - Shapes, materials, methods of adjusting clearances. Design Criteria & Calculations for sideways, Design for wear resistance, Design for stiffness. Guide ways operating under liquid friction conditions -Hydrodynamic & Hydrostatic sideways, Design of Aerostatic sideways, Design of Antifriction Guide ways, Combination guide ways, protecting devices for sideways.
Design of Power Screws -Sliding friction power screws, Rolling friction Power Screws. **[a, e,k,l]**

UNIT 5 **[7Hrs]**

Design of Spindles & Spindle Supports Functions of spindle unit & requirements, Materials of spindles, design calculations of spindles – Deflection of spindle axis due to bending, deflection of spindle axis due to compliance of spindle supports, optimum spacing between spindle supports deflection due to compliance of the Tapered Joint permissible deflection & design for stiffness. Antifriction bearings -Preloading of antifriction bearing. Sliding bearings - Sleeve bearings, hydrodynamic journal bearing, and air -lubricated bearings**.** [a, e,k,l]

8th Semester

ME1458	PE V : Machine Tool Design	L=4	T=0	P=0	Credits=4

UNIT 6 **[8Hrs]**

Testing & Control of Machine Tools

a) Testing: Objects and procedure for Acceptance Test, Instrumentation for acceptance, Accuracy of machine tools, and accuracy of work pieces.

b) Control systems: Electrical control, push button control, directional control relays, electrical brakes, automation in feed mechanism

c) Hydraulic control: positional control, power pack for lubrication system in hydraulic drive.

d) Control system for gear sliding and feed mechanism (open loop or close loop) for NC/CNC machine using stepper motor or DC motor. **[a, e,k,l]**

Text books:

S.N.	Title of the book	Edition (Year of publication)	Author(s)	Publisher
1	Machine Tool Design	2007	N. K. Mehata	Tata McGraw-Hill, 1984
2	Principles of Machine Tools	2011	Gopal Chandra Sen, Amitabha Bhattacharyya	New central book agency
3	Design Of Machine Tools	5th edition 2008	Basu, Pal	Oxford and IBH Publishing, 2008
4	Principles of Machine tools		Sen and Bhattacharya	New central book agency

8th Semester

ME1459	PE V : INDUSTRIAL SAFETY	L=4	T=0	P=0	Credits=4

Objective	Course Outcome
•To understand the need and importance of safety. Study different types of accidents and its preventions. Also study the various safety equipments and their applications.	(I) Student will be able to understand the risk management [**a, c, d, e, f, g, h, i ,j ,k]**
	(II) Student will be able to handle the accidental situation in plant. [**a, c, d, e, f, g, h, i ,j ,k]**
•Learn how to get higher operating plant and equipment reliability that lifts efficiency and output of operating assets, stops equipment failures and creates higher plant and equipment reliability, with this subject. [**a, c, d, e, f, g, h, i ,j ,k]**	(III) Student will be able to understand the operations of different type of safety instruments. [**a, c, d, e, f, g, h, i ,j ,k]**
	(IV) Student will be able to arrange the training for employees on Safety. [**a, c, d, e, f, g, h, i ,j ,k]**

Unit 1 **[7Hrs]**

Introduction

Introduction to occupational safety & health, need for occupational safety, Safety Organization, Safety Policy, Safety Committee, Safety Officer, Medical Officer, Labour welfare Officer, Safety manual, Disaster management plan, Government & other autonomous occupational safety & health organizations. Introduction to OHSAS 18000**.[a, c, d, e, f, h]**

Unit 2 **[8Hrs]**

Occupational Accidents

Accident, causes of accident, cost of accident, unsafe conditions, unsafe actions, unsafe personal factors, Accident causations models, accident reporting, accident investigation & analysis, Application of remedial measures, result monitoring, Personal Protective Equipments(ppe), Types of ppe, legal provisions of accident reporting, safety performance measurement, Frequency Rate, Severity Rate, Incidence Rate, Introduction to IS:3786.[**a ,c ,d, f ,g]**

Unit 3 **[7Hrs]**

Risk Identification & Risk management

Plant safety inspection, Job safety analysis, Hazards identification & Risk analysis **(HIRA)**, Fault tree analysis **(FTA)**, Hazards & operability Study **(HAZOP)**, Failure mode & Effect analysis**(FMEA)**, Failure mode, criticality & effect analysis **(FMCEA)**, Safety audits, Safety Integrity Level **(SIL)**, Level of Protection Analysis **(LOPA)**.**[a, d, g,h ,I ,k]**

Unit 4 **[7Hrs]**

Safety & The Law

Introduction to various Laws & Rules pertaining to Safety, Health & Welfare of Indian work-force. Provisions of Factories Acts' 1948 pertaining to Safety only, **[b, c, d, e, g, h]**

Unit 5 **[8Hrs]**

Safety with Machines

Safety in design, Plant layout & housekeeping, Machine maintenance, Machine guarding, types of machine guards, special tools for enhancing safety, safety in use of compressed gas cylinder, safety around grinding wheel, safety in drill machines, safety in use of hand tools, safety in press machines, handling and disposal of hazardous chemicals, electrical safety, fire safety**.[a, c, d, i, j, k,]**

Unit 6 **[7Hrs]**

Safety Training & Awareness

Safety training and safety education, safety awareness methods viz safety competitions, safety posters and hording, safety magazine, safety pamphlets, safety campaign, Tool-Box talk, Employees participation in promoting safety**.[a, c, d, i, j, k]**

Text books:

S.N.	Title of the book	Edition (Year of publication)	Author(s)	Publisher
1	Industrial Safety	3rd editiion	Roland Patton Blake	Prentice-Hall, 1963
2	Industrial Safety	1977	Jack W. Boley	Gulf Publishing Company, Book Division,

8th Semester

ME1460	**PE V : Advance Welding Techniques**	**L=4**	**T=0**	**P=0**	**Credits=4**

Objective	Course Outcome
To study and analyze various welding methods with advanced techniques to pin engineering materials [c,m]	**1.Student will understand the concept of advance welding processes applicable to industry.[c,m]**
	2.Student can understand the parameters needed for welding to increase the durability of product.[c,m]

Unit 1 **[8 hrs]**
High energy Density Welding processes, Mode of metal transfer in welding, Electron Beam Welding, Principle Bead geometry, Mediums of beam, Vacuum range, Laser Beam welding, Principle, Keyhole technique, applications, Laser materials, Gaseous Lasers..**[c,m]**

Unit 2 **[7 hrs]**
Resistance Welding Methods, Variations in the process, Effect of current, Pressure and resistance on nugget quality, Expulsion of metal, Mushrooming of electrodes, Materials, Direct spot welding, two sides spot welding, multiple spot welding, Shunt current, Electrode material, Seam welding, Projection welding, Butt welding, Flash butt welding, applications. **[c,m]**

Unit 3 **[8 hrs]**
Solid state welding Processes, Friction, Welding, Principle, Variables affecting weld quality, Heat generated, Machines used, Ultrasonic welding, Principle, Comparison with Resistance Spot Welding,Diffusion Bonding., Explosive Welding. **[c,m]**

Unit 4 [7 hrs]
Brazing, Soldering, ,Capillary action, wetting action, joint designs for sheet metal brazements, brazing filler wire, Butt Joint design for sheet metal brazements, brazing methods, filler materials in brazing, Soldering, materials solder combinations, soldering fluxes,
Oxy-fuel welding with chemical reaction . Welding problems and remedies for ferrous and non-ferrous metals. [c,m]

Unit 5 **[8 hrs]**
Cutting:- Arc cutting, Flame cutting, Plasma cutting, Gouging, Plasma cutting with different gases, Comparision with Oxyacetylene cutting, Oxyacetylene cutting, colour codes for cylinder.
Arc welding processes with consumable and non-consumable electrodes**,** Use of Inert Gas, Submerg arc welding. **[c,m]**

Unit 6 **[7 hrs]**
Welding defects, Weldment testing, Destructive and non destructive testing, Coupon, Determination of yield strengths, ultimate strength, visual Inspection, Dye Penetrant test, penetrants and developers, Eddy current testing, Ultrasonic testing, Magnetic particle Inspection , advantages and application of each method.Welding Procedure specifications, Weldor qualification. **[c,m]**

8th Semester

ME1460	PE V : Advance Welding Techniques	L=4	T=0	P=0	Credits=4

Reference books

Text books:				
S.N.	**Title of the book**	**Edition (Year of publication)**	**Author(s)**	**Publisher**
1	Welding and Welding Technology	2008	Richard Little	McGraw-Hill, 1973
2	Welding	10th edition	A. C. Davies, Davies	Cambridge University Press, 2002
3	Laser Machining and Welding	2007	Rykalin, Uglov, kokora	Pergamon Press, 1978
4	Welding Engineering and Technology	1997	R. S. Parmar	Khanna, 1997
5	Welding Metallurgy	2nd edition 2003	Sindo Kau	John Wiley & Sons, 2003
6	Manufacturing Science		Ghosh and Mallik	Ellis Horwood
7	Manufacturing Technology Vol-I 3E	3rd edition 2009	P.N.Rao	Tata McGraw-Hill Education,

8th Semester

ME1482	PE-V : Air Conditioning	L=4	T=0	P=0	Credit=4

Objectives	Outcome
II)To study about psychrometric properties and change in properties in different psychrometric process. III) To explain about design of year round air conditioning system and duct design IV) To explain the method of cooling load calculation for human comfort .	COI- student will be able to understand various psychrometric properties COII- student will be able to understand and change in psychometric properties in the process.[a,e,k] COIII- student will be able to student will be able to design year round air conditioning system.[a,e,k] COIV- student will be able to find out cooling load calculation and understand different parameters for human comfort..[a,e,k] COV- student will be able to understand industrial practices in air conditioning.[a,e,k] COVI- student will be able to understand air distribution and duct design system..[a,e,k]

UNIT I Fundamentals of Air conditioning
Introduction to air conditioning, psychometrics, important terms and definitions, enthalpy of air, adiabatic saturation ,temperature, psychrometric properties, psychometric chart, its construction and use. [a,e,k]

UNIT II Psychometric processes
Sensible heating and cooling, humidification and dehumidification, adiabatic mixing, bypass factor, evaporative cooling, drying process, air-washer.[a,e,k]

UNIT III Air-conditioning systems
Sensible heat factor, design of summer air conditioning system, calculation of dehumidified air quantity and apparatus dew point, ERSHF method, air-conditioning systems for monsoon and winter, air conditioning systems using all fresh air. **[a,e,k]**

UNIT IV Comfort and Cooling load Estimation
Comfort and its requirements, mechanism of body heat loss, effect of heat on body and body defence mechanism, effective temperature, comfort chart and its use, factors affecting human comfort, Cooling load estimation, components of cooling load, sensible and latent loads, ASHRAE methods of load estimation. Cold storage heat load calculation **[a,e,k]**

UNIT V Industrial practices in Air conditioning
General layout of central air conditioning Plant, , selection of pump.
Fans, types and characteristics, filters types and selection, defrosting methods Systems .Applications of air conditioning, working of room air-conditioning and split air-conditioning and package air conditioning. **[a,e,k]**

UNIT VI Air Distribution and duct design
Components of air handling systems, principles of air distribution, types of supply and return air openings and related definitions, consideration s for selection and location of supply and return air openings. Duct design: General duct design rules, equivalent diameter of ducts ducting materials, friction chart and its use, methods of duct design. Visit to central air conditioning unit, frozen food processing unit. **[a,e,k]**

8th Semester

ME1482	**PE-V : Air Conditioning**	**L=4**	**T=0**	**P=0**	**Credit=4**

Recommended Books:

1. Dossat Roy J.; Principles of Refrigeration, 4th Ed.; Pearson Education Asia Publication
2. Arora C.P.; Refrigeration and Air conditioning, 2nd Ed.; Tata Mc Graw Hill Publication
3. Ballaney P.L.; Refrigeration and Air conditioning; Khanna publishers
4. Prasad Manohar; Refrigeration and Air conditioning, 2nd Ed.; New edge Publication
5. Arora, Domkundwar; A course in Ref. &Air Conditioning, 7th Ed.; Dhanpat Rai Publications.
7. Pita Edward G.; Air conditioning principles and systems, 4th Ed.; Prentice Hall
8. ASHRAE handbook and CARRIER hand book.

8th Semester

ME1483	PE V: Cryogenic Systems	L=4	T=0	P=0	Credit=4

Objectives	Outcome
	After learning the course the students should be able to: Properties of material at low temperature. Pressure, temperature, flow, fluid quality and liquid level measurement at low temperature. Different types of cryogenic insulations. Different cryogenic applications. Low temperature hazards. After learning the course the students should be able to know about different methods of producing cryogenic temperature, types of cryocoolers, Liquefaction of gases.

Unit I: - Introduction to Cryogenics System
Introduction, application areas of cryogenic engineering, Low temperature properties of engineering materials, Properties of cryogenic fluid.

Unit II: - Gas liquefaction System
Open and closed cycles, liquefaction system such as Linde Hampson, Claude cycle for liquefaction, liquefaction system for hydrogen and helium and other gases, Simulation of performance of different liquefaction cycles.

Unit III: - Gas Cycle Cryogenic Refrigeration System
Cryogenic Refrigerators – Recuperative and Regenerative cycles, Microminiature and miniature cryocoolers for space and defence applications.

Unit IV: - Gas Separation and Gas Purification Systems
Design criteria for equipment associated with low temperature systems – heat exchangers, compressors, expanders, Separation and purification systems, and commercial air separation cycles.

Unit V: - Cryogenic Fluid Storage and Transfer Systems
Cryogenic fluid storage vessels, Inner vessel, Outer Insulation, Suspension system, Cryogenic fluid transfer, External pressurization, Self pressurization, Transfer pump. Industrial Safety and handling of cryogens.

Unit VI: - Application of Cryogenic Systems
Cryogenic application for food preservation – Instant Quick Freezing techniques, Super conductive devices, Cryogenic applications for space technology.

References:-
1. Randall F. Barron, "Cryogenics Systems", Second Edition Oxford University Press New York, Clarendon Press, Oxford, 1985.
2. Timmerhaus, Flynn, "Cryogenics Process Engineering", Plenum Press, New York.
3. Cryogenics fundamentals, HaseldonG, Academic press.1971
4. Advance cryogenic –bailey, plenum press

8th Semester

ME1484	**Tribology**	**L= 3**	**T=0**	**P=0**	**Credits=3**

Course Objectives
Tribology deals with design of fluid containment systems like seals and gasket, Lubrication of surfaces in relative motion to achieve reduced friction and wear. The structure of the bearing and the nature of fluid flow determine the loads that can be supported. Modeling systems as hydrostatic squeeze film and Elasto-hydrodynamic lubrication will be studied as infinite and later finite structures. Gas (air) lubricated and rolling contact type motions with deformation at contact will be studied as special systems.

UNIT-1: Introduction
Introduction to tribology, History of tribology, Interdisciplinary Approach, Economic Benefits.

UNIT-2: Friction
Causes of Friction, Adhesion Theory, Abrasive Theory, Junction Growth Theory, Laws of Rolling Friction, Friction Instability.

UNIT-3: Wear
Wear Mechanisms, Adhesive Wear, Abrasive Wear, Corrosive Wear, Fretting Wear, Wear Analysis

UNIT-4: Lubrication and Lubricants
Importance of Lubrication, Boundary Lubrication , Mixed Lubrication , Full Fluid Film Lubrication ; Hydrodynamic, Elastohydrodynamic lubrication , Types & Properties of Lubricants, Lubricants Additives.

UNIT-5: Fluid film lubrication
Fluid mechanics concepts, Equation of Continuity & Motion, Generalised Reynolds Equation with Compressible & Incompressible Lubricants.

UNIT-6: Application Tribology
Introduction, Rolling Contact Bearings, Gears, Journal Bearings - Finite Bearings.

Reference Books:
1. Dowson D, History of Tribology, Longman London, 1979.
2. Stachowiak G N, Batchelor A W and Stachowick G B "Experimental methods in Tribology", Tribology Series 44, Editor D Dowson, 2004.
3. Michael M Khonsari, Applied Tribology (Bearing Design and Lubrication),John Wiley & Sons, 2001.
4. Jost H P, Lubrication (Tribology) : A Report on the present position and industry`s needs, Her Majesty`s Stationary Office, London, 1966.
5. J Halling, Principles of Tribology, The Macmillan Press Ltd, London, 1975.
6. Archard J F and Hirst W, The Wear of Metals under Unlubricated Conditions, Proc. R. Soc., London, A 236, 397-410, 1956.
7. Ludema K C, Friction, Wear, Lubrication: A textbook in Tribology, CRC Press, 2010.

8th Semester

ME1472	Comprehension Viva Voce	L=0	T=0	P=0	Credits=3

Objective	Course Outcome
To equip the students with the thorough knowledge of the Mechanical Engineering branch. Through knowledge of each and every subject learnt till date. This will be helpful for preparations of competitive examinations and campus interviews.[i]	(I)The student will able to give good performance in competitive examinations. [i]
	(II) The student will able to give good performance in campus recruitments. [i]

COMP. VIVA VOCE

The viva voce will be on complete syllabus learnt during the period of 4 years for completion of studies to obtain the degree of Mechanical Engineering.

8th Semester

ME1473	PROJECT – Phase-II	L=0	T=0	P=8	Credits=8

Objective	Course Outcome
The project topic for the batch is decided in the 1st semester of final year, the student shall carry out the project work further 2nd semester of final year. [d,e,g,j,k,l]	(I)The student will able to understand various facets of engineering problems..**[d]**
	(II)The student will able to communicate his ideas with others **[g]**
	(III)The student will able to identify various solutions of engineering problems. **[e]**
	(IV)The student will able to understand the need to update knowledge. **[j]**
	(V)The student will able to use latest techniques to find solutions. **[k,l]**

S.No	Rubrix
I	Objective and literature survey
II	Innovativeness,Presentation and reasoning skill
III	Working & fabrication,experinentation
IV	Presentation of result and discussion
V	Paper presentation

Evaluation : The term work will be assessed by the project guide. The students will be examined by the external examiner and the project guide. Marks will be allotted on the basis of work done and performance in the examination.

8th Semester

ME1474	EXTRA CURRICULUR ACTIVITIES	L=0	T=0	P=0	Credits=2

Objective	Course Outcome
To develop the personality of student, nurture his talent and help him to achieve the goals. **To inculcates the some responsibility towards society in general.** **To communicate and develop the team work ability.[f,g,i]**	(I)The student will be able to develop his hobbies and interests..[i]
	(II)The student will be able to communicate and work in team..[g]
	(III)The student will be able to develop the sense of responsibility..[f]

EXTRA CURRICULUR ACTIVITIES

Every student has to participate in at least two extra-curricular activities from Second year. The certificate of these activities to be submitted to the related Coordinator/head of the department.
The credit for these activities shall be given in 8th semester.