GOVERNMENT COLLEGE OF ENGINEERING
SALEM - 636 011
(An Autonomous Institution Affiliated to Anna University, Chennai)

REGULATIONS 2023

CURRICULUM AND SYLLABUS

(For Candidates admitted from 2023 - 2024 onwards)

DEPARTMENT OF MECHANICAL ENGINEERING

(PART TIME PROGRAMME)

B.E. Mechanical Engineering- Part Time

Code No.	Course	Category	Hours/Week			Credits	Maximum Marks		
			Lecture	Tutorial*	Practical		CA	FE	Total
SEMESTER - I									
THEORY									
23PTMA101	Mathematics – I	BS	3	0	0	3	40	60	100
23PTCY101	Environmental Science and Engineering	ES	3	0	0	3	40	60	100
23PTME101	Engineering Thermodynamics	PC	3	0	0	3	40	60	100
23PTME102	Fluid Mechanics and Machinery	PC	3	0	0	3	40	60	100
23PTME103	Manufacturing Technology - I	PC	3	0	0	3	40	60	100
	Total		**15**	**0**	**0**	**15**	**200**	**300**	**500**
SEMESTER – II									
THEORY									
23PTMA201	Mathematics - II	BS	3	0	0	3	40	60	100
23PTEE205	Basic Electrical and Electronics Engineering	ES	3	0	0	3	40	60	100
23PTME201	Engineering Mechanics	ES	3	0	0	3	40	60	100
23PTME202	Thermal Engineering	PC	3	0	0	3	40	60	100
23PTME203	Manufacturing Technology - II	PC	3	0	0	3	40	60	100
	Total		**15**	**0**	**0**	**15**	**200**	**300**	**500**
SEMESTER - III									
THEORY									
23PTMA301	Numerical Methods	BS	3	0	0	3	40	60	100
23PTCS301	Fundamental of Problem Solving and C Programming	ES	3	0	0	3	40	60	100
23PTME301	Strength of Materials	PC	3	0	0	3	40	60	100
23PTME302	Kinematics of Machinery	PC	3	0	0	3	40	60	100
23PTME303	Engineering Materials and Metallurgy	PC	3	0	0	3	40	60	100
	Total		**15**	**0**	**0**	**15**	**200**	**300**	**500**
SEMESTER - IV									
THEORY									
23PTME401	Engineering Metrology and Instrumentation	PC	3	0	0	3	40	60	100
23PTME402	Design of Machine Elements	PC	3	0	0	3	40	60	100
23PTME403	Refrigeration and Air conditioning	PC	3	0	0	3	40	60	100
23PTME404	Dynamics of Machinery	PC	3	0	0	3	40	60	100
PRACTICAL									
23PTME405	CAD/CAM Laboratory	PC	0	0	3	1.5	60	40	100
	Total		**12**	**0**	**3**	**13.5**	**220**	**280**	**500**

Code No.	Course	Category	Hours/Week			Credits	Maximum Marks		
			Lecture	Tutorial*	Practical		CA	FE	Total
SEMESTER -V									
THEORY									
23PTME501	Heat and Mass Transfer	PC	3	0	0	3	40	60	100
23PTME502	Design of Transmission System	PC	3	0	0	3	40	60	100
23PTME503	Applied Hydraulics and Pneumatics	PC	3	0	0	3	40	60	100
23PTME504	Solar and Wind Energy System	PC	3	0	0	3	40	60	100
23PTME505	Automobile Engineering	PC	3	0	0	3	40	60	100
	Total		**15**	**0**	**0**	**15**	**200**	**300**	**500**
SEMESTER – VI									
THEORY									
23PTME601	Industrial Engineering	PC	3	0	0	3	40	60	100
23PTME602	Mechatronics	PC	3	0	0	3	40	60	100
23PTMEEEXX	Professional Elective – I	PE	3	0	0	3	40	60	100
23PTMEEEXX	Professional Elective - II	PE	3	0	0	3	40	60	100
PRACTICAL									
23PTME603	Simulation Laboratory	PC	0	0	3	1.5	60	40	100
	Total		**12**	**0**	**3**	**13.5**	**220**	**280**	**500**
SEMESTER - VII									
THEORY									
23PTME701	Finite Element Analysis	PC	3	0	0	3	40	60	100
23PTME702	Operation Research	PC	3	0	0	3	40	60	100
23PTMEEEXX	Professional Elective - III	PE	3	0	0	3	40	60	100
23PTMEEEXX	Professional Elective - IV	PE	3	0	0	3	40	60	100
	Total		**12**	**0**	**0**	**12**	**160**	**240**	**400**
SEMESTER - VIII									
THEORY									
23PTME801	Total Quality Management	PC	3	0	0	3	40	60	100
23PTMEEEXX	Professional Elective - V	PE	3	0	0	3	40	60	100
23PTMEEEXX	Professional Elective - VI	PE	**3**	**0**	**0**	**3**	40	60	100
PRACTICAL									
23PTME802	Project Work	EEC	0	0	6	3	120	80	200
	Total		**6**	**0**	**6**	**12**	**200**	**200**	**500**
	Grand Total					**111**			**3900**

List of Group Electives (Professional Electives) (PE)

Code	Course	Hours/Week			Credit	Maximum Marks		
		L	T	P		CA	FE	Total
Electives-VI SEMESTER								
23PTMEE01	Aeronautical Engineering	3	0	0	3	40	60	100
23PTMEE02	Advanced Internal Combustion Engines	3	0	0	3	40	60	100
23PTMEE03	Advanced Strength of Materials	3	0	0	3	40	60	100
23PTMEE04	Composite Materials	3	0	0	3	40	60	100
23PTMEE05	Design of Production Tooling	3	0	0	3	40	60	100
23PTMEE06	Gas Dynamics and Jet propulsion	3	0	0	3	40	60	100
23PTMEE07	Power Plant Engineering	3	0	0	3	40	60	100
23PTMEE08	Rapid Product Development Technologies	3	0	0	3	40	60	100
23PTMEE09	Industrial Psychology	3	0	0	3	40	60	100
Electives-VII SEMESTER								
23PTMEE10	Concurrent Engineering	3	0	0	3	40	60	100
23PTMEE11	Entrepreneurship Development	3	0	0	3	40	60	100
23PTMEE12	Fracture Mechanics and Failure Analysis	3	0	0	3	40	60	100
23PTMEE13	Maintenance Engineering	3	0	0	3	40	60	100
23PTMEE14	Marine Engineering	3	0	0	3	40	60	100
23PTMEE15	Nano Technology	3	0	0	3	40	60	100
23PTMEE16	Nuclear Engineering	3	0	0	3	40	60	100
23PTMEE17	Product Design and Costing	3	0	0	3	40	60	100
23PTMEE18	Thermal Turbo Machines	3	0	0	3	40	60	100
Electives-VIII SEMESTER								
23PTMEE19	Computer Integrated Manufacturing	3	0	0	3	40	60	100
23PTMEE20	Introduction to Computational Fluid Dynamics	3	0	0	3	40	60	100
23PTMEE21	Marketing Management	3	0	0	3	40	60	100
23PTMEE22	Modern Concepts of Engineering Design	3	0	0	3	40	60	100

23PTMEE23	Process Planning and Costing	3	0	0	3	40	60	100
23PTMEE24	Production Planning and Control	3	0	0	3	40	60	100
23PTMEE25	Professional Ethics and Human Values	3	0	0	3	40	60	100
23PTMEE26	Robotics	3	0	0	3	40	60	100
23PTMEE27	Safety Engineering	3	0	0	3	40	60	100

23PTMA101	MATHEMATICS - I	Semester			I
PREREQUISITES	Category	BS	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	To make the student acquire sound knowledge of techniques in solving ordinary and partial differential equations that model engineering problems.
2	To make the student to understand the techniques in solving partial differential equations that model engineering problems
3	To acquaint the student with the concepts of vector calculus, needed for solving engineering problems.
4	To understand the concept of analytic functions.
5	To obtain the knowledge of complex integration.

Unit I	ORDINARY DIFFERENTIAL EQUATION	9	0	0	9

Higher order linear differential equations with constant coefficients – Method of variation of parameters – Cauchy's and Legendre's linear equations.

Unit II	PARTIAL DIFFERENTIAL EQUATIONS	9	0	0	9

Formation of partial differential equations by elimination of arbitrary constants and arbitrary functions – Lagrange's linear equation – Homogeneous linear partial differential equations of second order with constant coefficients.

Unit III	VECTOR CALCULUS	9	0	0	9

Gradient, divergence and curl – Directional derivative – Irrotational and solenoidal vector fields – Vector integration – Statement of Gauss divergence theorem and Stokes theorem – Simple applications involving cubes and rectangular parallelopipeds.

Unit IV	ANALYTIC FUNCTIONS	9	0	0	9

Functions of a complex variable – Analytic functions – Necessary conditions, Cauchy – Riemann equation and sufficient conditions (excluding proofs) – Properties of analytic function – Harmonic conjugate – construction of analytic functions – Conformal mapping: w= z+c, cz, 1/z and bilinear transformation.

Unit V	COMPLEX INTEGRATION	9	0	0	9

Complex integration – Statement and applications of Cauchy's integral theorem and Cauchy's integral formula – Taylor's and Laurent's expansions – Singular points – residues – Residue theorem – Application of residue theorem to evaluate real integrals over unit circle and semi-circular contours (excluding poles on boundaries).

Total (45L) =45 Periods

Text Books:	
1	Grewal. B.S, "Higher Engineering Mathematics", 43rd Edition, Khanna publications, Delhi, 2014.
2	P. Kandasamy, K. Thilagavathy and K. Gunavathy, Engineering Mathematics (For I year B.E., B.Tech), Ninth Edition, S. Chand & Co. Ltd. New Delhi, 2010.
Reference Books:	
1	James Stewart, "Calculus with Early Transcendental Functions", Cengage Learning, New Delhi, (2008).
2	Veerarajan T. Engineering mathematics (For semester I and II), 5th Edition, Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2009.
3	Erwin Kreyszig, "Advanced Engineering mathematics", 7th Edition, Wiley India, 2007.
4	Jain R.K. and Iyengar S.R.K, "Advanced Engineering mathematics", 3rd Edition, Narosa Publishing House Pvt. Ltd., 2007.

Course Outcomes: Upon completion of this course, the students will be able to:	
CO1	Find the techniques of solving ordinary differential equations that arise in engineering problems.
CO2	Find the techniques of solving partial differential equations that arise in engineering problems.
CO3	Apply the concept of vector calculus and vector integration.
CO4	Understand analytic function and its properties.
CO5	Evaluate various integrals by using Cauchy's residue theorem.

23PTCY101	ENVIRONMENTAL SCIENCE AND ENGINEERING	Semester			I
PREREQUISITES	Category	ES	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

To make the student conversant with the Principles of environmental resources, Preservation of ecosystem and biodiversity, Principles of environmental threats and pollution, Principles of solid waste management and Environmental issues and ethics.

Unit I	ENVIRONMENTAL RESOURCES	9	0	0	9

Forest resources – importance, deforestation – water resources – hydrological cycle – food resources – effects of modern agriculture, fertilizers, pesticides – mineral resources –types – mining - environmental effects of extracting and using mineral resources – Land Resources- Land degradation-soil erosion.

Unit II	ECOSYSTEM AND BIODIVERSITY	9	0	0	9

Environment – biotic and abiotic components – Ecosystem – components – food chain and food web, tropic levels – energy flow in ecosystem, ecological pyramids – ecological succession, types – Biodiversity, types, values of biodiversity, hotspots of biodiversity, threat to biodiversity, endangered and endemic species, conservation of biodiversity – In-situ and Ex-situ conservation.

Unit III	ENVIRONMENTAL POLLUTION	9	0	0	9

Air pollution – classification of air pollutants - gaseous, particulates – sources, effects and control of gaseous pollutants, SOx, NOx, H2S, CO and particulates – control methods – cyclone separator, electrostatic precipitator, catalytic convertor – Water pollution – heavy metal ions pollutants – organic pollutants, oxygen demanding wastes, aerobic and anaerobic decomposition, BOD and COD - experimental determination of BOD only, treatment of domestic and industrial wastewater – Noise pollution –decibel scale - sources, effects and control measures.

Unit IV	ENVIRONMENTAL THREATS AND SOLID WASTE MANAGEMENT	9	0	0	9

Acid rain, greenhouse effect and global warming, ozone layer depletion, photochemical smog, eutrophication, bio amplification – disaster management – origin, effects and management of earthquake and floods. Solid waste management – solid wastes, classification, origin, effects – treatment methods – composting, sanitary land filling – destructive methods – incineration, pyrolysis, reduce, reuse and recycling – e-waste – sources, effects and disposal

Unit V	SOCIAL ISSUES AND ENVIRONMENTAL ETHICS	9	0	0	9

From unsustainable to sustainable development, objectives and ways of achieving – urban problems related to energy and energy conservation – water conservation and management, rain water harvesting – waste land reclamation. Environmental ethics – consumerism – human population, exponential and logistic growth, variation in population among countries, population explosion, population policy, family welfare programme – population control methods – HIV and AIDS.

Total (45L) = 45 Periods

Text Books:	
1	Elements of Environmental science and Engineering, P.Meenakshi, Prentice Hall of India, New Delhi, 2009.
2	A Textbook of Environmental Chemistry and Pollution Control: (With Energy, Ecology, Ethics and Society), Revised Edition, Dr. S.S. Dara, D.D. Mishra Published by S. Chand & Company Ltd, 2014.
Reference Books:	
1	Introduction to Environmental Engineering and Science, Gilbert M. Masters; Wendell P. Ela Publisher: Prentice-Hall India, 3rd Edition, 2008.
2	Environmental Science, Eldren D. Enger, Bredley F.Smith, WCD McGraw Hill 14th Edition 2015.

Course Outcomes:	
Upon completion of this course, the students will be able to:	
CO1	Play an important role in conservation of natural resources for future generations.
CO2	Paraphrase the importance of ecosystem and biodiversity
CO3	Analyze the impact of pollution and hazardous waste in a global and social context
CO4	Understand contemporary issues that result in environmental degradation that would attempt to provide solutions to overcome the problems.
CO5	Consider the issues of environment and human population in their professional undertakings.

23PTME101	ENGINEERING THERMODYNAMICS	Semester			I
PREREQUISITES	Category	PC	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	To impart the knowledge on concepts of zeroth and first law of thermodynamics.
2	To make the learners to understand the third law of thermodynamics and analyze the various work and heat interactions in closed and open systems.
3	To teach properties of pure substance.
4	To impart knowledge on the concepts of steam power cycle.
5	To derive thermodynamic relations for ideal and real gases.

Unit I	BASIC CONCEPT AND FIRST LAW	9	0	0	9

Role of Thermodynamics in Engineering and Science - Applications of Thermodynamics. Basic concepts - concept of continuum, macroscopic approach, thermodynamic systems. Property, state, path and processes, quasi-static process, Thermodynamic equilibrium, Displacement work, P-V diagram. Zeroth law of thermodynamics – concept of temperature and heat. First law of thermodynamics – application to closed and open systems, internal energy, specific heat capacities, enthalpy, steady flow process with reference to various thermal equipment.

Unit II	SECOND LAW AND ENTROPY	9	0	0	9

Heat engine – Refrigerator – Heat Pump, Second law of thermodynamics – Kelvin and Clausius statements- Equivalence of these statements and their corollaries. Reversibility and irreversibility. Carnot cycle, Reversed Carnot cycle. Clausius inequality, Concept of entropy, principle of increase of entropy, T-s diagram, T-ds equations.

Unit III	PROPERTIES OF PURE SUBSTANCES	9	0	0	9

Steam - formation and its thermodynamic properties - p-v, p-T, T-v, T-s, h-s diagrams. PVT surface. Determination of dryness fraction. Calculation of work done and heat transfer in non-flow and flow processes using Steam Table and Mollier Chart.

Unit IV	STEAM POWER CYCLE	9	0	0	9

Standard Rankine cycle, Performance Improvement - Reheat cycle, Regenerative cycle and their combination cycles.

Unit V	IDEAL AND REAL GASES AND THERMODYNAMIC RELATIONS	9	0	0	9

Properties of ideal and real gases, equation of state of ideal and real gases, Avogadro's law, Vander Waal's equation of states, Principle of corresponding states, reduced properties and compressibility chart. Exact differentials, Maxwell relations, Specific heat equations, T-ds relations, Clausius Clapeyron equations and Joule Thomson Coefficient.

Total (45L) = 45 Periods

Text Books:	
1	Nag. P.K, "Engineering Thermodynamics", Tata McGraw-Hill, New Delhi, 1998.
2	Sonntag, R.E., Borgnakke, C., and Van Wylen, G.J., Fundamentals of Thermodynamics, 6th ed., John Wiley, 2003.
3	Arora C.P, "Thermodynamics", Tata McGraw Hill, New Delhi, 2003.
4	Venwylen and Sontag, "Classical Thermodynamics", Wiley Eastern, 1987.
Reference Books:	
1	Cengel, "Thermodynamics- An Engineering Approach", 3rd Edition, Tata McGraw Hill, 2003.
2	Merala C, Pother, Craig W and Somerton, "Thermodynamics for Engineers", Schaum Outline Series, Tata McGraw Hill, New Delhi, 2004.

Course Outcomes: Upon completion of this course, the students will be able to:	
CO1	Understand the concepts of zeroth, first and second law of thermodynamics.
CO2	Analyze the various work and heat interactions for different types of processes for closed and open systems
CO3	Evaluate the different properties of pure substances using steam tables and Mollier chart.
CO4	Analyze the performance of Rankine cycle.
CO5	Derive thermodynamic relations for ideal and real gases.

23PTME102	FLUID MECHANICS AND MACHINERY	Semester			I
PREREQUISITES	Category	PC	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	To study the applications of the conservation laws to flow through pipes and hydraulic machines.
2	To understand the importance of dimensional analysis.
3	To understand the importance of various types of flow in pumps and turbines.

Unit I	INTRODUCTION	9	0	0	9

Definitions and units of measurement of physical quantities. Behaviour of fluids - density, relative density, bulk modulus of elasticity, vapour pressure, surface tension, capillarity and viscosity. Fluid Statics: Concept of Hydrostatic Pressure, Manometers. Buoyancy and Archimedes' principle.

Unit II	FLUID KINEMATICS	9	0	0	9

Classification of fluid flows, streamline, streak line, path line, stream function, velocity potential function, vorticity and circulation, flow net. Continuity equation and applications. Fluid Dynamics: Bernoulli's equation and its applications. Dimensional Analysis: Buckingham Π theorem, similarity laws and models.

Unit III	INCOMPRESSIBLE FLUID FLOW	9	0	0	9

Viscous flow – Navier-Stokes equation. Shear stress, pressure gradient relationship. Laminar flow through circular pipes, Laminar flow between parallel plates. Turbulent flow through pipes. Friction factors in turbulent flow. Moody's friction factor chart. Flow through Pipes: Series and Parallel, Power transmission. Boundary Layer flows: Boundary layer thickness, Boundary layer separation, Drag and Lift coefficients.

Unit IV	HYDRAULIC TURBINES	9	0	0	9

Fluid Machines - classification, Euler's equation for turbo machines. Working principles, velocity triangles, work done, specific speed, efficiency and performance curves of Pelton, Francis and Kaplan turbines.

Unit V	HYDRAULIC PUMPS	9	0	0	9

Classification of pumps. Centrifugal pumps - working principle, velocity triangle, specific speed, efficiency and performance curves. Reciprocating pumps - classification, working principle, indicator diagram, air vessels and performance curves. Cavitation in pumps. Working principles of gear and vane pumps.

Total (45L) = 45 Periods

Text Books:

1. Bansal, R.K., "Fluid Mechanics and Hydraulic Machines", Laxmi Publication Pvt Ltd, 2007.

2	Kumar, D.S., “Fluid Mechanics and Fluid Power Engineering”, S.K.Kataria Sons, 2009.
3	Subramanya, K., “Fluid Mechanics”, Tata McGraw Hill publishing company Ltd, 2007.
4	Rajput, R.K., “Fluid Mechanics and Hydraulic Mechanics”, S.Chand and Company Ltd, 2002.
Reference Books:	
1	Streeter, V.L and Wyile, E.B., “Fluid Mechanics”, Mc-Graw-Hill, 1999.
2	Som, S.K and Biswas, G, “Introduction to Fluid Mechanics and Fluid Machines”, Tata McGraw Hill publishing company Ltd., New Delhi, 1998.

Course Outcomes: Upon completion of this course, the students will be able to:	
CO1	Understand the definitions of fundamental concepts of fluid mechanics such as continuum, surface tension, capillary effect etc., and also fundamental concepts of buoyancy and Archimedes principle.
CO2	Apply the Bernoulli equation to solve problems in fluid mechanics.
CO3	Understand the concepts of viscous flow and also have a knowledge in boundary layer concept.
CO4	Apply the principles of fluid mechanics to the design and operation of hydraulic turbines.
CO5	Apply the principles of fluid mechanics to the design and operation of hydraulic pumps.

23PTME103	MANUFACTURING TECHNOLOGY - I	Semester			I
PREREQUISITES	Category	PC	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	To expose the students to various casting, joining, metal forming and metal cutting (turning) processes
2	To introduce the concepts of basic manufacturing processes and fabrication techniques, such as metal casting, metal joining, metal forming and manufacture of plastic components

Unit I	THEORY OF METAL CUTTING	9	0	0	9

Introduction: material removal processes, types of machine tools theory of metal cutting: chip formation, orthogonal metal cutting, cutting tool materials, tool wear, tool life, surface finish, cutting fluids.

Unit II	CENTRE LATHE AND SPECIAL PURPOSE LATHES	9	0	0	9

Centre lathe, constructional features, cutting tools, various operations, taper turning methods, thread cutting methods, special attachments, machining time and power estimation. Capstan and turret lathes – automatic lathes: semi-automatic, automats – single spindle: cutting off, Swiss type, automatic screw type – multi spindle; cutting off, bar type

Unit III	RECIPROCATING AND MILLING MACHINES	9	0	0	9

Reciprocating machine tools: shaper, planer, slotter, Mlling: types, milling cutters, operations; hole making: drilling, reaming, boring, tapping

Unit IV	ABRASIVE PROCESS, SAWING AND BROACHING	9	0	0	9

Abrasive processes: grinding wheel – specifications and selection, types of grinding process – cylindrical grinding, surface grinding, centreless grinding – honing, lapping, super finishing, polishing and buffing, abrasive jet grinding-Sawing machine: hack saw, band saw, circular saw; broaching machines: broach construction – push, pull, surface and continuous broaching machines.

Unit V	CNC MACHINE TOOLS AND PART PROGRAMMING	9	0	0	9

Numerical control (NC) machine tools – CNC: types, constructional details, special features. Part programming fundamentals – manual programming – computer assisted part programming –APT language.

Total (45L) = 45 Periods

Text Books:

1	Rao, P.N. "Manufacturing Technology- Metal Cutting and Machine Tools", Tata McGraw Hill, New Delhi, 2003.
2	Sharma, P.C, "A Text Book of Production Engineering", S. Chand and Co. Ltd, 4th Edition, 1993

3	HMT, “Production Technology”, Tata McGraw Hill, 1998.
4	Kesavan, R and Vijay Ramnath, B, “Machine Tools”, University Science Press, 2009.
Reference Books:	
1	Hajra Choudry, “Elements of Workshop Technology – Vol. II”, Media Promoters. 2002
2	Richerd R. Kibbe, John E. Neely, Roland O. Merges and Warren J. White, “Machine Tool Practices”, Prentice Hall of India, 2003.

Course Outcomes:	
Upon completion of this course, the students will be able to:	
CO1	Understand the concepts of mechanism in metal cutting processes.
CO2	Understand the constructional and operational feature of special purpose lathe.
CO3	Describe the constructional and operational feature of reciprocating and milling machines.
CO4	Describe the constructional and operational feature of grinding and broaching machines.
CO5	Understand the construction and working of CNC machines and learn to write the CNC programs.

23PTMA201	MATHEMATICS - II	Semester			II
PREREQUISITES	Category	BS	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	The objective is to impact analytical skills in the areas of boundary value problems and transform techniques
2	It will be necessary for their effective studies in a large number of engineering subjects like heat conduction, communication systems, electro-optics and electromagnetic theory
3	It will also serve as a prerequisite for post graduate and specialized studies and research.

Unit I	FOURIER SERIES	9	0	0	9

Drichlet's conditions – General Fourier series – Odd and even functions – Half range sine series – Half range cosine series – Parseval's Identity – Harmonic Analysis.

Unit II	BOUNDARY VALUE PROBLEMS	9	0	0	9

Classification of second order quasi linear partial differential equations – Solutions of one dimensional wave equation – One dimensional heat equation – Steady state solution of two-dimensional heat equation (Insulated edges excluded) – Fourier series solutions in Cartesian coordinates.

Unit III	LAPLACE TRANSFORM	9	0	0	9

Laplace Transform- Conditions for existence – Transform of elementary functions – Basic Properties – Transform of derivatives and integrals – Initial and Final value theorems- Transform of periodic Functions – Inverse Laplace Transform- solutions of linear ODE of second order with constant coefficients using Laplace transformation techniques- statement and application of convolution theorem

Unit IV	FOURIER TRANSFORM	9	0	0	9

Statement of Fourier integral theorem – Fourier transform pair – Sine and Cosine transforms – Properties – Transforms of simple functions – Convolution theorem - Parseval's Identity

Unit V	Z -TRANSFORM AND DIFFERENCE EQUATIONS	9	0	0	9

Z-transform of simple functions and properties – Inverse Z – transform –initial and final value theorems-Convolution theorem -Formation of difference equations – Solution of difference equations using Z – transform technique.

Total (45L) = 45 Periods

Text Books:

1	Veerarajan T, "Engineering Mathematics (For Semester III)", 3rd Edition, Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2009.
2	P.Kandasamy, K.Thilagavathy and K.Gunavathy, "Engineering Mathematics, Volume III", S. Chand & Company ltd., New Delhi, 1996.

Reference Books:	
1	Grewal, B.S., "Higher Engineering Mathematics", 43rd Edition, Khanna Publishers, Delhi, 2014.
2	Wylie C. Ray and Barrett Louis, C., "Advanced Engineering Mathematics", Sixth Edition, McGraw-Hill, Inc., New York, 1995.
3	Andrews, L.A., and Shivamoggi B.K., "Integral Transforms for Engineers and Applied Mathematicians", MacMillan, New York, 1988.
4	Narayanan, S., ManicavachagomPillai, T.K. and Ramaniah, G., "Advanced Mathematics for Engineering Students", Volumes II and III, S. Viswanathan (Printers and Publishers) Pvt. Ltd. Chennai, 2002.

Course Outcomes: Upon completion of this course, the students will be able to:	
CO1	Acquired the knowledge about the Fourier series.
CO2	Learnt the techniques of solving boundary value problems
CO3	Apply the knowledge of the Laplace Transforms.
CO4	Apply the knowledge of the Fourier Transform in engineering problems.
CO5	Apply the knowledge of the Z-Transform in engineering problems.

23PTEE205	BASIC ELECTRICAL AND ELECTRONICS ENGINEERING	Semester			II
PREREQUISITES	Category	ES	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	To understand and analyze basic electric circuits.
2	To study working principle of electrical machines and transformer.
3	To study basics of electronic devices and operational amplifier.
4	To understand the concepts of electrical installations.

Unit I	DC CIRCUITS	9	0	0	9

Electrical circuit elements (R, L and C) - Voltage and current sources - Ohm's law and Kirchoff's laws- Series and parallel circuits - Analysis of simple electrical circuits with DC excitation using fundamental laws – Superposition theorem, Thevenin's and Norton's theorems.

Unit II	AC CIRCUITS	9	0	0	9

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

Unit III	ELECTRICAL MACHINES AND TRANSFORMERS	9	0	0	9

DC Motor: Construction, operation, types and applications, Speed control of DC shunt motor - Construction and working of three-phase induction motors - Working of single-phase induction motor and its applications – Transformers: Ideal and practical transformer, Construction and working, losses and efficiency in transformers, Introduction to Three phase transformers

Unit IV	BASIC ELECTRONICS SYSTEM	9	0	0	9

Introduction - Basic structure of semiconductors devices- PN junction diode, Zener diode and V-I characteristics- BJT – CE, CB, CC configuration and working principle. Operational Amplifier-principle of operation, Characteristics, Applications-Inverting Amplifier, Non inverting Amplifier, summing amplifier and differential amplifier.

Unit V	ELECTRICAL INSTALLATIONS	9	0	0	9

Components of LT Switchgear: Switch Fuse Unit (SFU), MCB, ELCB, MCCB - Types of wires and cables – Earthing - Basics of house wiring tools and components, types of house wiring – Batteries: Principle Characteristics-Types and its applications - Introduction to UPS and SMPS.

Total (45L) = 45 Periods

Text Books:	
1	Muthu Subramaniyam, R., Salivaganan, R., and Muralidharan, K. A., "Basic Electrical and Electronics Engineering", Second Edition, Tata McGraw Hill, 2010.
2	Kothari, D. P., and Nagrath, I. J., "Basic Electrical Engineering", Tata McGraw Hill, 2010.
3	Kulshreshtha, D.C., "Basic Electrical Engineering", Tata McGraw Hill, 2009.
Reference Books:	
1	Bobrow, L. S., "Fundamentals of Electrical Engineering", Oxford University Press, 2011.
2	Hughes, E., "Electrical and Electronics Technology", Pearson, 2010.

Course Outcomes: Upon completion of this course, the students will be able to:	
CO1	Analyze the DC circuits using fundamental laws and theorems.
CO2	Analyze the single and three phase AC circuits.
CO3	Recognize the working principle of electrical machines and transformers.
CO4	Recognize the fundamentals and characteristics of diode, BJT and operational amplifier.
CO5	Demonstrate the concept of electrical installations.

23PTME201	ENGINEERING MECHANICS		Semester			II
PREREQUISITES		**Category**	**ES**	**Credit**		**3**
1. Engineering Physics. 2. Engineering Mathematics.		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Learning Objectives

1	To develop the capacity to predict the effect of force and motion in the course of carrying out the design functions of engineering.
2	To analyze the force systems and friction.
3	To study the dynamics of particles, impulse and momentum

Unit I	**STATICS OF PARTICLES**	**9**	**0**	**0**	**9**

Fundamental Concepts and Principles, Systems of Units, Method of Problem Solutions, Statics of Particles -Forces in a Plane, Resultant of Forces, Resolution of a Force into Components, Rectangular Components of a Force, Unit Vectors. Equilibrium of a Particle- Newton's First Law of Motion, Space and Free-Body Diagrams, Forces in Space, Equilibrium of a Particle in Space.

Unit II	**EQUILIBRIUM OF RIGID BODIES**	**9**	**0**	**0**	**9**

Principle of Transmissibility, Equivalent Forces, Vector Product of Two Vectors, Moment of a Force about a Point, Varignon's Theorem, Rectangular Components of the Moment of a Force, Scalar Product of Two Vectors, Mixed Triple Product of Three Vectors, Moment of a Force about an Axis, Couple - Moment of a Couple, Equivalent Couples, Addition of Couples, Resolution of a Given Force into a Force -Couple system, Further Reduction of a System of Forces, Equilibrium in Two and Three Dimensions - Reactions at Supports and Connections.

Unit III	**PROPERTIES OF SURFACES AND SOLIDS**	**9**	**0**	**0**	**9**

Centroid of simple figures from first principle, centroid of composite sections; Centre of Gravity and its implications; Area moment of inertia- Definition, Moment of inertia of plane sections from first principles, Theorems of moment of inertia, Moment of inertia of standard sections and composite sections; Theorems of Pappus-Guldinus.

Unit IV	**FRICTION**	**9**	**0**	**0**	**9**

The laws of dry friction. Coefficient of friction, Angle of friction, Wedge, Wheel friction. Rolling resistance, Ladder friction.

Unit V	**DYNAMICS OF PARTICLES**	**9**	**0**	**0**	**9**

Kinematics - Rectilinear Motion and Curvilinear Motion of Particles. Kinetics- Newton's Second Law of Motion -Equations of Motions, Dynamic Equilibrium, Energy and Momentum Methods - Work of a Force, Kinetic Energy of a Particle, Principle of Work and Energy, Principle of Impulse and Momentum, Impact of elastic bodies.

Total (45L) = 45 Periods

Text Books:	
1	A Textbook of Engineering Mechanics, R.K. Bansal, Laxmi Publications, 2010.
2	Rajasekaran S and Sankarasubramanian G., "Fundamentals of Engineering Mechanics", Vikas Publishing House Pvt. Ltd., 2013.
Reference Books:	
1	Beer Ferdinand P, Russel Johnston Jr., David F Mazurek, Philip J Cornwell, Sanjeev Sanghi, Vector Mechanics for Engineers: Statics and Dynamics, McGraw Higher Education. 11thEdition, 2017.
2	Timoshenko S, Young D H, Rao J V and SukumarPati, Engineering Mechanics, 5thEdition, McGraw Hill Higher Education, 2013.
3	Hibbeller, R.C., Engineering Mechanics: Statics, and Engineering Mechanics: Dynamics, 13th edition, Prentice Hall, 2013.
4	Palanichamy M.S. and Nagam S., "Engineering Mechanics – Statics & Dynamics", Tata McGraw-Hill, 2001
5	Engineering Mechanics, D.S. Bedi, Khanna Book Publishing Co. (P) Ltd, 2019.
E-REFERENCES:	
1.	https://nptel.ac.in/courses/122104014
2.	https://nptel.ac.in/courses/112106286

Course Outcomes:	
Upon completion of this course, the students will be able to:	
CO1	Apply the various methods to determine the resultant forces and its equilibrium acting on a particle in 2D and 3D
CO2	Apply the concept of reaction forces (non-concurrent coplanar and non-coplanar forces) and moment of various support systems with rigid bodies in 2D and 3D.
CO3	Evaluate area moments of inertia for various sections by applying the concepts of centroids.
CO4	Apply the concepts of frictional forces at the contact surfaces of various engineering systems.
CO5	Apply the various methods for evaluating dynamic parameters of the particles subjected to concurrent coplanar forces.

23PTME202	THERMAL ENGINEERING	Semester			II
PREREQUISITES	Category	PC	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

(Use of standard thermodynamic tables, Mollier diagram, Psychrometric chart and Refrigerant property tables are permitted in the examination)

Course Learning Objectives

1	To integrate the concepts, laws and methodologies from the first course in thermodynamics into analysis of cyclic processes
2	To apply the thermodynamic concepts into various thermal application like IC engines, Steam Turbines, Compressors and Refrigeration and Air conditioning systems

Unit I	GAS POWER CYCLES	9	0	0	9

Otto, Diesel, Dual, Brayton cycles, Calculation of mean effective pressure and air standard efficiency, Actual and theoretical PV diagram of Four stroke engines, Actual and theoretical PV diagram of two stroke engines.

Unit II	INTERNAL COMBUSTION ENGINES	9	0	0	9

Classification of IC engine, IC engine components and functions. Valve timing diagram and port timing diagram. Comparison of two stroke and four stroke engines. Fuel supply systems, Ignition Systems, Performance calculation. Comparison of petrol and diesel engine. Fuels, Air-fuel ratio calculation, Knocking and Detonation. Lubrication system and cooling system. Exhaust gas analysis, pollution control norms.

Unit III	STEAM NOZZLES AND TURBINES	9	0	0	9

Flow of steam through nozzles, shapes of nozzles, effect of friction, critical pressure ratio, supersaturated flow. Impulse and reaction turbine principles, compounding, velocity diagrams for simple and multistage turbines, speed regulations-governors and nozzle governors.

Unit IV	AIR COMPRESSOR	9	0	0	9

Classification and working principle, work of compression with and without clearance. Volumetric efficiency, Isothermal efficiency and isentropic efficiency of reciprocating air compressors. Multistage air compressor and inter cooling – work of multistage air compressor, various types of compressors (Descriptive treatment only).

Unit V	REFRIGERATION AND AIR-CONDITIONING	9	0	0	9

Vapour compression Refrigeration cycle – super heat, sub cooling, performance calculations. Working principle of vapour absorption system. Ammonia – water, Lithium bromide – water systems (Description only), Comparison between vapour compression and absorption systems. Psychrometry, Psychometric chart, Cooling load calculations. Concept of RSHF, GSHF, ESHF, Air conditioning systems.

Total (45L) = 45 Periods

Text Books:	
1	Rajput, R.K, “Thermal Engineering”, S. Chand Publishers, 2000.
2	Rudramoorthy, R, “Thermal Engineering”, Tata McGraw Hill, New Delhi, 2003.
3	Kothandaraman, C.P., Domkundwar, S. and Domkundwar, A.V, “A course in Thermal Engineering”, Dhanpat Rai and Sons, 5th Edition, 2002.
4	Sarkar B.K, “Thermal Engineering”, Tata McGraw Hill, 1998
5	Rajput, R.K, “Thermal Engineering”, S. Chand Publishers, 2000.
Reference Books:	
1	Holman. J.P., “Thermodynamics”, McGraw Hill, 1985.
2	Arora.C.P, “Refrigeration and Air Conditioning”, TMH, 1994.

Course Outcomes:	
Upon completion of this course, the students will be able to:	
CO1	Analyze the air standard cycles of internal combustion engines based on Otto, diesel and dual cycles.
CO2	Get an insight of various components of internal combustion engines.
CO3	Apply thermodynamic concepts in steam nozzles and turbines.
CO4	Get an insight of various types of air compressors.
CO5	Design refrigeration and air conditioning system for applications.

23PTME203	MANUFACTURING TECHNOLOGY-II	Semester			II
PREREQUISITES	Category	PC	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	To understand the concept and basic mechanics of metal cutting, working of standard machine tools such as lathe, shaping and allied machines, milling, drilling and allied machines, grinding and allied machines and broaching.
2	To understand the basic concepts of Computer Numerical Control (CNC) of machine tools and CNC Programming.

Unit I	GEAR MANUFACTURING PROCESSES	9	0	0	9

Introduction-Gear generating processes- hobbing, shaping-bevel gear generator-Indexing-Gear finishing-gear shaving, gear grinding, gear lapping, shot blasting, phosphate coating-Gear testing.

Unit II	MODERN CASTING TECHNOLOGY	9	0	0	9

Basic principle, process variables and characteristics of the following processes: squeeze casting, Rheocasting, Thixo casting, CO_2 process, Shaw process, Slush casting, Continuous casting, H-process, Electro slag casting, CLA process, Full mould process.

Unit III	ADVANCED FORMING PROCESSES	9	0	0	9

High-speed forming-basic principle, process variables, characteristics and applications of the following processes: Dynapack, Electrohydraulic forming, Electromagnetic forming, Explosive forming and water hammer forming.

Unit IV	ADVANCED MACHINING PROCESSES	9	0	0	9

Introduction-Electric discharge machining (EDM), Wire EDM, Electrochemical machining (ECM), Electrochemical spark machining (ECSM), Ultrasonic machining, Abrasive flow machining, Water jet machining, Magneto rheological abrasive flow machining (MRAFM).

Unit V	RAPID PROTOTYPING	9	0	0	9

History of RP systems, classification of RP systems - Stereo lithography system - Selective laser sintering - Fusion deposition modeling - Solid ground curing - Data Preparation - data files and machine details - applications.

Total (45L) = 45 Periods

Text Books:

1	Jain R.K. and Gupta S.C, "Production Technology", Khanna Publishers, New Delhi, 2008.
2	Sharma P.C, "A Text Book of Production Technology (Manufacturing processes)", S Chand and Company Ltd., New Delhi 6th Edition, 2007.
3	Jain, V.K, "Advanced Machining Processes", Allied Publishers, Mumbai, 2008.

4	Jacobs, Paul.F, “Stereo Lithography and other RP and Manufacturing Technologies”, SME, New York, 1996.
Reference Books:	
1	ASM, Metals Hand Book on Casting, 2000.
2	Pharm, D.T, and Dimov, S.S, “Rapid manufacturing”, Verlag, London, 2001.

Course Outcomes: Upon completion of this course, the students will be able to:	
CO1	Identify and suggest the suitable manufacturing process for making various types of gears in advanced materials.
CO2	Understand the concepts of various modern casting technology.
CO3	Understand the concepts of various advanced forming processes.
CO4	Understand the concepts of various advanced machining processes.
CO5	Apply the basic principles of rapid prototyping (RP), rapid tooling (RT) technologies to product development

23PTMA301	NUMERICAL METHODS		Semester			III
PREREQUISITES		Category	BS	Credit		3
		Hours/Week	L	T	P	TH
			3	0	0	3

Course Learning Objectives

1	With the present development of the computer technology, it is necessary to develop efficient algorithms for solving problems in science, engineering and technology.
2	It gives a complete procedure for solving different kinds of s engineering problems numerically.
3	The students would be acquainted with the basic concepts in numerical methods and their uses.

Unit I	SOLUTION OF EQUATIONS	9	0	0	9

Solutions of nonlinear equations by iteration method and Newton Raphson method -Solutions of linear system of equations by Gauss Elimination, Gauss Jordan, Gauss Jacobi and Gauss - Seidal methods - Inverse of a matrix by Gauss Jordan Methods.

Unit II	INTERPOLATION AND APPROXIMATION	9	0	0	9

Finite differences – Operators and their relations – interpolation with Equal Intervals-Newton's Forward and Backward interpolations- Unequal intervals-Newton's divided difference formula and Lagrangian polynomials Interpolating with cubic spline polynomial.

Unit III	NUMERICAL DIFFERENTIATION AND INTEGRATION	9	0	0	9

Newton's Forward and Backward Differences to compute derivatives - Trapezoidal rule - Simpson's 1/3 rule, Simpson's 3/8 rule – Two and three point Gaussian quadrature formulas

Unit IV	INITIAL VALUE PROBLEMS FOR ORDINARY DIFFERENTIAL EQUATIONS	9	0	0	9

Solving first order ODE – Single step method: Taylor series method-Euler and modified Euler method- Fourth order Runge-Kutta method- Multistep method: Milne's and Adam's predictor and corrector methods.

Unit V	BOUNDARY VALUE PROBLEMS IN ORDINARY AND PARTIAL DIFFERENTIAL EQUATION	9	0	0	9

Finite difference solution of second order ordinary differential equations - Finite difference solutions of one-dimensional heat equation by explicit and implicit methods - One dimensional wave equation and two-dimensional Laplace and Poisson equations.

Total (45L) = 45 Periods

Text Books:	
1	Veerarajan. T and Ramachandran, "Numerical methods with Programs in C and C++ ",Tata McGraw Hill, New Delhi,2006
2	Kandasamy.P, Thilagavathy.K, Gunavathi.K, "Numerical Methods" S.Chand & Co., New Delhi, 2005.
Reference Books:	
1	Gerald, C. F. and Wheatley, P.O.," Applied Numerical Analysis" , Sixth Edition , Pearson Education Asia , New Delhi – 2002
2	M.K.Venkataraman, "Numerical Methods", National Publishing Company,2000
3	Jain M.K.Iyengar, K & Jain R.K., "Numerical Methods for Scientific and Engineering Computation ",New Age International (P) Ltd, Publishers 2003

Course Outcomes:	
Upon completion of this course, the students will be able to:	
CO1	Learn to obtain the numerical solutions of linear and non-linear equations
CO2	Acquired the techniques of interpolation and approximations
CO3	Familiarize with the numerical differentiation and integration, will know to solve the initial value problems for ordinary differential equations.
CO4	Learn to solve the initial value problems for ordinary differential equations.
CO5	Learn to solve the boundary value problems in ordinary differential equations and partial differential equations.

23PTCS301	FUNDAMENTAL OF PROBLEM SOLVING AND C PROGRAMMING	Semester			III
PREREQUISITES	Category	ES	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	To introduce the problem solving methodologies
2	To learn the basic concepts of developing an algorithm and pseudo code
3	To understand the concepts of C programming

Unit I	INTRODUCTION	9	0	0	9

Characteristics of Computers – Evolution of Computers -Computer Generations – Classification of Computers – Basic Computer organization – Number System -Binary – Decimal – Conversation - Problems.

Unit II	PROBLEM SOLVING	9	0	0	9

Problem formulation, Problem Solving methods, Need for logical analysis and thinking – Algorithum - Pseudo code – Flow Chart. C Character set, Identifies and keywords, Data Types, Declarations, Expressions, Statements and Symbolic constants.

Unit III	C PROGRAMMING BASICS	9	0	0	9

Operators -Arithmetic Operators -Unary operators -Relational and Logical Operators -Assignment operators – Conditional operators. Managing Input and Output operation, Pre-Processor directives and storage classes.

Unit IV	CONTROL STATEMENTS, ARRAYS AND STRINGS	9	0	0	9

Conditional statements -branching and looping statements. Arrays -Initializations -Declarations -one dimensional and two dimensional arrays, Strings – String operations -String handling functions

Unit V	FUNCTIONS, POINTERS STRUCTURES AND UNIONS	9	0	0	9

Function- Library functions and user -Defined functions – Function prototypes and function definition – Call by value – Call by reference – Recursion – Pointers definition – Structure definition and Examples - Union

Total (45L) = 45 Periods

Text Books:

1	RAnita Goel and Ajay Mittal, “Computer Fundamentals and Programing in C”, Dorling Kindersley (India) Pvt,Ltd, Pearson Education in South Asia, 2011
2	E Balagurusamy, “Programming in ANSI C”, Fourth Edition, Tata McGraw- Hill, 2008

Reference Books:

1	Byron S Gottfried, " Programming with C" Schaum"sOutlines , Second Edition, Tata McGraw
E-Reference	
1	https://nptel.ac.in/courses/106106210

Course Outcomes: Upon completion of this course, the students will be able to:	
CO1	Understand the basic terminology used in computer programming
CO2	Understand the concepts of "C"
CO3	Understand, analyze and implement software development tools like algorithm,
CO4	Write programs to solve simple problem in "C"

23PTME301	STRENGTH OF MATERIALS		Semester			III
PREREQUISITES		**Category**	**PC**	**Credit**		**3**
1. Differentiation, Partial Differential Equations 2. Engineering Mechanics.		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Learning Objectives

1	To understand the nature of stresses developed in simple geometries such as bars, cantilevers, beams, shafts, cylinders and spheres for various types of simple loads.
2	To calculate the shear force and bending moment of various beams transverse loading.
3	To estimate the slope and the deflection of beams and strengths of the columns.
4	To evaluate the axial and hoop stresses in thin and thick shells for the applied internal and external pressures.
5	To learn about the torsion behaviour of shafts and coil springs.

Unit I	**STRESS, STRAIN AND DEFORMATION OF SOLIDS**	**9**	**0**	**0**	**9**

Deformation in solids- Hooke's law, stress and strain- tension, compression and shear stresses-elastic constants and their relations- volumetric, linear and shear strains- principal stresses and principal planes- Mohr's circle. Deformation of simple compound bars-Relation between elastic constants-Thermal stresses.

Unit II	**TRANSVERSE LOADING ON BEAMS AND STRESSES IN BEAMS**	**9**	**0**	**0**	**9**

Beams and types of transverse loading on beams- shear force and bending moment diagrams Types of beam supports, simply supported and over-hanging beams, cantilevers. Theory of bending of beams, bending stress distribution and neutral axis, shear stress distribution, point and distributed loads. Shear stress distribution of simple beams- circular, rectangular, "I" section, "T" section and channel sections.

Unit III	**DEFLECTION OF BEAMS AND COLUMNS**	**9**	**0**	**0**	**9**

Moment of inertia about an axis and polar moment of inertia, deflection of a beam using double integration method, computation of slopes and deflection in beams, Macaulay's method – Area moment method - Conjugate beam and strain energy – Maxwell's reciprocal theorems. Columns: End Conditions - Equivalent length of a column - Euler's equation Slenderness ratio - Rankine's formula for columns.

Unit IV	**THIN CYLINDERS, SPHERES AND THICK CYLINDERS**	**9**	**0**	**0**	**9**

Axial and hoop stresses in cylinders subjected to internal pressure, deformation of thick and thin cylinders, deformation in spherical shells subjected to internal pressure – Lame's theorem.

Unit V	**TORSION AND SPRINGS**	**9**	**0**	**0**	**9**

Torsion, stresses and deformation in circular and hollow shafts, stepped shafts, deflection of shafts fixed at both ends. Torsion on springs - Wahl's factor of spring Stresses in helical springs under torsion loads - Stiffness and deflection of springs under axial load.

Total (45L) = 45 Periods

Text Books:	
1	Rajput, R.K, “Strength of Materials”, S.Chand and Co, 3rd Edition, 2003.
2	Bansal, R.K., "Strength of Materials", Laxmi Publications (P) Ltd., 2016.
Reference Books:	
1	Strength of Materials, D.S. Bedi, Khanna Publishing House
2	Subramanian R., "Strength of Materials", Oxford University Press, Oxford Higher Education Series, 2010.
3	Mechanics of Materials, Punmia, Jain and Jain, Laxmi Publications
4	Strength of Materials (Mechanics of Solid), R.S. Khurmi, S.Chand Publications

Course Outcomes: Upon completion of this course, the students will be able to:	
CO1	Evaluate the stress, strain and strain energy of simple bars.
CO2	Familiarize the load transferring mechanism in beams and stress distribution due to shearing force and bending moment.
CO3	Evaluate the slope and the deflection of beams and strengths of the columns.
CO4	Analyze and design thin and thick shells for the applied internal and external pressures.
CO5	Analyze the torsion behavior of shafts and coil springs.

23PTME302	KINEMATICS OF MACHINERY	Semester			III
PREREQUISITES	Category	PC	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	To understand the basic components and layout of linkages in the assembly of a system / machine.
2	To understand the principles in analyzing the assembly with respect to the displacement, velocity, and acceleration at any point in a link of a mechanism.
3	To understand the motion resulting from a specified set of linkages, design few linkage mechanisms and cam mechanisms for specified output motions.
4	To understand the basic concepts of toothed gearing and kinematics of gear trains and the effects of friction in motion transmission and in machine components.

Unit I	BASICS OF MECHANISMS	9	0	0	9

Basic kinematic concepts and definitions - Degree of Freedom, Mobility - Kutzbach criterion, Gruebler's criterion - Grashoff's law - Kinematic Inversions of Four-bar chain and slider crank chains - Mechanical Advantage - Transmission angle - Description of common Mechanisms-Single, double and offset slider mechanisms - Quick return mechanisms - Ratchets and escapements - Straight line generators-Design of Crank-rocker Mechanisms.

Unit II	KINEMATIC ANALYSIS	9	0	0	9

Displacement, velocity and acceleration - analysis in simple mechanisms - Graphical Method velocity and acceleration polygons - Velocity analysis using instantaneous centers - Kinematic analysis by Complex Algebra methods-Vector Approach, Computer applications in the kinematic analysis of simple mechanisms-Coincident points- Coriolis Acceleration.

Unit III	KINEMATICS OF CAM	9	0	0	9

Classification of cams and followers – Terminology - Displacement diagrams- Uniform velocity, Simple harmonic, parabolic and Cycloidal motions - Layout of plate cam profiles - Derivatives of Follower motion - circular arc and tangent cams - Pressure angle and undercutting.

Unit IV	GEARS AND GEAR TRAINS	9	0	0	9

Involute and cycloidal gear profiles, gear parameters, fundamental law of gearing and conjugate action, spur gear contact ratio and interference/undercutting- helical, bevel, worm, rack & pinion gears, epicyclic and regular gear train kinematics.

Unit V	FRICTION IN MACHINE ELEMENTS	9	0	0	9

Surface contacts- sliding and rolling friction- friction drives- friction in screw threads – bearings and lubrication- friction Clutches- belt and rope drives- friction in brakes.

Total (45L) = 45 Periods

Text Books:	
1	Rattan S.S, “Theory of Machines”, Tata McGraw Hill Publishing Company Ltd., New Delhi, 1998.
2	Shigley J.E and Uicker J.J, “Theory of Machines and Mechanisms”, McGraw-Hill, Inc, 1995.
3	Ghosh, A and Mallick, A.K, “Theory of Mechanisms and Machines”, East-West Pvt. Ltd., New Delhi, 1988.
4	Ambekar A.G, “Mechanism and Machine Theory” Prentice Hall of India, New Delhi, 2007.
Reference Books:	
1	Thomas Bevan, “Theory of Machines”, CBS Publishers and Distributors, 1984.
2	Rao J.S and Dukkipati R.V, “Mechanism and Machine Theory”, Wiley-Eastern Ltd., New Delhi, 1992.
3	Erdman AG and Sandor G N, “Mechanism Design, Analysis and Synthesis”, Vol.I, PHI Inc., 1997.
4	John Hannah and Stephens R C, “Mechanisms of Machines”, Viva Low Price Student Edition, New Delhi, 1999.

Course Outcomes: Upon completion of this course, the students will be able to:	
CO1	Demonstrate an understanding of the concepts of various mechanisms and pairs.
CO2	Represent velocity and acceleration analysis of simple mechanisms.
CO3	Synthesize simple mechanisms for function, path generation and motion generation.
CO4	Design basic cam for specified motion.
CO5	Analyze gears, gear trains and gyroscopes.

23PTME303	ENGINEERING MATERIALS AND METALLURGY	Semester			III
PREREQUISITES	Category	PC	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	To impart concept on reactions, treatment, microstructure and mechanical behavior of engineering materials at different temperature.
2	To learn basic principles in metallurgy and materials engineering.
3	To identity and select suitable engineering materials based on their applications

Unit I	FERROUS AND NON FERROUS METALS	9	0	0	9

Constitution of alloys – Solid solutions, substitution and interstitial – phase diagrams, Isomorphous, eutectic, peritectic, eutectoid and peritectoid reactions, Iron – Iron carbide equilibrium diagram. Classification of steel and cast Iron microstructure, properties and application. Effect of alloying additions on steel (Mn, Si, Cr, Mo, V Ti and W) - stainless and tool steels – HSLA - maraging steels – Gray, White, Malleable, spheroid - Graphite - alloy cast irons , Copper alloys – Brass, Bronze and Cupronickel, Aluminium alloys, Bearing alloys.

Unit II	HEAT TREATMENT	9	0	0	9

Definition – Full annealing, stress relief, recrystallisation and spheroidizing –normalizing, hardening and Tempering of steel. Isothermal transformation diagrams – cooling curves superimposed on I.T. diagram CCR - Hardenability, Jominy end quench test – Austempering, martempering – case hardening, carburising, nitriding, cyaniding, carbo-nitriding – Flame and Induction hardening. Heat treatment of non-ferrous alloys - precipitation and age hardening. Heat treatment of HSS tools, gears, springs and gauges.

Unit III	NON-METALLIC MATERIALS	9	0	0	9

Engineering Ceramics – Properties and applications of Al_2O_3, SiC, Si_3, N_4. PSZ Fracture and Defects of ceramics - Ceramic coating methods: Plasma spraying - APS and VPS, process principles, component preparation, deposition rates, coating materials. Chemical Vapour Deposition - deposition rates, carbon control of the substrate, industrial CVD, typical procedures, advantages and disadvantages, use of CVD coatings in metal cutting, wear mechanisms.– Fibre and particulate reinforced composites.

Unit IV	MECHANICAL PROPERTIES AND TESTING	9	0	0	9

Mechanical properties of engineering materials - Mechanisms of plastic deformation, slip and twinning – Creep, Fatigue and Fracture - Types of fracture – Testing of materials - tension, compression and shear loads - fatigue and creep tests – hardness and its effects – testing for hardness (Brinell, Vickers and Rockwell) - Impact test - Izod and Charpy test.

Unit V	NON DESTRUCTIVE TESTING AND SURFACE ENGINEERING	9	0	0	9

Non Destructive Testing: Non Destructive Testing basic principles and testing method for radiographic Testing, Ultrasonic testing, Magnetic Particle Inspection and Liquid Penetrant Inspections Introduction to surface engineering Definition of surface engineering, diffusion techniques, deposition methods, high and low energy beam methods, surface engineering charts, elastic contact mechanics.
Total (45L) = 45 Periods

Text Books:	
1	Kenneth G. Budinski and Michael K. Buinski, "Engineering Materials", Prentice Hall of India Ltd, 2002.
2	Raghavan, V, "Materials Science and Engineering", Prentice Hall of India (P) Ltd., 1999.
3	Aswani.K.G, "A Text Book of Material Science", S.Chand and Co. Ltd., New Delhi, 2001.
4	Khanna O.P., "A Text Book of Materials Science and Metallurgy", Dhanpat Rai Sons, 2004.
Reference Books:	
1	William. D.Callsber, "Material Science and Engineering", John Wiley and Sons, 1997.
2	Sydney.H.Avner, "Introduction to Physical Metallurgy" Mc Graw Hill Book Company, 1994.

Course Outcomes: Upon completion of this course, the students will be able to:	
CO1	Describe properties, applications and types of various ferrous and non-ferrous metals used in fabrication industry.
CO2	Understand the principles of various heat treatment processes in fabrication industry.
CO3	Describe process principles, properties, applications of Non-metallic materials used in fabrication industry.
CO4	Understand the various mechanical properties of materials and their characterization techniques.
CO5	Understand the basic concepts of surface engineering and study about the various non-destructive tests.

23PTME401	ENGINEERING METROLOGY AND INSTRUMENTATION	Semester			IV
PREREQUISITES	**Category**	**PC**	**Credit**		**3**
	Hours/Week	**L**	**T**	**P**	**TH**
		3	**0**	**0**	**3**

Course Learning Objectives

1	To understand the working of linear and angular measuring instruments.
2	To familiarize with the working of optical measuring instruments and fundamentals of limits and limit gauges.
3	To give an exposure to advanced measuring devices and machine tool metrology
4	To provide students an overview of mechanical measurement systems and principle of instruments for motion and dimension measurement.
5	To provide basic idea about working principle and applications of devices for measurement of force and torque; strain and stress and temperature.

Unit I	**CONCEPT OF MEASUREMENT**	**9**	**0**	**0**	**9**

General concept – Generalized measurement system-Units, standards-measuring instruments-characteristics-static, and dynamic response-repeatability-systematic and random errors-correction, calibration, interchangeability.

Unit II	**LINEAR AND ANGULAR MEASUREMENT**	**9**	**0**	**0**	**9**

Definition of metrology-Linear measuring instruments: Vernier, micrometer, interval measurement, Slip gauges and classification, limit gauges, Comparators: Mechanical, pneumatic optical and electrical types, applications. Angular measurements: Sine bar, optical bevel protractor, angle Decker – Taper measurements. Distance measurement: Light year, Doppler method, Red shift method

Unit III	**FORM MEASUREMENT**	**9**	**0**	**0**	**9**

Measurement of screw threads: Thread gauges, floating carriage micrometer, Measurement of gear tooth thickness: constant chord and base tangent method - Gleason gear testing machine – Radius measurements - Surface finish, Straightness, and Flatness and Roundness measurements.

Unit IV	**LASER AND ADVANCES IN METROLOGY**	**9**	**0**	**0**	**9**

Precision instruments based on laser: Principles- laser interferometer - application in linear, angular measurements and machine tool metrology. Coordinate measuring machine (CMM): Constructional features – types, applications – digital devices- computer aided inspection. Interferometry, Optical flats.

Unit V	**MISCELLANEOUS MEASUREMENTS**	**9**	**0**	**0**	**9**

Force, torque, power: mechanical, pneumatic, hydraulic and electrical type - Flow Measurement: venturi, orifice, rotameter, pitot tube – Velocity Measurement: Types of anemometer, turbine meter – Temperature Measurement: bimetallic strip, pressure thermometers, thermocouples, electrical resistance thermistor, altitude measurements, strain gauges

Total (45L) = 45 Periods

Text Books:	
1	Jain R.K, “Engineering Metrology”, Khanna Publishers, 1994
2	Beckwith T.G and Lewis Buck, N, “Mechanical Measurements”, Addison Wesley, 1991.
3	Gupta S.C, “Engineering Metrology”, Dhanpat Rai Publications, 1984.
4	Jayal A.K, “Instrumentation and Mechanical Measurements”, Galgotia Publications, 2000.
Reference Books:	
1	Alan S. Morris, “The Essence of Measurement”, Prentice Hall of India, 1997.
2	Donald D Eckman, “Industrial Instrumentation”, Wiley Eastern, 1985.

Course Outcomes: Upon completion of this course, the students will be able to:	
CO1	Understand the fundamental concepts of measuring instruments such as accuracy, precision and error.
CO2	Determine the least count of instruments and also measure the simple elements using linear such as vernier caliper, micrometer and slip gauges and angular measurements such as sine bar.
CO3	Measure the dimensions of various thread forms and gears.
CO4	Understand the basic principles of laser and CMM construction and its applications.
CO5	Understand the fundamental concepts of temperature, pressure and velocity measurements.

23PTME402	DESIGN OF MACHINE ELEMENTS	Semester			IV
PREREQUISITES	Category	PC	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	Identify appropriate analytical models to describe and predict the behaviour of standard machine components
2	Reduce the behaviour of a complex machine into appropriate sub- systems/elements and then analyse the behaviour of their elements
3	Apply stress analysis theory, fatigue theory and appropriate criteria of failure to the design of simple machine elements
4	Design simple power transmission systems
5	Communicate the results of a design assignment by means of drawings and a design report

Unit I	STEADY AND VARIABLE STRESSES IN MACHINE MEMBERS	9	0	0	9

Introduction to the design process – Product development cycle- factors influencing machine design, selection of materials based on mechanical properties -- Preferred numbers– Direct, Bending and Torsional stress – Impact and shock loading – Calculation of principle stresses for various load combinations, eccentric loading – Design of curved beams – crane hook and 'C' frame - Factor of safety - theories of failure – stress concentration – design for variable loading – Soderberg, Goodman and Gerber relations .

Unit II	DESIGN OF SHAFTS, COUPLINGS AND PIN JOINTS	9	0	0	9

Design of solid and hollow shafts based on strength, rigidity and critical speed – Design of keys and key ways - Design of rigid and flexible couplings – Design of pin joints like cotter and knuckle joints.

Unit III	DESIGN OF THREADED FASTENERS, RIVETED AND WELDED JOINTS	9	0	0	9

Threaded fasteners - Design of bolted joints including eccentric loading – Design of riveted and welded joints for pressure vessels and structures.

Unit IV	DESIGN OF PRESSURE VESSELS AND PIPES, SPRINGS AND LEVERS	9	0	0	9

Design of pressure vessels and pipes, Design of helical and leaf springs under constant loads and varying loads – Design of Levers.

Unit V	DESIGN OF INTERNAL COMBUSTION ENGINE PARTS	9	0	0	9

Heat engines- Brief details about external combustion and internal combustion engines, Design of I.C engine cylinder, piston, connecting rod, crankshaft and flywheel. Design of bearings – sliding contact and rolling contact types.

	Total (45L) = 45 Periods

Text Books:	
1	Bhandari V.B, "Design of Machine Elements", Tata McGraw Hill Book Co, 2003.
2	Md. Jalaludeen, S, "A Text Book of Machine Design", Anuradha Publications, 2006
Reference Books:	
1	Juvinall R.C, and Marshek K.M, "Fundamentals of Machine Component Design", John Wiley and Sons, 3rd Edition, 2002.
2	Gitin M Maitra and Prasad L V, "Handbook of Mechanical Design", Tata McGraw Hill, New Delhi, 2006.
3	PSG Tech, "Design Data Handbook", M/s DPV Printers, Coimbatore, 2009.
4	Md. Jalaludeen, S, "Design Data Handbook", Anuradha Publications, Chennai, 2006.
5	Robert L Norton, "Machine Design an Integrated Approach", Pearson Education, NewDelhi, 2005.

Course Outcomes: Upon completion of this course, the students will be able to:	
CO1	Apply the concept of steady and variable stresses in design of machine elements.
CO2	Design shafts and couplings for various applications
CO3	Select and Design the temporary and permanent joints for various applications.
CO4	Select and Design the springs, levers, pressure vessels for different applications.
CO5	Identify the dimensions of various energy storing elements and also select the bearings as per the applications and to design.

23PTME403	REFRIGERATION AND AIR CONDITIONING	Semester			IV
PREREQUISITES	Category	PC	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	To understand the underlying principles of operations in various Refrigeration & Air conditioning systems
2	To familiarize the components of the refrigerating systems
3	To know the applications of refrigeration and air conditioning systems
4	To provide knowledge on cooling load calculation and the system design aspects
5	To know the wide range of applications of refrigeration and air conditioning systems

Unit I	INTRODUCTION	9	0	0	9

Thermodynamics of refrigeration- reversed Carnot cycle- heat pump and refrigeration machines, Limitations of reversed Carnot cycle - Unit of Refrigeration and C.O.P.– Ideal cycles- Refrigerants Desirable properties – Classification – Nomenclature – ODP & GWP.

Unit II	VAPOUR COMPRESSION REFRIGERATION SYSTEM	9	0	0	9

Vapour compression cycle: p-h and T-s diagrams – deviations from theoretical cycle – sub cooling and super heating- effects of condenser and evaporator pressure on COP- multi-pressure system – low temperature refrigeration – Cascade systems – problems. Equipment's: Type of Compressors, Condensers, Expansion devices, Evaporators.

Unit III	OTHER REFRIGERATION SYSTEMS	9	0	0	9

Working principles of Vapour absorption systems and adsorption cooling systems – Steam jet refrigeration- Ejector refrigeration systems- Thermoelectric refrigeration- Air refrigeration – Magnetic – Vortex and Pulse tube refrigeration systems

Unit IV	PSYCHROMETRIC PROPERTIES AND PROCESSES	9	0	0	9

Properties of moist air - Gibbs Dalton law, Specific humidity, Dew point temperature, Degree of saturation, Relative humidity, Enthalpy, Humid specific heat, Wet bulb temperature Thermodynamic wet bulb temperature, Psychrometric chart; Psychrometric of air-conditioning processes, mixing of air streams.

Unit V	AIR CONDITIONING SYSTEMS AND LOAD ESTIMATION	9	0	0	9

Air conditioning loads: Outside and Inside design conditions; Heat transfer through structure, Solar radiation, Electrical appliances, Infiltration and ventilation, internal heat load; Apparatus selection; fresh air load, human comfort and IAQ principles, effective temperature and chart, calculation of summer and winter air conditioning load; Classifications, Layout of plants; Air distribution system; Filters; Air Conditioning Systems with Controls: Temperature, Pressure and Humidity sensors, Actuators and Safety controls.

Total (45L) = 45 Periods

Text Books:	
1	Arora, C.P., "Refrigeration and Air Conditioning", 3rd edition, McGraw Hill, New Delhi, 2010
2	Arora S. C. and Domkundwar, Refrigeration and Air-Conditioning, Dhanpat Rai, 2010
Reference Books:	
1	Roy J. Dossat, "Principles of Refrigeration", 4th edition, Pearson Education Asia, 2009.
2	Stoecker, W.F. and Jones J. W., "Refrigeration and Air Conditioning", McGraw Hill, New Delhi, 1986.
3	Ballaney P. L, Refrigeration and Air-Conditioning, Khanna Publishers, New Delhi, 2014
4	Manohar Prasad, Refrigeration and Air-Conditioning, New Age International, 2011
5	ASHRAE Hand book, Fundamentals, 2010
E-REFERENCES:	
1.	nptel.ac.in/ courses/downloads

Course Outcomes: Upon completion of this course, the students will be able to:	
CO1	Students understood the basic concepts of refrigeration and properties of refrigerants
CO2	Knowledge about the simple and multiple vapour compression systems has been acquired by the students
CO3	Students have understood the other refrigeration systems and their applications
CO4	The Knowledge about the psychrometric processes and the use of charts in problem solving have been practiced by the students
CO5	Students can able to demonstrate the operations and also able to design Refrigeration and Air Conditioning Systems for various applications.

23PTME404	DYNAMICS OF MACHINERY	Semester			IV
PREREQUISITES	Category	PC	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	To impart students with the knowledge about motion, masses and forces in machines and the Principle of Virtual Work
2	To facilitate students to understand the concept of balancing of rotating and reciprocating masses
3	To teach students concepts of linear vibration analyses of one and two degree-of-freedom rigid body systems
4	To teach students concepts of torsional vibrations analyses of rigid body systems and to give awareness to students on the phenomenon of vibration and its effects
5	To teach students about the concept of various types of governors

Unit I	FORCE ANALYSIS	9	0	0	9

Rigid Body dynamics in general plane motion – Equations of motion - Dynamic force analysis - Inertia force and Inertia torque – D'Alemberts principle - The principle of superposition - Dynamic Analysis in Reciprocating Engines – Gas Forces - Equivalent masses - Bearing loads - Crank shaft Torque - Turning moment diagrams - Fly wheels –Engine shaking Forces - Cam dynamics - Unbalance, Spring, Surge and Windup.

Unit II	BALANCING	9	0	0	9

Static and dynamic balancing - Balancing of rotating masses - Balancing a single cylinder Engine - Balancing Multi-cylinder Engines - Partial balancing in locomotive Engines - Balancing linkages - balancing machines

Unit III	LONGITUDINAL AND TRANSVERSE VIBRATION	9	0	0	9

Basic features of vibratory systems - idealized models - Basic elements and lumping of parameters - Degrees of freedom - Single degree of freedom - Free vibration - Equations of motion - Natural frequency of longitudinal and transverse (Free, Forced) vibrations - Types of Damping - Damped vibration (Free, Forced) - critical speed of simple shaft. Response to periodic forcing - Harmonic Forcing - Forcing caused by unbalance - Support motion – Force transmissibility and amplitude transmissibility – Vibration isolation.

Unit IV	TORSIONAL VIBRATION AND VIBRATING MEASUREMENTS	9	0	0	9

Torsional systems - Natural frequency of free torsional vibration – Single, two and three rotor systems – Torsionally Equivalent shaft - Introduction to multi-degree-of-freedom systems. Vibration instruments: vibrometer, accelerometer. Vibration Measuring Devices - Vibration exciters - FFT analyzer.

Unit V	GOVERNORS	9	0	0	9

Governors - Types - Centrifugal governors - Gravity controlled and spring controlled centrifugal governors – Characteristics - Effect of friction - Controlling Force - other Governor mechanisms.
Total (45L) = 45 Periods

Text Books:	
1	Design of Machinery, Fourth Edition, by R.L. Norton, McGraw Hill, 2007
2	Mechanical Vibration, V.P.Singh, Dhanpatrai, Delhi
Reference Books:	
1	Ballaney, P.L., “Theory of Machines and Mechanisms", Khanna Publishers, New Delhi, 2002.
2	Shigley, J.E. and Uicker, J.J., “Theory of Machines and Mechanisms”, TMH ND, 1998.
3	Amithabha Ghosh, and Ashok Kumar Malik., “Theory of Mechanisms and Machines”, 2nd Ed., Affiliated East and West Press Limited, 1998.
4	Prof.Nakara iit, Delhi Reference Books
E-REFERENCES:	
1.	www.university.youth4work.com/IIT_Kharagpur_Indian-Institute-of-Technology/study/1653-dynamics-of-machinery-ebook
2.	http://nptel.ac.in/courses/112104114/

Course Outcomes: Upon completion of this course, the students will be able to:	
CO1	Apply basic principles of mechanisms in mechanical system and Perform static and dynamic analysis of simple mechanisms.
CO2	Perform balancing of rotating and reciprocating masses.
CO3	Model and analyse mechanical systems subjected to longitudinal and transverse vibration.
CO4	Analyse the mechanical systems subjected to torsional vibration.
CO5	Study the various types of governors and its speed control mechanism.

23PTME405	CAD / CAM LABORATORY	Semester	IV
PREREQUISITES	Category	PC	Credit 1.5

1. Engineering Drawing, 2. Machine Drawing	Hours/Week	L	T	P	TH
		0	0	3	3

Course Learning Objectives

1	Understand the Code of drawing practice as per BIS conventions for mechanical elements using CAD software.
2	Practice the methods for sectioning and drawing the joints, couplings, bearings, and keys.
3	Prepare assembly drawings, sectional views and bill of materials for selected assemblies.
4	To equip the students for implement CNC programs for milling and turning machining operations.
5	To create a computer aided manufacturing (CAM) model and generate the machining codes automatically using the CAM system.

CAD EXPERIMENTS

The students will be required to carry out the following exercises using software packages (e.g. 3D modeling package / Pro Engineer/ CATIA /I-Deas/ Solid Edge/Solid Works etc.)

- Introduction to advanced modeling software
- Part Modeling of Screw Jack
- Part Modeling of Flange Coupling
- Part Modeling of Plummer Block
- Part Modeling of Knuckle Joint
- Creation of 3D assembly model of universal joint
- Creation of 3D assembly model of connecting rod
- Creation of 3D assembly model of crankshaft

CAM EXPERIMENTS

- Study and Demonstration on CNC Turning & Milling Machines.
- Tool path generation, Part programming, G & M codes development for machining operations, Physical interpretation of machining features and tool geometries.
- Part Program generation and tool path simulation for turning & Milling for Fanuc Control System using CAM software.

CNC –Milling

1. Linear and Circular Interpolation
2. Circular Pocketing
3. Rectangular Pocketing
4. Peck Drilling
5. Mirroring

Total (45P) = 45 Periods

Course Outcomes: Upon completion of this course, the students will be able to:	
CO1	Describe how CAD technology can be leveraged in the design process and the basic and advanced features available with CAD software
CO2	Design a part or assembly of parts using Computer-Aided Design software.
CO3	Design a detailed view of part or assembly of parts using Computer-Aided Design software.
CO4	Understand the CNC concepts and manual part programming using G and M codes.
CO5	Understand modern CNC control systems (Fanuc, Siemens etc.) and application of various CNC machines.

23PTME501	HEAT AND MASS TRANSFER	Semester			V
PREREQUISITES	Category	PC	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	To understand the mechanisms of heat transfer under steady and transient conditions
2	To understand the concepts of heat transfer through extended surfaces.
3	To learn the thermal analysis and sizing of heat exchangers and to understand the basic concepts of mass transfer

Unit I	CONDUCTION	9	0	0	9

Basic concepts, Mechanism of heat transfer, Fourier's Law of conduction, General Differential equation of heat conduction – Cartesian and Cylindrical Coordinates– One Dimensional Steady State Heat conduction, Conduction through plane wall, cylinders and spheres, Composite geometries, contact resistance, conduction with heat generation.

Unit II	CONVECTION	9	0	0	9

Basic governing equations - boundary layer concept – Forced convection: external flow – flow over plates, cylinders, spheres and bank of tubes. Internal flow – entrance effects. Free convection –flow over vertical plate, horizontal plate, inclined plate, cylinders and spheres.

Unit III	PHASE CHANGE HEAT TRANSFER AND HEAT EXCHANGERS	9	0	0	9

Regimes of Pool boiling and Flow boiling, Nusselt's theory of condensation- correlations in boiling and condensation. Heat Exchanger - Types - Overall Heat Transfer Coefficient – Fouling Factors. LMTD and NTU methods.

Unit IV	RADIATION	9	0	0	9

Radiation laws, Black Body and Gray body Radiation. Shape Factor. Electrical Analogy. Radiation Shields.

Unit V	MASS TRANSFER	9	0	0	9

Basic Concepts – Diffusion Mass Transfer – Fick's Law of Diffusion – Steady state Molecular Diffusion - Equimolal counter diffusion. Basic Convective Mass Transfer Problems.

Total (45L) = 45 Periods

Text Books:

1	Holman J.P, "Heat and Mass Transfer", Tata McGraw Hill, 2000.
2	Sachdeva, R.C, "Fundamentals of Engineering Heat and Mass Transfer", New Age International Publishers, New Delhi, 1995.

3	Bejan, A, “Heat Transfer”, John Wiley and Sons, 1995.
4	Ozisik, M.N, “Heat Transfer”, McGraw Hill Book Co., 1994.
Reference Books:	
1	Yadav.R, “Heat and Mass Transfer”, Central Publishing House, Allahabad, 1995.
2	C.P.Kothandaraman, “Fundamentals of Heat and Mass Transfer”, New Age International Publishers, NewDelhi, 1998.

Course Outcomes: Upon completion of this course, the students will be able to:	
CO1	Analyze the mechanism of heat conduction under steady and transient conditions.
CO2	Develop solutions to problems involving convective heat transfer.
CO3	Design a heat exchanger for any specific application.
CO4	Adopt the concept of radiation heat transfer in real time systems.
CO5	Develop solutions to problems involving combined heat and mass transfer.

23PTME502	DESIGN OF TRANSMISSION SYSTEMS	Semester			V
PREREQUISITES	Category	PC	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	Select appropriate mechanical components from manufacturers' catalogues.
2	Apply codes and standards to machine component design.
3	Communicate the results of a design assignment by means of drawings and a design report.
4	Design simple power transmission systems like belt, gear, cam and clutch etc.,

Unit I	DESIGN OF BELT DRIVES, CHAIN DRIVES AND WIRE ROPES	9	0	0	9

Selection of flat belts and pulleys – Selection of V-belts and pulleys – Selection of Transmission chains and Sprockets, Wire ropes and pulleys, Design of pulleys and sprockets.

Unit II	DESIGN OF SPUR AND HELICAL GEARS	9	0	0	9

Gear drives- Spur gears-Gear Terminology-Speed ratios and number of teeth- Force analysis -Tooth stresses - Gear materials – Module and Face width- Power rating calculations based on strength and wear considerations - Parallel axis Helical Gears – Pressure angle in the normal and transverse plane- Equivalent number of teeth- forces and stresses. Estimating the size of the helical gears.

Unit III	DESIGN OF BEVEL GEARS AND WORM GEARS	9	0	0	9

Bevel gears – Types - Gear materials - Terminology – Tooth forces and stresses, equivalent number of teeth - Design of bevel gears based on strength and wear conditions. Worm Gears - Merits and demerits- Terminology. Thermal capacity, materials-forces and stresses, efficiency, estimating the size of the worm gear pair.

Unit IV	DESIGN OF GEAR BOXES AND POWER SCREWS	9	0	0	9

Gear boxes - Geometric progression - Standard step ratio - Ray diagram, kinematics layout -Design of sliding mesh gear box -Constant mesh gearbox. – Design of multi speed gearbox. Design of power screws for screw jack, design of lead screw for lathe.

Unit V	DESIGN OF CAM, CLUTCHES AND BRAKES	9	0	0	9

Cam Design: Types-pressure angle and undercutting base circle determination - forces and surface stresses. Design of plate clutches – axial clutches - cone clutches - internal expanding rim clutches - internal and external shoe brakes.

Total (45L) = 45 Periods

Text Books:

1	Bhandari V.B, “Design of Machine Elements”, Tata McGraw-Hill Book Co, 2003.

2	Md. Jalaludeen, S, “A Text Book of Machine Design”, Anuradha Publications, 2006.
Reference Books:	
1	Juvinall R.C and Marshek K.M, “Fundamentals of Machine Component Design”, John Wiley and Sons, 3rd Edition, 2002.
2	Spotts M.F, Shoup T.E, “Design and Machine Elements”, Pearson Education, 2004.
3	PSG Tech, “Design Data Handbook”, M/s DPV Printers, Coimbatore, 2009.
4	Md. Jalaludeen, S, “Design Data Handbook”, Anuradha Publications, Chennai, 2006.

Course Outcomes: Upon completion of this course, the students will be able to:	
CO1	Choose suitable flexible drive for specific application.
CO2	Design spur and helical gear by considering strength and life.
CO3	Estimate the dimensions of bevel and worm gears
CO4	Construct the gearbox for suitable application.
CO5	Apply the uniform pressure and wear theories to design the various clutches and brakes

23PTME503	APPLIED HYDRAULICS AND PNEUMATICS	Semester			V
PREREQUISITES	Category	PC	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	To provide student with knowledge on the application of fluid power in process, construction and manufacturing Industries.
2	To provide students with an understanding of the fluids and components utilized in modern industrial fluid power system.
3	To develop a measurable degree of competence in the design, construction and operation of fluid power circuits.

Unit I	FLUID POWER PRINICIPLES AND HYDRAULIC PUMPS	9	0	0	9

Introduction to Fluid power – Advantages and Applications – Fluid power systems – Types of fluids - Properties of fluids and selection – Basics of Hydraulics – Pascal's Law – Principles of flow - Friction loss – Work, Power and Torque Problems, Sources of Hydraulic power : Pumping Theory – Pump Classification – Construction, Working, Design, Advantages, Disadvantages, Performance, Selection criteria of linear and rotary – Fixed and Variable displacement pumps.

Unit II	HYDRAULIC ACTUATORS AND CONTROL COMPONENTS	9	0	0	9

Hydraulic Actuators: Cylinders – Types and construction, Application, Hydraulic cushioning – Hydraulic motors - Control Components : Direction Control, Flow control and pressure control valves – Types, Construction and Operation – Servo and Proportional valves – Applications – Accessories : Reservoirs, Pressure Switches – Applications – Fluid Power ANSI Symbols.

Unit III	HYDRAULIC CIRCUITS AND SYSTEMS	9	0	0	9

Accumulators, Intensifiers, Industrial hydraulic circuits – Regenerative, Pump Unloading, Double Pump, Pressure Intensifier, Air-over oil, Sequence, Reciprocation, Synchronization, Fail-Safe, Speed Control, Hydrostatic transmission, Electro hydraulic circuits, Mechanical hydraulic servo systems.

Unit IV	PNEUMATIC AND ELECTRO PNEUMATIC SYSTEMS	9	0	0	9

Properties of air – Perfect Gas Laws – Compressor – Filters, Regulator, Lubricator, Muffler, Air control Valves, Quick Exhaust Valves, Pneumatic actuators, Design of Pneumatic circuit – Cascade method – Electro Pneumatic System – Elements – Ladder diagram – Problems, Introduction to fluidics and pneumatic logic circuits.

Unit V	TROUBLE SHOOTING AND APPLICATIONS	9	0	0	9

Installation, Selection, Maintenance, Trouble Shooting and Remedies in Hydraulic and Pneumatic systems, Design of hydraulic circuits for Drilling, Planning, Shaping, Surface grinding, Press and Forklift applications. Design of Pneumatic circuits for Pick and Place applications and tool handling in CNC Machine tools – Low cost Automation – Hydraulic and Pneumatic power packs.
Total (45L) = 45 Periods

Text Books:	
1	Anthony Esposito, "Fluid Power with Applications", Pearson Education, 2005.
2	Majumdar S.R., "Oil Hydraulics Systems- Principles and Maintenance", Tata McGraw Hill, 2001.
Reference Books:	
1	Anthony Lal, "Oil hydraulics in the service of industry", Allied publishers, 1982.
2	Dudelyt, A. Pease and John T. Pippenger, "Basic Fluid Power", Prentice Hall, 1987.
3	Majumdar S.R., "Pneumatic systems – Principles and maintenance", Tata McGraw Hill, 1995
4	Michael J, Prinches and Ashby J. G, "Power Hydraulics", Prentice Hall, 1989.
5	Shanmuga sundaram.K, "Hydraulic and Pneumatic controls", Chand & Co, 2006

Course Outcomes: Upon completion of this course, the students will be able to:	
CO1	Explain the Fluid power and operation of different types of pumps.
CO2	Summarize the features and functions of Hydraulic motors, actuators and control valves.
CO3	Explain the different types of hydraulic circuits and systems.
CO4	Explain the working of different pneumatic circuits and systems.
CO5	Summarize the various trouble shooting methods and applications of hydraulic and pneumatic systems.

23PTME504	SOLAR AND WIND ENERGY SYSTEMS	Semester			V
PREREQUISITES	Category	PC	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	To learn the fundamentals of solar and wind energy conversion systems,
2	The available solar and wind energy, and their applications.
3	To learn about PV technology principles and techniques of various solar cells
4	Learn the current technology of the solar energy systems for making the process economical, environmentally safe and sustainable.
5	To learn the basic design aspects of WET

Unit I	SOLAR COLLECTORS	9	0	0	9

Solar collectors: classification, comparison of concentrating and non-concentrating types. Flat plate collectors: construction, liquid flat-plate collector efficiency, effect of various parameters on performance. Concentrating collectors: Working principle of flat plate collector with plane reflectors - Cylindrical parabolic concentrators - Compound Parabolic Concentrator (CPC) - linear fresnel lens collector - Paraboloidal dish collector - Central tower receiver.

Unit II	APPLICATIONS OF SOLAR THERMAL TECHNOLOGY	9	0	0	9

Electric power generation: Low temperature systems - Low temperature power generation using liquid flat plate collectors - Solar pond electric power plant - Solar chimney power plant. Medium temperature system - Power generation using line focusing cylindrical parabolic concentrating collectors. High temperature systems - Power generation using paraboloid dish collectors - Central tower receiver power plant. Solar water heating system, passive solar space heating and cooling system, solar cooker, solar distillation, solar dryer, solar cooling - Absorption cooling - Solar desiccant cooling. Solar green house.

Unit III	SOLAR PHOTOVOLTAIC SYSTEMS	9	0	0	9

Fundamentals of solar cells, P-N junction photodiode, photovoltaic conversion - description and principle of working of a solar cell, cell structure, solar module and panel, I-V characteristics of a PV module, maximum power point, cell efficiency, fill factor, SPV system classification, SPV system components, SPV applications.

Unit IV	WIND ENERGY TECHNOLOGY	9	0	0	9

Principle of wind energy conversion-power in the wind - conversion of wind to electrical energy. Types of wind power plants - Horizontal Axis Wind Turbine (HAWT) - Vertical Axis Wind Turbine (VAWT). Stand alone and grid connected WPPs-Components of wind power plants-Working of wind power plants-specifications of wind power plants- Siting of wind power plants.

Unit V	AERODYNAMICS AND ECONOMICS OF WIND POWER PLANTS	9	0	0	9

Aerodynamic power regulation of wind power plants- stall regulation of WPPs- pitch regulation of WPPs- stall, pitch and active stall regulation comparison. Introduction to economics of WPPs – investment-economic result-risk assessment and financing. Wind power project development.
Total (45L) = 45 Periods

Text Books:	
1	Sukhatme.S.P, Nayak.J.K, "Solar Energy, Principles of Thermal Collection and Storage", Tata McGraw Hill, Third edition, 2010.
2	Spera D.A., Wind Turbine Technology: Fundamental Concepts of Wind Turbine Engineering, ASME Press, NY 1994.
Reference Books:	
1	Garg.H.P, Prakash.J, "Solar Energy: Fundamentals & Applications", Tata McGraw Hill, 2000.
2	Duffie.J.A and Beckman.W.A, "Solar Engineering of Thermal Processes", John Wiley, 1991.
3	Alan L. Fahrenbruch and Richard H. Bube, "Fundamentals of Solar Cells: PV Solar Energy Conversion", Academic Press, 1983.
4	Rai.G.D, "Solar Energy Utilization", Khanna Publishers, Year 2011.
5	Khan.B.H, "Non-Conventional Energy Resources", Tata McGraw Hill, Second edition, 2011.
6	Freris L.L., Wind Energy Conversion Systems, Prentice Hall 1990.
7	Johnson, G.L., Wind Energy Systems, Prentice Hall, 1985.
E-REFERENCES:	
1.	nptel.ac.in / courses / downloads

Course Outcomes: Upon completion of this course, the students will be able to:	
CO1	Acquire the fundamentals of the solar collectors and its types.
CO2	Study of the various applications of solar thermal technologies.
CO3	Acquire the fundamentals of the solar resource and solar energy systems the fundamentals of photovoltaic cells and systems.
CO4	Evaluation of the resource, introduction to the conversion process and performance of wind energy systems in operation.
CO5	Study about fundamentals of the wind resources, wind turbine aerodynamics, design and control.

23PTME601	INDUSTRIAL ENGINEERING	Semester			VI
PREREQUISITES	Category	PC	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	Assume professional, technical, managerial and leadership roles in the industrial organizations.
2	Apply knowledge through discovery, synthesis, and integration for the betterment of the organization.
3	Apply engineering principles to the work environment.
4	Use quality tools to foresee and solve issues in the industrial situations.
5	Work collaboratively.

Unit I	FORECASTING AND INVENTORY	9	0	0	9

Characteristics and Principles, Qualitative methods - Delphi technique, Market Research, Intrinsic method - Time-series analysis, Moving averages, Exponential smoothing - The Bon Jenkins method, Extrinsic methods - Regression models, Measurement of forecast errors. Inventory models - Classification of inventory systems – EOQ models and purchase discounts - ABC and other classification methods - Applications

Unit II	FACILITIES PLANNING	9	0	0	9

Facilities planning - An overview, Facilities planning and engineering economic analysis - Facilities location problems – Types of layouts - Computerized layout planning - Warehouse management, Value added management, Management system audit - Role of KAIZEN, TQM, QC and POKA YOKE in facilities planning.

Unit III	JIT AND MODERN MANUFACTURING PRINCIPLES	9	0	0	9

Introduction - Elements of Just In Time (JIT), Pull versus Push method, Kanban system - Single Minute Exchange of Die (SMED) - Continuous improvement - Optimized production technology - Business process reengineering (BPR), Lean manufacturing concepts – Implementation of Six Sigma concepts - Cellular manufacturing - Concurrent engineering - Agile manufacturing - Rapid manufacturing.

Unit IV	AGGREGATE PLANNING AND SUPPLY CHAIN MANAGEMENT	9	0	0	9

Approaches to aggregate planning - Development of master production schedule - Capacity planning - Materials requirements planning (MRP-I), Manufacturing resources planning (MRP-II), Enterprises resources planning (ERP) - Supply chain management (SCM) – Supply chain and “Keiretsu”.

Unit V	SCHEDULING AND CONTROLLING	9	0	0	9

Objectives in scheduling - Major steps involved - Production control in repetitive, batch and job shop manufacturing environment - Allocation of units for a single resource, allocation of multiple resources - Resource balancing - Flexible manufacturing system - Concepts, advantages and limitation.

Total (45L) = 45 Periods

Text Books:	
1	Dilworth B. James, "Operations Management Design, Planning and control for Manufacturing and Services", McGraw Hill Inc., New York, 1992.
2	Samson Eilon, "Elements of Production Planning and Control", Universal Book Corpn.1984.
Reference Books:	
1	Tomkins, J.A and White, J.A, "Facilities Planning", John Wiley and Sons, 1984.
2	Vollman T.E, "Manufacturing Planning and Control systems", Galgotia Publications, 2002.
3	Elwood S. Buffa, and Rakesh K.Sarin, "Modern Production and Operations Management", 8th Edition. John Wiley and Sons, 2000.
E-REFERENCES:	
1.	NPTEL Lectures in Industrial Engineering, Indian Institute of Technology

Course Outcomes:	
Upon completion of this course, the students will be able to:	
CO1	Apply the knowledge in mathematics, science, and engineering in the direction to improve the productivity of industries.
CO2	Explain the concepts in engineering economic analysis for effective utilization and management of available facilities.
CO3	Apply the concept of JIT and modern manufacturing principles in professional organization.
CO4	Explain the concepts of supply chain management for efficient use of available resources with aggregate planning.
CO5	Develop the productivity by proper scheduling and controlling of resources.

23PTME602	MECHATRONICS	Semester			VI
PREREQUISITES	Category	PC	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	To impart knowledge about the elements and techniques involved in Mechatronics systems which are very much essential to understand the emerging field of automation.

Unit I	INTRODUCTION TO MECHATRONICS	9	0	0	9

Introduction to Mechatronic Systems - Mechatronic products and their functioning - Advanced applications in Mechatronics - Measurement systems- Sensors and transducers – Performance terminology – Sensors for displacement, position and proximity; velocity, motion, force, fluid pressure, liquid flow, liquid level, temperature, light sensors – Selection of sensors

Unit II	PHYSICAL SYSTEM MODELING	9	0	0	9

System Models - mechanical systems, electrical systems, thermal systems, electromechanical systems, hydro-mechanical systems, pneumatic systems - Basis of analogies in physical system models.

Unit III	ACTUATION SYSTEMS	9	0	0	9

Electric motors - Solenoids - Solid state switches - Stepper motors - Servo motors - Mechanical actuators - Hydraulic motors - Piezo actuators– Control systems - PID Controllers. Artificial intelligence in Mechatronics – Adaptive and nonlinear control design - Neural networks and fuzzy systems.

Unit IV	PROGRAMMING LOGIC CONTROLLERS	9	0	0	9

Introduction to Programmable Logic Controllers – Basic Structure – Input / Output processing – Ladder logic programming – Mnemonics –relays and counters – Shift registers – Master and Jump controls – Data handling – Analog Input / Output – Case studies on PLC.

Unit V	MECHATRONICS SYSTEMS DESIGN	9	0	0	9

Stages in designing of Mechatronics systems – Traditional and Mechatronic design - Possible design solutions. Case studies: Data acquisition and control - Pick and place robot – Automatic car park barrier systems – Engine management systems - Mechatronic control in automated manufacturing.

Total (45L) = 45 Periods

Text Books:

1	Bolton, W, Mechatronics, Pearson Education, 6th Edition, 2015.
2	Ganesh S.Hegde, Mechatronics, Jones & Bartlett publishers, 1st Edition, 2010.

Reference Books:

1	Michael B. Histand and David G. Alciatore, Introduction to Mechatronics and Measurement Systems, McGraw Hill International Editions, 3rd Edition, 2007.

2	Bradley D. A., Dawson D., Buru N.C. and. Loader A.J, Mechatronics, Chapman and Hall, 1st Edition, 1993.
3	Dan Necsulesu, Mechatronics, Pearson Education Asia, 1st Edition, 2002
4	Brian Morriss, Automated Manufacturing Systems - Actuators, Controls, Sensors and Robotics, McGraw Hill International Edition, 1995.

Course Outcomes:

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

CO1	Students will be able to understand the basic elements underlying Mechatronic systems and integrate them in the design of mechatronics systems.
CO2	Students will be able to develop a simulation model for simple physical systems and illustrate mechatronics design process.
CO3	Students will be capable of designing, interfacing and understand issues of implementation of different actuation in a mechatronic system for a set of specifications.
CO4	Students understand how to interface electromechanical systems to PLCs.
CO5	Students will gain practical experience in applying knowledge gained in the course through a hands-on project.

23ME603	SIMULATION LABORATORY		Semester			
PREREQUISITES		**Category**		**Credit**		**1.5**
1. Basic knowledge in any modeling software. **2.** Fundamental knowledge in FEA.		**Hours/Week**	**L**	**T**	**P**	**TH**
			0	**0**	**3**	**3**

Course Learning Objectives

1	To make the students analyze the structural components for deflection, stress and reaction forces.
2	To make the students analyze the force, stress, deflection in mechanical components.
3	To make the students analyze thermal stress and heat transfer in mechanical components.
4	To make the students analyze the vibration of mechanical components.
5	To make the students analyze the modal, harmonic, transient and spectrum concepts in mechanical components.

LIST OF EXPERIMENTS

Analysis of Mechanical Components – Use of FEA packages, like ANSYS/ NASTRON etc.,
The following exercises shall include FEA analysis of

1. Force and Stress analysis using link elements in Trusses.
2. Force and stress analysis using link elements in axially loaded bars.
3. Stress and deflection analysis in beams with different support conditions.
4. Stress analysis of flat plates.
5. Stress analysis of axis–symmetric components.
6. Thermal stress and heat transfer analysis of plates.
7. Thermal stress analysis of cylindrical shells.
8. Vibration analysis of spring-mass systems.
9. Modal analysis of Beams.
10. Harmonic, transient and spectrum analysis of simple systems

Total (45P) = 45 Periods

E-REFERENCES:

1	https://www.ansys.com/
2	https://bmsce.ac.in/Content/ME/MFELAB_manual_Jan2019_Updated_28_1_2019.pdf
3	https://confluence.cornell.edu/display/SIMULATION/ANSYS+Learning+Modules

COURSE OUTCOMES: **On completion of the course the student will be able to**	
CO1	Analyze the structural components for deflection, stress and reaction forces.
CO2	Analyze the force, stress, deflection in mechanical components.
CO3	Analyze thermal stress and heat transfer in mechanical components.
CO4	Analyze the vibration of mechanical components.
CO5	Analyze the modal, harmonic, transient and spectrum concepts in mechanical components.

23PTME701	FINITE ELEMENT ANALYSIS		Semester			VII
PREREQUISITES		Category	PC	Credit		3
		Hours/Week	L	T	P	TH
			3	0	0	3

Course Learning Objectives

1	To equip the students with the basic concepts of Finite Element methods
2	Polynomial interpolation, application of boundary conditions, assembly of global arrays, and solution of the resulting algebraic systems.
3	To learn and apply finite element solutions to structural, thermal, dynamic problem to develop the knowledge and skills.
4	To familiarize the students in deriving FEA equations for 1D and 2D problems with different types of elements.
5	To make the students understand the need for FEA package and the procedure for solving problems

Unit I	INTRODUCTION	9	0	0	9

Basics of FEM – history - Comparison with other methods - General steps of FEM - Applications and Advantages -Matrix approach- Application to the continuum – Discretization - Types of elements based on geometry- Node numbering, Half band width - Matrix algebra- Gaussian elimination - Classical techniques in FEM - Weighted residual methods –general weighted residual statement – weak formulation of the weighted residual statement –comparisons – piecewise continuous trial functions example of a bar finite element – functional and differential forms – principle of stationary total potential – Rayleigh Ritz method – piecewise continuous trial functions – application to bar element.

Unit II	ONE DIMENSIONAL FEA	9	0	0	9

General form of total potential for 1-D applications – generic form of finite element equations – linear bar element – quadratic element –nodal approximation – development of shape functions – derivation of element stiffness matrices and vectors – assembly- example problems – extension to plane truss– development of element equations – assembly – element connectivity – global equations – solution methods –beam element – nodal approximation – shape functions – element matrices and vectors – assembly – solution – example solid mechanics problems - Temperature effects.

Unit III	TWO DIMENSIONAL FEA	9	0	0	9

Introduction – approximation of geometry and field variable – 3 noded triangular elements – four noded rectangular elements – higher order elements – Interpolation polynomials- Linear, quadratic and cubic. Simplex complex and multiplex elements- 2D PASCAL's triangle - generalized coordinates approach to nodal approximations – difficulties – natural coordinates and coordinate transformations – CST elements - Shape functions and Nodal load vector - Strain displacement matrix and Jacobian for triangular and rectangular element – structural mechanics applications in 2-dimensions – elasticity equations – stress strain relations – plane problems of elasticity – element equations – assembly – example problems in plane stress, plane strain - axisymmetric element applications

Unit IV	ISOPARAMETRIC FORMULATIONS	9	0	0	9

Isoparametric elements – sub parametric and Super parametric elements - natural co-ordinate systems - Shape functions for isoparametric elements – One and two dimensions – Serendipity elements – axisymmetric applications - need for quadrature formula – transformations to natural coordinates – Gaussian quadrature Numerical integration and application to plane stress problems – Matrix solution techniques - Langrange's interpolation- Higher order one dimensional elements - Quadratic and cubic element - Applying numerical integration: 1, 2 and 3 gauge point for 1D and 2D cases - example problems.					
Unit V	**HEAT TRANSFER AND FLUID FLOW APPLICATION**	**9**	**0**	**0**	**9**
One dimensional heat transfer element – Steady state heat transfer, 1D heat conduction governing Equations -Functional approach for heat conduction- Galerkin's approach for heat conduction - application to one-dimensional heat transfer problems- 1D heat transfer in thin fins problems - scalar variable problems in 2-Dimensions – Applications to heat transfer in 2-Dimension – Incompressible fluid flow- Basic equations - solution procedure - Galerkin Approach - Problems in incompressible fluid flow.					
Total (45L) = 45 Periods					

Text Books:	
1	Chandrupatla T. R & Belagundu A. D, "Introduction to Finite Elements in Engineering", 3rd Edition, Prentice Hall College Div, 1990.
2	Seshu, P, "Text Book of Finite Element Analysis", Prentice-Hall of India Pvt. Ltd., New Delhi, 2007.
Reference Books:	
1	Reddy. J.N., "An Introduction to the Finite Element Method", 3rd Edition, Tata McGraw-Hill, 2005.
2	Rao, S.S., "The Finite Element Method in Engineering", 3rd Edition, Butterworth Heinemann, 2004.
3	Robert D. Cook, David S. Malkus, Michael E. Plesha, Robert J. Witt, "Concepts and Applications of Finite Element Analysis", 4th Edition, Wiley Student Edition, 2002.
4	Bathe K.J, "Finite Element Procedures in Engineering Analysis", Prentice hall, 1981.
5	C.S. Desai and J.P. Abel, "Introduction to Finite Element Method", Affiliated East West Press, 1972.
E-REFERENCES:	
1.	http://nptel.ac.in/courses/112104115/
2.	http://www.tech.plym.ac.uk/sme/FEANotes

Course Outcomes: Upon completion of this course, the students will be able to:	
CO1	Formulate the physical design problems into FEA including domain discretization, polynomial interpolation, application of boundary conditions, assembly of global arrays, and solution of the resulting algebraic systems.
CO2	Apply FEM concept for developing FE equations for solving 1-D problems with bar, truss and beam elements.
CO3	Apply FEM concept for developing FE equations for solving 2-D problems with CST elements for plane stress, plane strain and axisymmetric problems.
CO4	Derive Iso-parametric formulations for quadrilateral element and apply the gauss quadrature for numerical integration.
CO5	Apply the concepts of FEA for solving 1-D heat transfer and fluid flow problems under the given boundary conditions.

23PTME702	OPERATIONS RESEARCH	Semester	VII
PREREQUISITES	Category	PC	Credit 3

	L	T	P	TH
Hours/Week	3	0	0	3

Course Learning Objectives

1	Build the capabilities to analyze different industrial/business situations involving limited resources.
2	Develop the skills to build own formulations/expand existing formulations, to critically evaluate the impact of model assumptions.
3	Strengthen the ability to choose an appropriate solution technique for a given formulation.
4	Finding the optimal solution for any practical situation which is subjected with some constraints.
5	Enhance the skills on managerial science.

Unit I	LINEAR MODELS	9	0	0	9

The phases of operations research study - Formation of linear programming model - Graphical method - Simplex algorithm - Big M method – Two phase method - Dual simplex method.

Unit II	TRANSPORTATION AND ASSIGNMENT MODELS	9	0	0	9

Transportation models - Optimal solution by North West Corner method - Least Cost Method - Vogel's Approximation Method - optimality test - MODI method - Assignment problem formulation - Hungarian method - Unbalanced and maximization assignment problems.

Unit III	NETWORK MODELS	9	0	0	9

Construction of project networks - Network optimization algorithms - Shortest route models, Minimal spanning tree models, Maximum flow models - CPM and PERT networks - Critical path scheduling.

Unit IV	REPLACEMENT AND SEQUENCING MODELS	9	0	0	9

Replacement of items that deteriorate with time: value of money change with time, not change with time - Optimum replacement policy - Individual and group replacement - Sequencing problems – Problems with *n* jobs with *2* machines, *n* jobs with *3* machines, *n* jobs with *k* machines, *2* jobs with *k* machines.

Unit V	QUEUING THEORY AND SIMULATION	9	0	0	9

Replacement of items that deteriorate with time: value of money change with time, not change with time - Optimum replacement policy - Individual and group replacement - Sequencing problems – Problems with *n* jobs with *2* machines, *n* jobs with *3* machines, *n* jobs with *k* machines, *2* jobs with *k* machines.

Total (45L) = 45 Periods

Text Books:

1. Taha, H.A, "Operations Research", 9th Edition, Pearson Education India, 2014.

2	Hira and Gupta, “Introduction to Operations Research”, S. Chand and Co, 2011.
Reference Books:	
1	S.D.Sharma - Operations Research , Kedarnath, Ramnath 2015
2	Hiller & Libermann - Introduction to O.R, Mc Graw Hill 2011
3	Sharma J.K, “Operations Research”, 6th Edition Macmillan India Ltd, 2007.
4	A.M.Natarajan,P.Balasubramani,A. Tamilarasi -Operations Research , Pearson .Education.
E-REFERENCES:	
1.	NPTEL Lectures in Operation Research, Indian Institute of Technology

COURSE OUTCOMES: **On completion of the course the student will be able to**	
CO1	Formulate and solve linear programming problems for getting optimal solution under given constraints.
CO2	Solve transportation and production problems and optimize, interpret the results obtained and translate solutions into directives for action.
CO3	Solve network models arising from a wide range of applications.
CO4	Solve replacement and sequencing problems and optimize, interpret the results obtained and translate solutions into directives for action.
CO5	Explain procedures for queuing theory models and getting solutions using simulation.

23PTME801	TOTAL QUALITY MANAGEMENT	Semester			VIII
PREREQUISITES	Category	PC	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	Understand the philosophy and core values of Total Quality Management (TQM).
2	Explain the salient contributions of Quality Gurus like Deming, Juran and Crosby.
3	Know about general barriers in implementing TQM.
4	Determine the voice of the customer and convert into quality terms to enhance the economic performance and long-term business success of an organization.
5	Apply and evaluate best models and practices for the attainment of total quality in the organization.

Unit I	INTRODUCTION	9	0	0	9

Definition of Quality - Dimensions of Quality - Quality planning - Quality costs, Analysis techniques for quality costs - Basic concepts of total quality management (TQM) - Historical review - Principles of TQM - Leadership - Role of senior management - Quality council, Quality statements - Strategic planning - Deming philosophy - Barriers to TQM implementation.

Unit II	TQM PRINCIPLES	9	0	0	9

Customer satisfaction - Customer perception of quality, Customer complaints, Service quality, Customer Retention, Employee involvement - Motivation, Empowerment, Teams, Recognition and reward, Performance appraisal - Continuous process improvement – Juran Trilogy, PDSA Cycle, 5S, Kaizen - Supplier Partnership, Sourcing, Supplier selection, Supplier rating, Relationship development - Performance measures, Basic concepts, Strategy.

Unit III	STATISTICAL PROCESS CONTROL (SPC)	9	0	0	9

The seven tools of quality, Statistical fundamentals – Measures of central tendency and dispersion, Population and sample, Normal curve - Control charts for variables and attributes, Process capability - Concept of six sigma, new seven Management tools.

Unit IV	TQM TOOLS	9	0	0	9

Benchmarking – Reasons to benchmark, Benchmarking process, Quality Function Deployment (QFD) process – House of quality, Benefits - Taguchi quality loss function - Total Productive Maintenance (TPM) concept, Improvement needs - FMEA – Stages of FMEA.

Unit V	QUALITY MANAGEMENT SYSTEMS	9	0	0	9

Need for ISO 9000 and other quality systems, ISO 9001:2008 quality system – Elements, Implementation of quality system, Documentation, Quality auditing, TS 16949:2002.

Total (45L) = 45 Periods

Text Books:	
1	Dale H. Besterfiled et al., "Total Quality Management", Pearson Education Asia, 1999.
2	Feigenbaum.A.V. "Total Quality Management", McGraw Hill, 1991.
Reference Books:	
1	Oakland.J.S, "Total Quality Management", Butterworth – Hcinemann Ltd., Oxford. 1989.
2	Narayana V and Sreenivasan, N.S, "Quality Management – Concepts and Tasks", New Age International, 1996.
3	James R.Evans and William M.Lidsay, "The Management and Control of Quality", 5th Edition, South-Western, 2002.
4	Zeiri, "Total Quality Management for Engineers", Wood Head Publishers, 1991.
E-REFERENCES:	
1.	NPTEL Lectures in Total Quality Management, Indian Institute of Technology

Course Outcomes: Upon completion of this course, the students will be able to:	
CO1	Ability to apply TQM concepts in a selected enterprise.
CO2	Ability to apply TQM principles in a selected enterprise.
CO3	Ability to understand Six Sigma and apply Traditional tools, new tools, Benchmarking and FMEA.
CO4	Ability to understand Taguchi's Quality Loss Function, Performance Measures and apply QFD, TPM, COQ and BPR.
CO5	Ability to apply QMS and EMS in any organization.

23PTME802	PROJECT WORK	Semester	VIII
PREREQUISITES	Category	EEC	Credit 3

	Hours/Week	L	T	P	TH
		0	0	6	6

Course Learning Objectives

1	The main objective is to give an opportunity to the student to get hands on training in the fabrication of one or more components of a complete working model, which is designed by them.
2	It is intended to start the project work early in the seventh semester and carry out both design and fabrication of a mechanical device whose working can be demonstrated. The design is expected to be completed in the seventh semester and the fabrication and demonstration will be carried out in the eighth semester

GUIDELINE FOR REVIEW AND EVALUATION

1	The students may be grouped into 2 to 4 and work under a project supervisor. The device/system/component(s) to be fabricated may be decided in consultation with the supervisor and if possible, with an industry. A project report to be submitted by the group and the fabricated model, which will be reviewed and evaluated for internal assessment by a committee constituted by the Head of the Department. At the end of the semester examination the project work is evaluated based on oral presentation and the project report jointly by external and internal examiners (Supervisors) constituted by the Head of the Department.

Total (90P) = 90 Periods

Course Outcomes:

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

CO1	Initiate and motivate the students to come out with innovative ideas for different applications.
CO2	Create an environment to convert the ideas into design of prototype for useful industrial, agricultural and social applications.
CO3	Create an environment to convert the design into manufacturing of prototype for useful industrial, agricultural and social applications.
CO4	Assign and undertake tasks in a team as per team discussion.
CO5	Do presentation and write technical reports for effective communication within and outside the team.

23PTMEE01	AERONAUTICAL ENGINEERING		Semester			VI
PREREQUISITES		Category	PE	Credit		3
		Hours/Week	L	T	P	TH
			3	0	0	3

Course Learning Objectives

1	To understand the fundamentals of aerospace engineering
2	To learn about the concepts of aero foil
3	To provide an understanding of flight instruments
4	To provide an understanding of aero propellers
5	To learn about the basics about aerodynamics

Unit I	INTRODUCTION	9	0	0	9

The atmosphere-characteristics of troposphere, stratosphere, thermosphere, and ionosphere- pressure, temperature and density variations in the atmosphere. Application of dimensional analysis – aerodynamic force – model study and similitude. 2D aero foils -Nomenclature and classification- pressure distribution in inviscid and real flows- momentum and circulation theory of aero foil- characteristics.

Unit II	CONCEPT OF AERO FOIL	9	0	0	9

3D or Finite aero foils – effect of releasing the wingtips- wing tip vortices- replacement of finite wing by horse shoe vertex system, lifting line theory-wing load distribution – aspect ratio, induced drag calculation of induced drag from momentum considerations. Skin friction and from drag- changes in finite wing plan shape.

Unit III	AERO PROPELLERS	9	0	0	9

Propellers – momentum and blade element theories – propeller coefficients and charts. Aircraft performance - straight and level flight – power required and power available graphs for propeller and jet aircraft.

Unit IV	GLIDING AND CLIMBING	9	0	0	9

Rate of climb-service and absolute ceilings-gliding angle and speed of flattest glide take-off and landing performance – length of runway required- aircraft ground run- circling flight – radius of tightest turn-jet and rocket assisted take –off high lift devices-range and endurance of airplanes-charts for piston and jet engine aircrafts.

Unit V	AERODYNAMICS	9	0	0	9

Basics of aerodynamics - Fundamentals of potential flows from subsonic to supersonic speeds - Viscous flows including laminar and turbulent boundary layers - Aerodynamic models of airfoils and wings.

Total (45L) = 45 Periods

Text Books:

1	A.C. Kermode Mechanics of flight, Prentice Hall, 2007

2	Anderson, Fundamentals of Aerodynamics, McGraw-Hill, 2010
Reference Books:	
1	Hill, Mechanics and thermodynamics of propulsion
2	EHJ Pallet, Aircraft Instruments and Integrated systems, Longman,1992
3	Houghton and brock, Aerodynamics for Engineering Student, Hodder & Stoughton,1977
E-REFERENCES:	
1.	nptel.ac.in / courses /downloads

Course Outcomes: Upon completion of this course, the students will be able to:	
CO1	Identify, formulate and solve aerospace engineering problems.
CO2	Understand the basic concepts of aerofoil.
CO3	Understand the design of aero propellers.
CO4	Analyze the concepts of gliding and climbing of airplanes.
CO5	Learn about the basics about aerodynamics.

23PTMEE02	ADVANCED INTERNAL COMBUSTION ENGINES	Semester			VI
PREREQUISITES	Category	PE	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	To understand the underlying principles of operation of different I.C Engines and components.
2	To provide knowledge on pollutant formation, control, alternate fuel etc.

Unit I	SPARK IGNITION ENGINES	9	0	0	9

Air-fuel ratio requirements, Design of carburettor –fuel jet size and venture size, Stages of combustion-normal and abnormal combustion, Factors affecting knock, Combustion chambers, Introduction to thermodynamic analysis of SI Engine combustion process.

Unit II	COMPRESSION IGNITION ENGINES	9	0	0	9

Combustion-normal and abnormal combustion – Factors affecting knock, Direct and Indirect injection systems, Combustion chambers, Turbo charging.

Unit III	ENGINE EXHAUST EMISSION CONTROL	9	0	0	9

Formation of NO_X , HC/CO mechanism , Smoke and Particulate emissions, Green House Effect, Methods of controlling emissions, Three way catalytic converter and Particulate Trap, Emission (HC,CO, NO and NO_X) measuring equipments, Smoke and Particulate measurement, Indian Driving Cycles and emission norms.

Unit IV	ALTERNATE FUELS	9	0	0	9

Alcohols, Vegetable oils and bio-diesel, Bio-gas, Natural Gas, Liquefied Petroleum Gas, Hydrogen, Properties, Suitability, Engine Modifications, Performance, Combustion and Emission Characteristics of SI and CI Engines using these alternate fuels.

Unit V	RECENT TRENDS	9	0	0	9

Homogeneous Charge Compression Ignition Engine, Lean Burn Engine, Stratified Charge Engine, Surface Ignition Engine, Four Valve and Overhead cam Engines, Electronic Engine Management, Common Rail Direct Injection Diesel Engine, Gasoline Direct Injection Engine, Data Acquisition System – pressure pick up, charge amplifier PC for Combustion and Heat release analysis in Engines

Total (45L) = 45 Periods

Text Books:

1	Ganesan.V “Internal Combustion Engines”, Third Edition, Tata McGraw-Hill, 2007
2	Patterson D.J. and Henein N.A, “Emissions from combustion engines and their control,” Ann Arbor Science publishers Inc, USA, 1978
3	Gupta H.N, “Fundamentals of Internal Combustion Engines”, Prentice Hall of India, 2006

Reference Books:	
1	Heinz Heisler, 'Advanced Engine Technology," SAE International Publications, USA, 1998
2	John B Heywood," Internal Combustion Engine Fundamentals", Tata McGraw-Hill, 1988
E-REFERENCES:	

Course Outcomes: Upon completion of this course, the students will be able to:	
CO1	To understand the combustion stages and the factors affecting the combustion in the spark ignition Engines.
CO2	To understand the combustion stages and the factors affecting the combustion in the compression ignition Engines.
CO3	To understand the mechanism of Pollutant formation and its control in IC Engines.
CO4	To select proper alternate fuels used in S.I and C.I Engines and also analyze its utilization techniques.
CO5	To know about the recent trends introduce in the S.I and C.I engines.

23PTMEE03	ADVANCED STRENGTH OF MATERIALS	Semester			VI
PREREQUISITES	Category	PE	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	To impart knowledge on simple stresses, strains and deformation in components due to external loads.
2	To assess stresses and deformations of beams and twisted bars.
3	To analyze the stresses and deformations through advanced mathematical models.
4	To estimate the design strength of various industrial equipments.
5	To understand stress functions, and understand stresses in plates and shells, thick circular cylinders and discs, contact stresses and stress concentration.

Unit I	ANALYSIS OF PLATES	9	0	0	9

Mathematical modeling of plates with normal loads – Point and Distributed Loads – Support conditions – Rectangular plates - Stresses along coordinate axes – Plate deformations – Axi-symmetric plates – Radial and tangential stresses – plate deflections.

Unit II	THICK CYLINDERS AND SPHERES	9	0	0	9

Equilibrium and compatibility conditions - Lame's Theorem – Boundary conditions – distribution of radial and tangential stresses – compound cylinders – Interference fits - Stresses due to temperature distributions.

Unit III	ROTATING DISCS	9	0	0	9

Lame-Clayperon Theorem – radial and tangential stresses in discs due to centrifugal effects – boundary conditions – solid and hollow discs – Interference fit on shafts –Strengthening of the hub – residual stresses – Autofrettege – Discs of variable thickness – Disc profile for uniform strength.

Unit IV	BEAMS ON ELASTIC FOUNDATION	9	0	0	9

Infinite beam subjected to concentrated load – Boundary Conditions – Infinite beam subjected to a distributed load segment – Triangular load – Semi-infinite beam subjected to loads at the ends and concentrated load near the ends – Short beams.

Unit V	CURVED BEAMS AND CONTACT STRESSES	9	0	0	9

Analysis of stresses in beams with large curvature – Stress distribution in curved beams – Stresses in crane hooks and C clamps – Contact Stresses – Hertz equation for contact stresses – applications to rolling contact elements

Total (45L) = 45 Periods

Text Books:

1	Boresi A.P and Schmidt R.J., "Advanced Mechanics of Materials", John Wiley and Sons, 6th Edition, 2003.
2	Dally J.W. and Riley W.F, "Experimental Stress Analysis", John Wiley and Sons, 2003.
Reference Books:	
1	Burr A. H and Cheatham J.B, "Mechanical Analysis and Design", 2nd Edition, Prentice Hall of India, 2001.
2	Den-Hartog J.P, "Strength of Materials", John Wiley and Sons, 1993.
3	Subramanian R. "Advanced Strength of Materials", Oxford University Press, 2007.
4	Timothy A. Philpot, "Mechanics of Materials: An Integrated Learning System", Wiley Publication, 2008.

Course Outcomes: Upon completion of this course, the students will be able to:	
CO1	Analyze the stresses and deformations in the plates through advanced mathematical models.
CO2	Estimate the design strength of various industrial equipments like thick cylinder and sphere.
CO3	Analyze the centrifugal forces in rotating components.
CO4	Analyze the short beam with various types of loads.
CO5	Apply various methods to solve problems in complex stress systems and contact stresses.

23PTMEE04	COMPOSITE MATERIALS	Semester			VI
PREREQUISITES	Category	PE	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	Define a composite, enumerate advantages and drawbacks of composites over monolithic materials, and discuss factors which influence mechanical properties of a composite
2	Develop stress-strain relationships for a unidirectional/bidirectional lamina
3	Develop concepts of volume and weight fraction of fiber and matrix, density and void fraction in composites
4	Find the elastic stiffness's of laminate based on the elastic moduli of individual laminas and the stacking sequence
5	Introduce other mechanical design issues in laminated composites

Unit I	INTRODUCTION TO COMPOSITES	9	0	0	9

Fundamentals of composites - need for composites – Enhancement of properties - classification of composites – Matrix-Polymer matrix composites (PMC), Metal matrix composites (MMC), Ceramic matrix composites (CMC) – Reinforcement – Particle reinforced composites, Fibre reinforced composites. Applications of various types of composites

Unit II	POLYMER MATRIX COMPOSITES	9	0	0	9

Polymer matrix resins – Thermosetting resins, thermoplastic resins – Reinforcement fibres – Rovings – Woven fabrics – Non-woven random mats – various types of fibers. PMC processes - Hand lay-up processes – Spray up processes – Compression moulding – Reinforced reaction injection moulding - Resin transfer moulding – Pultrusion – Filament winding – Injection moulding. Fibre reinforced plastics (FRP), Glass fibre reinforced plastics (GRP).

Unit III	METAL MATRIX COMPOSITES	9	0	0	9

Characteristics of MMC, Various types of Metal matrix composites Alloy vs. MMC, Advantages of MMC, Limitations of MMC, Metal Matrix, Reinforcements – particles – fibres. Effect of reinforcement - Volume fraction – Rule of mixtures. Processing of MMC – Powder metallurgy process - diffusion bonding – stir casting – squeeze casting.

Unit IV	CERAMIC MATRIX COMPOSITES	9	0	0	9

Engineering ceramic materials – properties – advantages – limitations – Monolithic ceramics - Need for CMC – Ceramic matrix - Various types of Ceramic Matrix composites- oxide ceramics – non oxide ceramics – aluminum oxide – silicon nitride – reinforcements – particles- fibres- whiskers. Sintering - Hot pressing – Cold Isostatic Pressing (CIPing) – Hot Isostatic Pressing (HIPing).

Unit V	ADVANCES IN COMPOSITES	9	0	0	9

Carbon /carbon composites – advantages of carbon matrix – limitations of carbon matrix. Carbon fibre – chemical vapour deposition of carbon on carbon fibre perform. Sol-gel technique. Composites for aerospace applications.
Total (45L) = 45 Periods

Text Books:	
1	Mathews F.L. and Rawlings R.D., "Composite materials: Engineering and Science", 1st Edition, Chapman and Hall, London, England, 1994.
2	Chawla K.K., "Composite Materials", Springer and Verlag, 1987.
Reference Books:	
1	Clyne T.W. and Withers P.J., "Introduction to Metal Matrix Composites", Cambridge University Press, 1993.
2	Strong A.B., "Fundamentals of Composite Manufacturing", SME, 1989.
3	Sharma S.C., "Composite Materials", Narosa Publications, 2000.
4	Stephen W. Tsai, "Introduction to Composite Materials", Techonomic Pub Company, 2008.

Course Outcomes: Upon completion of this course, the students will be able to:	
CO1	Identify the various matrices, reinforcements and their combinations in composite materials.
CO2	Select composite materials for suitable applications.
CO3	Develop suitable metal matrix composites.
CO4	Identify perfect ceramic matrix composites for high temperature applications.
CO5	Choose various combinations of fibres and resins.

23PTMEE05	DESIGN OF PRODUCTION TOOLING	Semester			VI
PREREQUISITES	Category	PE	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	Describe tool design methods and punch and die manufacturing techniques
2	Select material for cutting tools and gages; classify various cutting tools and gages and identify their nomenclature
3	Describe the principles of clamping, drill jigs and computer aided jig design
4	Design fixtures for milling, boring, lathe, grinding, welding; identify fixtures and cutting tools for NC machine tools
5	Explain the principles of dies and moulds design

Unit I	DESIGN OF CUTTING TOOLS	9	0	0	9

Tool materials, design of single point cutting tool, form tool, drill, reamer, broach and plain milling cutter.

Unit II	METAL CUTTING	9	0	0	9

Theory of metal cutting – design of tool holders for single point tools – Boring bars – selection of tools for machining applications – economics of machining.

Unit III	DESIGN OF FIXTURES	9	0	0	9

Standard work holding devices – principles of location and clamping – clamping methods and elements – quick-acting clamps – design and sketching of milling fixtures for simple components – Turning, Grinding, Welding fixtures. Inspection fixtures and design of gauges.

Unit IV	DESIGN OF DRILL JIGS	9	0	0	9

Drill bushings – types of jigs: Plate, Leaf, Turn over and Box Jigs – Design and sketching of drill jigs for machining simple components.

Unit V	PRESS TOOLS	9	0	0	9

Power presses – die cutting operations – centre of pressure – scrap strip lay out for blanking – press tonnage calculations – Progressive and Compound dies – die design for simple components. Drawing dies – blank development – estimation of drawing force – blank holders and blank holding pressure – design and sketching of drawing dies for simple components – Bending dies and Combination tools.

Total (45L) = 45 Periods

Text Books:

1	Cyril Donaldson, Lecain and Goold: Tool Design – Tata Mc-Graw Hill publications.
2	A Bhattacharyya: Metal Cutting – Theory and Practice – Central Book Agency Kolkata.

Reference Books:	
1	ASTME: Fundamentals of Tool Design – Prentice Hall.
2	F W Wilson: Hand Book of Fixture Design - Mc Graw Hill publications.
3	Edward G Hoffman, “Jigs and Fixture Design”, Thomson – Delmar Learning, Singapore 2004.
4	Joshi P H, “Jigs and Fixtures”, Tata McGraw Hill Publishing Company Limited, New Delhi 2004.

Course Outcomes: Upon completion of this course, the students will be able to:	
CO1	Identify the various cutting tools for different machining processes.
CO2	Select suitable tools for metal machining.
CO3	Identify suitable fixtures for various components.
CO4	Ability to design jigs for machining components.
CO5	Ability to design jigs, fixtures and press tools

23PTMEE06	GAS DYNAMICS AND JET PROPULSION	Semester			VI
PREREQUISITES	Category	PE	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	To understand the basic difference between incompressible and compressible flow.
2	To understand the phenomenon of shock waves and its effect on flow.
3	To gain some basic knowledge about jet propulsion and Rocket Propulsion.

Unit I	BASIC CONCEPTS AND ISENTROPIC FLOWS	9	0	0	9

Energy and momentum equations of compressible fluid flows - Stagnation states, Mach waves and Mach cone - Effect of Mach number on compressibility - Isentropic flow through variable area ducts - Nozzle and Diffusers - Use of Gas tables.

Unit II	FLOW THROUGH DUCTS	9	0	0	9

Flow through constant area ducts with heat transfer (Rayleigh flow) and Friction (Fanno flow) - Variation of flow properties - Use of tables and charts - Generalized gas dynamics.

Unit III	NORMAL AND OBLIQUE SHOCKS	9	0	0	9

Governing equations - Variation of flow parameters across the normal and oblique shocks - Prandtl–Meyer relations - Use of table and charts – Applications.

Unit IV	JET PROPULSION	9	0	0	9

Theory of jet propulsion - Thrust equation - Thrust power and propulsive efficiency - Operation principle, cycle analysis and use of stagnation state performance of ram jet, turbojet, turbofan and turbo prop engines – Aircraft combustors.

Unit V	SPACE PROPULSION	9	0	0	9

Types of rocket engines - Propellants - Ignition and combustion - Theory of rocket propulsion – Performance study - Staging - Terminal and characteristic velocity - Applications - Space flights.

Total (45L) = 45 Periods

Text Books:

1	Yahya, S.M, “Fundamentals of Compressible Flow”, New Age International (P) Limited, New Delhi, 1996.
2	Ganesan, V, “Gas Turbines”, Tata McGraw Hill Publishing Co., New Delhi, 1999.
3	Hill, P and Peterson, C, “Mechanics and Thermodynamics of Propulsion”, Addison -Wesley Publishing Company, 1992.
4	Zucrow, N.J, “Principles of Jet Propulsion and Gas Turbines”, John Wiley, New York, 1970.

Reference Books:	
1	Zucrow, N.J, “Aircraft and Missile Propulsion”, Vol. I and II, John Wiley, 1975.

Course Outcomes: Upon completion of this course, the students will be able to:	
CO1	Understand the basic principles of thermodynamic cycles of jet engines
CO2	Analyze the steady one dimensional isentropic flow, frictional flow and isothermal flow.
CO3	Analyze the normal and oblique shocks in various engines.
CO4	Understand the basic principles and working of jet propulsion.
CO5	Understand the basic principles and working of space rocket propulsion.

23PTMEE07	POWER PLANT ENGINEERING		Semester			VI
PREREQUISITES		Category	PE	Credit		3
		Hours/Week	L	T	P	TH
			3	0	0	3

Course Learning Objectives

1	To understand the various components, operations and applications of different types of power plants.
2	Classify different types of coupled vapor cycles and list the advantages of combined cycle's power plant.
3	Describe the new and renewable sources of energy and types of power plants.
4	Estimate the cost of producing power per kW.
5	Define terms and factors associated with power plant economics.

Unit I	COAL BASED THERMAL POWER PLANTS	9	0	0	9

Rankine cycle - improvisations, Layout of modern coal power plant, Super Critical Boilers, FBC Boilers, Turbines, Condensers, Steam and Heat rate, Subsystems of thermal power plants – Fuel and ash handling, Draught system, Feed water treatment. Binary Cycles and Cogeneration systems

Unit II	DIESEL, GAS TURBINE AND COMBINED CYCLE POWER PLANTS	9	0	0	9

Otto, Diesel, Dual and Brayton Cycle - Analysis and Optimization. Components of Diesel and Gas Turbine power plants. Combined Cycle Power Plants. Integrated Gasifier based Combined Cycle systems.

Unit III	NUCLEAR POWER PLANTS	9	0	0	9

Basics of Nuclear Engineering, Layout and subsystems of Nuclear Power Plants, Working of Nuclear Reactors: Boiling Water Reactor (BWR), Pressurized Water Reactor (PWR), CANada Deuterium-Uranium reactor (CANDU), Breeder, Gas Cooled and Liquid Metal Cooled Reactors. Safety measures for Nuclear Power plants.

Unit IV	POWER FROM RENEWABLE ENERGY	9	0	0	9

Hydro Electric Power Plants – Classification, Typical Layout and associated components including Turbines. Principle, Construction and working of Wind, Tidal, Solar Photo Voltaic (SPV), Solar Thermal, Geo Thermal, Biogas and Fuel Cell power systems.

Unit V	ENERGY, ECONOMIC AND ENVIRONMENTAL ISSUES OF POWER PLANTS	9	0	0	9

Power tariff types, Load distribution parameters, load curve, Comparison of site selection criteria, relative merits & demerits, Capital and Operating Cost of different power plants. Pollution control technologies including Waste Disposal Options for Coal and Nuclear Power Plants.

Total (45L) = 45 Periods

Text Books:	
1	Arora S.C and Domkundwar, S, "A Course in Power Plant Engineering", Dhanpat Rai and Sons, TMH, 1998.
2	Nag P.K"Power Plant Engineering", Tata McGraw Hill Publishing Co. Ltd., 1998.
3	Bernhardt G. Askrotzki and William A. Vopat, "Power Station Engineering and Economy", Tata McGraw Hill Publishing Co. Ltd., 1972.
Reference Books:	
1	Frederick T. Mores, "Power Plant Engineering", Affiliated East-West Press Private Ltd., 1953.
2	Nagpal, G.R, "Power Plant Engineering", Khanna Publishers, 1998.
3	Joel Weisman and Roy Eckart, "Modern Power Plant Engineering", Prentice Hall International Inc., 1985.
E-REFERENCES:	
1.	nptel.ac.in / courses / downloads.

Course Outcomes: Upon completion of this course, the students will be able to:	
CO1	Identify elements and their functions of thermal power plant.
CO2	Identify elements and their functions of diesel and gas power plant.
CO3	Identify elements and their functions of nuclear power plant.
CO4	Identify elements and their functions of hydro-electric and solar power plant.
CO5	To extend their knowledge to power plant economics environmental hazards.

23PTMEE08	RAPID PRODUCT DEVELOPMENT AND TECHNOLOGIES	Semester			VI
PREREQUISITES	Category	PE	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	To understand advanced techniques in RPT.
2	To familiarize the students with recent developments in RPT.
3	To learn precision machining techniques.

Unit I	INTRODUCTION	9	0	0	9

Need for time compression in product development- Product development – conceptual design – development – detail design – prototype – tooling -History of RP systems- Survey of applications- Growth of RP industry- classification of RP systems

Unit II	STEREO LITHOGRAPHY SYSTEMS	9	0	0	9

Stereo lithography systems – Principle – process parameters – process details – machine details- Applications. Selective laser sintering – Principle – process parameters – process details – machine details- Applications-Direct Metal Laser Sintering (DMLS) system – Principle – process parameters – process details – machine details- Applications.

Unit III	FUSED DEPOSITION MODELING	9	0	0	9

Fusion Deposition Modeling – Principle – process parameters – process details – machine details- Applications. Laminated Object Manufacturing – Principle – process parameters – process details – machine details- Applications.

Unit IV	SOLID GROUND CURING AND CONCEPT MODELERS	9	0	0	9

Solid Ground Curing – Principle – process parameters – process details – machine details- Applications. 3-Dimensional printers – Principle – process parameters – process details – machine details- Applications - and other concept modelers like thermo jet printers - Sander's model maker - JP system 5-Object Quadra system. Laser Engineering Net Shaping (LENS) - Ballistic Particle Manufacturing (BPM) - Principle.

Unit V	RAPID TOOLING AND SOFTWARE	9	0	0	9

Introduction to rapid tooling – direct and indirect method - Indirect Rapid Tooling - Silicone rubber tooling - Aluminum filled epoxy tooling - Spray metal tooling- etc. Direct Rapid Tooling - Direct AIM - Quick cast process - Copper polyamide - Rapid Tool – DMILS - ProMetal- Sand casting tooling- Laminate tooling- soft tooling vs hard tooling. Software for RP – STL files – Magics - Mimics. Application of Rapid prototyping in Medical field**.**

Total (45L) = 45 Periods

Text Books:	
1	Pham D.T. & Dimov.S. S, “Rapid manufacturing”, Springer Verlag, London, 2001.
2	Paul F Jacobs, “Rapid Prototyping and manufacturing – Fundamentals of Stereolithographic”, Society of Manufacturing Engineering, Dearborn, USA 1992.
Reference Books:	
1	Terry wohlers, “Wohlers Report 2007”, Wohlers Associates, USA 2007.
2	“Rapid Prototyping and Tooling”, Industrial Design Centre, IIT Mumbai, 1998.

Course Outcomes: Upon completion of this course, the students will be able to:	
CO1	Learn about the hurdles, basic-essentials and key-drivers of innovation in digital manufacturing and its application in Automobile, Aerospace, Bio-medical etc.
CO2	Recognize the operational features of Stereo Lithography Systems.
CO3	Explain the concept of Fusion Deposition Modelling.
CO4	Design for manufacture solid ground curing and concept modelers.
CO5	Acquire the knowledge of Software for RP and apply RPT in Tooling.

23PTMEE09	INDUSTRIAL PSYCHOLOGY	Semester			VI
PREREQUISITES	Category	PE	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	The personnel characteristics of the persons are measured and proper man is selected for and placed on the job.
2	According to the ability and aptitude of the employees, distribute the work properly, so that they feel themselves satisfied and the employer may also get higher production at minimum cost.
3	Industrial psychology aims at minimizing the wastage of human power due to fatigue, illness, and accidents.
4	It studies several psychological factors causing fatigue or accidents and suggests measures for preventing the accidents or minimizing fatigue.
5	The techniques of motivation and morale are used for this purpose.

Unit I	ORGANIZATIONAL BEHAVIOR OVERVIEW	9	0	0	9

Organizational Behavior - Definition - Importance - Historical Background - Fundamental concepts of OB - 21st Century corporate - Different models of OB -autocratic, custodial, supportive, collegial - Perception Process - Nature & Importance - Perceptual Selectivity - Perceptual Organization - Social Perception - Impression Management - Personality & Attitudes - Meaning of personality - Development of personality - Nature and dimensions of attitude - Job Satisfaction - Organizational Commitment- Learning - Process of Learning - Principles of Learning - Organizational Reward Systems - Behavioral Management.

Unit II	MANAGEMENT OF CHANGE	9	0	0	9

Management of Change - Necessity of organizational changes and managing changes in order to make the organization competitive, organizational change, dilemma of change, pressure for change - Overcoming resistance to change - Introduction of change in the organization - Organizational Development as a toll for introduction of change- Types of changes, force field analysis, change process, resistance to change, overcoming the resistance to change, theories of change.

Unit III	GROUP DYNAMICS	9	0	0	9

Group Dynamics and Teams - Theories of Group Formation - Formal Organization and Informal Groups and their interaction - Importance of teams - Formation of teams - Team Work-Leadership - Definition - Importance - Leadership Styles - Models and Theories of Leadership Styles - Motivation - Motives - Characteristics - Classification of motives - Primary Motives - Secondary motives - Morale - Definition and relationship with productivity - Morale Indicators.

Unit IV	CONFLICT AND STRESS MANAGEMENT	9	0	0	9

Conflict Management - Traditional Vs Modern view of conflict - Constructive and Destructive conflict - Conflict Process - Strategies for encouraging constructive conflict - Strategies for resolving destructive conflict- Stress Management - Concept of stress - Sources of stress - Effects of stress on humans - Management of Stress.					
Unit V	**SCHOOLS AND FIELDS OF PSYCOLOGY**	**9**	**0**	**0**	**9**
Schools of Psychology-Structuralism, Gestalt Psychology, Functionalism, Behaviorism, Psychometric - Fields of Psychology- Abnormal Psychology, Applied Psychology, Clinical Psychology, Comparative Psychology, Cognitive Psychology, Developmental Psychology, Differential Psychology, Educational Psychology, Environmental Psychology, Industrial Psychology, Psycholinguistics, Psychometrics, Social Psychology Psychiatry.					
					Total (45L) = 45 Periods

Text Books:	
1	Fred Luthans, "Organizational Behavior", McGraw Hill Publication, 2007.
2	Robbins S.P, "Organizational Behavior", Prentice Hall Publication, 2009.
Reference Books:	
1	Hellrigel, Solcum and Wood "man, Organizational Behavior", South Western Publication, 2000.
2	Ronald Riggio, "Introduction to Industrial/Organizational Psychology", Pearson Publication, 2008.
3	Cummings and Worley, "Organizational Development and Change", South Western Publication, 1993.
4	French, W.L, "Organizational Development", Pearson Education, 2000.
E-REFERENCES:	
1.	NPTEL Lectures and videos

Course Outcomes:	
Upon completion of this course, the students will be able to:	
CO1	To understand the Industrial Psychology Principles and Practices in Industries.
CO2	Define the changes in organization and management.
CO3	To learn about the leadership styles and motives.
CO4	Understand about the conflict and stress management
CO5	Learn about the various types of psychology

23PTMEE10	CONCURRENT ENGINEERING	Semester	VII
PREREQUISITES	Category	PE	Credit 3

	L	T	P	TH
Hours/Week	3	0	0	3

Course Learning Objectives

1	To familiarize with the basics of concurrent engineering.
2	To understand about the tools and methodologies available in concurrent engineering.
3	To familiarize with the various approaches of concurrent engineering.

Unit I	INTRODUCTION	9	0	0	9

Extensive definition of CE – Development of CE-CE design methodologies - Organizing for CE - CE tool box collaborative product development.

Unit II	USE OF INFORMATION TECHNOLOGY	9	0	0	9

IT supports - Solid modeling - Product data management - Collaborative product commerce - Artificial Intelligence- Expert systems - Software hardware co-design.

Unit III	DESIGN STAGE	9	0	0	9

Life-cycle design of products - opportunity for manufacturing enterprises - modality of Concurrent Engineering Design - Automated analysis idealization control - Concurrent engineering in optimal structural design - Real time constraints.

Unit IV	MANUFACTURING CONCEPTS AND ANALYSIS	9	0	0	9

Manufacturing competitiveness - Checking the design process - conceptual design mechanism – Qualitative Physical approach - An intelligent design for manufacturing system - JIT system - low inventory - modular - Modeling and reasoning for computer based assembly planning - Design of Automated manufacturing.

Unit V	PROJECT MANAGEMENT	9	0	0	9

Life Cycle semi realization - design for economics - evaluation of design for manufacturing cost – concurrent mechanical design - decomposition in concurrent design - negotiation in concurrent engineering design studies -product realization taxonomy - plan for Project Management on new product development – bottleneck technology development.

Total (45L) = 45 Periods

Text Books:

1	Prasad, "Concurrent Engineering Fundamentals: Integrated Product Development", Prentice Hall, 1996.
2	Anderson MM and Hein, L. Berlin, "Integrated Product Development", Springer Verlog, 1987.

Reference Books:

1	Cleetus, J, "Design for Concurrent Engineering", Concurrent Engineering Research Centre, Morgantown, WV, 1992
2	Andrew Kusaik, "Concurrent Engineering: Automation Tools and Technology", Wiley, John and Sons Inc., 1992.
3	Parsaei, H.R , "Concurrent Engineering (Design and Manufacturing)", Springer, 1993
4	Hartely R John, Concurrent Engineering, Shortening lead times, raising quality & Lowering costs, Productivity press, Portland, Oregon -1992.
5	Carter DE & Baker BS, Concurrent Engineering, The product development environment for the 1990's. Addison – Wesley Publishing company, 1992.

Course Outcomes:

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

CO1	Students will understand the need for adopting CE methodology in their own organisation.
CO2	Students will be able to undertake an evaluation of their company's present communication infrastructure and recommend suitable changes to support the CE environment.
CO3	Students will have the ability to de sign and conduct experiments to ensure that the product design is robust and compatible with the capability of the manufacturing process.
CO4	Students will be able to apply cognitive design skills to generic design problems.
CO5	Students will understand various factors and techniques required to optimise the product development process.

23PTMEE11	ENTREPRENEURSHIP DEVELOPMENT	Semester			VII
PREREQUISITES	Category	PE	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	To expose the students of Business Management to appreciate and understand the concepts and fundamentals of Entrepreneurship
2	To make them understand the process of business idea generation and converting the idea into a business model.
3	To understand the role of government and the machinery that renders support in terms of policies, assistances etc.
4	To impart information about the process, procedure and rules and regulations for setting up a new projects.
5	To provide knowledge and information about the source of help, incentives and subsidies available from government to set up the project

Unit I	ENTREPRENEURSHIP	9	0	0	9

Entrepreneur – Types of Entrepreneurs – Difference between Entrepreneur and Intrapreneur – Entrepreneurship in Economic Growth, Factors Affecting Entrepreneurial Growth

Unit II	MOTIVATION	9	0	0	9

Major Motives Influencing an Entrepreneur – Achievement Motivation Training, Self-Rating, Business Game, Thematic Apperception Test – Stress management, Entrepreneurship Development Programs – Need, Objectives.

Unit III	BUSINESS	9	0	0	9

Small Enterprises – Definition, Classification – Characteristics, Ownership Structures – Project Formulation – Steps involved in setting up a Business – identifying, selecting a Good Business opportunity, Market Survey and Research, Techno Economic Feasibility Assessment – Preparation of Preliminary Project Reports – Project Appraisal – Sources of Information – Classification of Needs and Agencies.

Unit IV	FINANCING AND ACCOUNTING	9	0	0	9

Need – Sources of Finance, Term Loans, Capital Structure, Financial Institution, management of working Capital, Costing, Break Even Analysis, Network Analysis Techniques of PERT/CPM – Taxation – Income Tax, Excise Duty – Sales Tax.

Unit V	SUPPORT TO ENTREPRENEURS	9	0	0	9

Sickness in small Business – Concept, Magnitude, causes and consequences, Corrective Measures – Government Policy for Small Scale Enterprises – Growth Strategies in small industry – Expansion, Diversification, Joint Venture, Merger and Sub Contracting.

Total (45L) = 45 Periods

Text Books:	
1	S.S.Khanka "Entrepreneurial Development", S.Chand and Co. Ltd, 1999.
2	Essentials of Entrepreneurship and Small Business management (5/ed.): Thomas W. Zimmerer, and Norman M.Scarborough. PHI
Reference Books:	
1	EDII, "Faulty and External Experts – A Hand Book for New Entrepreneurs Publishers. Entrepreneurship Development", Institute of India, Ahmadabad, 1986.
2	Athore B. S and Saini J. S, "A Handbook of Entrepreneurship", Aapga Publications, 2004.
3	Rabindra N. Kanungo, "Entrepreneurship and Innovation", Sage Publications, New Delhi, 1998.
4	Gupta CB and Srinivasan P, "Entrepreneurship Development" Sultan Chand & Sons, New Delhi, 2005.
5	Dr CN Prasad, Small and Medium Enterprises in Global Perspective, New century publications, New Delhi.
6	Hisrich. R. D and Peters M. P, "Entrepreneurship", 5th Edition, Tata McGraw Hill, 2002.
E-REFERENCES:	
1.	http://nptel.ac.in/courses/118105009/50www.msme.gov.in, ww.nsic.co.in, www.niesbud.nic.in
2.	www.dcmesme.gov.in
3.	www.msmetraining.gov.in

Course Outcomes:	
Upon completion of this course, the students will be able to:	
CO1	Understand the scope of an entrepreneur, key areas of development, financial assistance by the institutions.
CO2	To compile and prepare accurate financial information for tax compliance and informed business decisions.
CO3	To design and develop a comprehensive small business marketing plan by using appropriate marketing strategies.
CO4	To know about the available sources of finance and to manage its accounts.
CO5	To know about the government policies to support the entrepreneurs, and have the ability to distinct entrepreneurial traits.

23PTMEE12	FRACTURE MECHANICS AND FAILURE ANALYSIS	Semester			VII
PREREQUISITES	Category	PE	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	Identify and explain the types of fractures of engineering materials and their characteristic features.
2	Understand the differences in the classification of fracture mechanics and how their corresponding parameters can be utilized to determine conditions under which engineering materials will be liable to fail catastrophically in service.
3	Understand and explain the mechanisms of fracture; and learn how to carry out engineering failure analysis.

Unit I	BASIC CONCEPTS IN FRACTURE MECHANICS	9	0	0	9

The geometry of stress and strain, elastic deformation, plastic and elasto-plastic deformation, Brittle fracture: Griffith's theory, Ductile fracture, Probabilistic aspects of fracture mechanics – Microstructure.

Unit II	MECHANICS OF FRACTURE- STATIC LOADING	9	0	0	9

Elastic fields – Analytical solutions yielding near a crack front – Irwin's approximation – plastic zone size – Dugdaale model – J integral and its relation to crack opening displacement. Strain energy release and stress intensity factor. Evaluation of fracture, Toughness of different materials: size effect and control.

Unit III	FAILURE ANALYSIS OF FATIGUE FRACTURE	9	0	0	9

Fundamental sources of failures- Deficiency in design, Empirical Relation describing crack growth by fatigue – Life calculations for a given load amplitude – effects of changing the load spectrum – Effects of Environment. Micro structural analysis of fatigue failures, some case studies in analysis of fatigue failures.

Unit IV	FAILURE ANALYSIS OF CREEP RUPTURE	9	0	0	9

Fracture at elevated temperature: Time dependent mechanical behaviour, stress rupture, Micro Structural changes during creep, Mechanism of creep deformation and Creep deformation maps, Prediction of time to rupture, Creep-fatigue interaction. Some case studies in analysis of creep failures

Unit V	FAILURE ANALYSIS OF CORROSION AND WEAR	9	0	0	9

A different environment. Types of wear, Role of friction, Interaction of corrosion and wear. Analysis of wear failure.

Total (45L) = 45 Periods

Text Books:	
1	Hertz berg R W, "Deformation and fracture mechanics of Engineering Materials" Second Edition John Wiley sons inc, New York 1983.
2	Knott. J.F, "Fundamentals of Fracture Mechanics" Butterworth London, 1973.
Reference Books:	
1	Evalds H L and RJH Warnhil,"Fracture Mechanics", Edward Arnold Ltd, Baltimore, 1984.
2	Campbell J E, Underwood J H, and Gerberich W., "Applications of Fracture Mechanics for the selection of Materials ", American Society for Metals, Metals Park Ohio, 1982.
3	Fracture Mechanics Metals Handbook, ninth edition, vol. 8437-491, American Society of Metals Metal Park Ohio, 1985.
4	Kare Hellan, "Introduction of Fracture Mechanics", McGraw-Hill Book Company, 1985.
5	Prashant Kumar, "Elements of Fracture Mechanics", Wheeler Publishing, 1999.

Course Outcomes: Upon completion of this course, the students will be able to:	
CO1	Ability to define different deformation and related theories.
CO2	Ability to design structure to prevent failure from the internal defect that unit within the structure.
CO3	Ability to design structure to prevent fatigue fracture.
CO4	Ability to design structure to prevent creep fracture.
CO5	Ability to analyse the corrosion and wear failure and system methods to prevent corrosion and wear.

23PTMEE13	MAINTENANCE ENGINEERING	Semester			VII
PREREQUISITES	Category	PE	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	To provide the students with the fundamental concepts.
2	The necessary knowledge and the basic skills related to systems reliability and systems maintenance function are learned.
3	The course intends to expose the students to the concept of reliability and to help them learn the techniques of estimating reliability and related characteristics of components/ systems
4	It exposes them to the necessary engineering techniques used for analyzing, planning and controlling maintenance systems

Unit I	INTRODUCTION	9	0	0	9

Need of Maintenance Management- Maintenance Policies- Strategies and options in Maintenance management- Maintenance forms/actions and their inter relationships-Maintenance Organizations-factors determining effectiveness-objectives of organization design- types of organization. Types of maintenance – corrective- planned preventive and predictive maintenance- Factors affecting maintenance-opportunistic maintenance. Maintainability- Factors affecting Maintainability- Maintainability design criteria-operating and down time categories- Availability- types of Availability- approaches to increase equipment Availability.

Unit II	MAINTENANCE PLANNING AND CONTROL	9	0	0	9

Establishing a Maintenance Plan-Preliminary considerations-Systematic method of Maintenance Plan and schedule planning and schedule of Plant shut downs- Maintenance practices on production machines-Lathe, Drilling, Milling, Welding, Shaper- Machine Reconditioning- Spare Parts Management-Capacity utilization, cost reduction approach to spares- reliability and quality of spares- spare parts procurement-and inventory control of spare parts.

Unit III	RELIABILITY	9	0	0	9

Definition and basic concepts - Failure data - failure modes and reliability in terms of hazard rate and failure density Function - Hazard models and bath tub curve - applicability of Weibull distribution - Reliability calculations for series, parallel and parallel-series Systems - Reliability calculations for maintained and stand-by systems. Reliability Centered Maintenance.

Unit IV	COMPUTER AIDED MAINTENANCE MANAGEMENT	9	0	0	9

Introduction – Definition - Basic components of CMMS - Uses of Computers in Maintenance - CMMS effectiveness - Approach towards Computerization - selection of computer system - Master files - Maintenance files - Maintenance Module - classification records - Preventive and repair planning module-codification for Break down - job sequencing files/records.

Unit V	CONDITION MONITORING	9	0	0	9

Condition Monitoring Techniques - Visual Monitoring- Leak detection - Wear monitoring - Crack monitoring - Noise and sound Monitoring - Temperature monitoring - Vibration monitoring – Signature analysis - Shock monitoring – Lubricant – Analysis – Methodology – Equipments - Applications.
Total (45L) = 45 Periods

Text Books:	
1	S.K.Shrivastava, "Industrial Maintenance Management", S. Chand and Co, 2000.
2	Bhattacharya, "Installation, Servicing and Maintenance", S. Chand and Co, 1995.
Reference Books:	
1	ADS Carter and Macmilan, "Mechanical Reliability Engineering", Macmillan Education Ltd., 1991.
2	Roy Billington, Allen, R.N and Pitman, "Reliability Evaluation of Engineering Systems", Pitman, London, 1983.
3	Gopal Krishnan, P and Banerji, A.K, "Maintenance & Spare Parts Management", Prentice-Hall of India Pvt Ltd, 1995.
4	Grant Ireson, W and Clyde, F, "Hand Book of Reliability Engineering & Management", McGraw Hill, 1998.
E-REFERENCES:	
1.	Handbook of Condition Monitoring - Techniques and Methodology. www.springer.com/in/book/9780412613203
2	www.bindt.org/What-is-CM/Condition-monitoring-methods/
3	www.ndt.net/article/nde-india2014/papers/CP0073_full.pdf
4	NPTEL Lectures.

Course Outcomes: Upon completion of this course, the students will be able to:	
CO1	To understand the maintenance principles, functions and practices adapted in industries.
CO2	To know the different categories of maintenance planning and control.
CO3	To gain knowledge about the failure analysis and reliability concepts.
CO4	To provide in depth knowledge i1n Maintenance management systems
CO5	To gain knowledge about the instruments used for condition monitoring.

23PTMEE14	MARINE ENGINEERING	Semester	VII
PREREQUISITES	Category	PE	Credit 3

	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	Understand the role of Marine machinery systems.
2	Be familiar with Marine propulsion machinery system.
3	Acquaint with Marine Auxiliary machinery system.
4	Have acquired basics of Marine Auxiliary boiler system.
5	Be aware of ship propellers and steering system.

Unit I	SHIP SYSTEMS	9	0	0	9

Ship system formulations, main propulsion system requirements, and main propulsion system trade-off studies, arrangement of machinery, piping diagrams, and auxiliary systems.

Unit II	I.C ENGINE CHARACTERISTICS	9	0	0	9

Characteristics of internal combustion engines, marine uses for such engines. Marine steam generators, selection and design of boilers. Main propulsion steam engines. Main propulsion steam turbines. Main propulsion gas turbines. Electric propulsion drives.

Unit III	VIBRATIONS ANALYSIS	9	0	0	9

Propeller shafting and shafting system vibration analysis. Pumps, blowers, compressors, ejectors, condensers, heat exchangers, distilling plants. Hull machinery design considerations and machinery installations, machinery foundation designs, hydrostatic power transmission equipment and systems.

Unit IV	ENVIRONMENTAL SYSTEM	9	0	0	9

Machinery for environmental control and waste treatment. Electric generating plants, switchboards and panels, lighting and power distribution, power equipment, lighting fixtures. Electronics navigation and radio communication. Automation systems. Safety considerations.

Unit V	NUCLEAR APPLICATIONS	9	0	0	9

Fundamentals of pressurized-water nuclear steam supply systems for use in marine propulsion, reactor design considerations, nuclear fuels, reactor coolants, reactor control, shielding, safety, health physics, and economics.

Total (45L) = 45 Periods

Text Books:

1	Grover T K, “Marine Engineering”,Anmol Publications Pvt Ltd, 2008.

2	Harrington and Roy, L, "Marine Engineering", The Society of Naval Architects and Marine Engineers, 1991.
Reference Books:	
1	Cameron, I.R., "Nuclear Fission Reactors", Plenum Press, 1998.
2	Henke and Russell, W., "Introduction to Fluid Power Circuits and Systems", Addison-Wesley, 1970.
E-REFERENCES:	
1.	www.free-marine.com/ebook.htm
2	NPTEL Lectures.

Course Outcomes: Upon completion of this course, the students will be able to:	
CO1	To know basic arrangements of ships and its accessories.
CO2	To understand about the various power generation available in the marine systems.
CO3	To analyse the vibrations involved in the marine system.
CO4	To know about the various accessories for electric and lighting arrangement in marine system.
CO5	To understand the nuclear applications in marine propulsion system.

23PTMEE15	NANO TECHNOLOGY	Semester			VII
PREREQUISITES	Category	PE	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	To gain some fundamental knowledge about Nano technology, Nano manufacturing and its applications.

Unit I	INTRODUCTION	9	0	0	9

Nanoscale Science and Technology- Implications for Physics, Chemistry, Biology and Engineering Classifications of nanostructured materials- nano particles- quantum dots, nanowires-ultra-thinfilmsmultilayered materials. Length Scales involved and effect on properties: Mechanical, Electronic, Optical, Magnetic and Thermal properties.

Unit II	GENERAL METHODS OF PREPARATION	9	0	0	9

Bottom-up Synthesis-Top-down Approach: Co-Precipitation, Ultrasonication, Mechanical Milling, Colloidal routes, Self-assembly, Vapour phase deposition, MOCVD, Sputtering, Evaporation, Molecular Beam Epitaxy, Atomic Layer Epitaxy, Metal Organic MBE (MOMBE).

Unit III	NANOMATERIALS	9	0	0	9

Nanoforms of Carbon - Buckminster fullerene- graphene and carbon nanotube, Single wall carbon Nanotubes (SWCNT) and Multi wall carbon nanotubes (MWCNT)- methods of synthesis(arc-growth, laser ablation, CVD routes, Plasma CVD), structure-property Relationships applications- Nanometal oxides-ZnO, TiO_2,MgO, ZrO_2, NiO, nanoalumina, CaO, $AgTiO_2$, Ferrites, Nanoclays- functionalization and applications-Quantum wires, Quantum dots-preparation, properties and applications

Unit IV	CHARACTERIZATION TECHNIQUES	9	0	0	9

X-ray diffraction technique, Scanning Electron Microscopy - environmental techniques, Transmission Electron Microscopy including high-resolution imaging, Surface Analysis techniques- AFM, SPM, STM, SNOM, ESCA, SIMS-Nano indentation.

Unit V	APPLICATIONS	9	0	0	9

Nano InfoTech: Information storage- Nano computer, molecular switch, super chip, nanocrystal, Nanobiotechnology: nanoprobes in medical diagnostics and biotechnology, Nano medicines, Targeted drug delivery, Bioimaging - Micro Electro Mechanical Systems (MEMS), Nano Electro Mechanical Systems (NEMS)- Nano sensors, nano crystalline silver for bacterial inhibition, Nanoparticles for sun barrier products - In Photostat, printing, solar cell, battery.

Total (45L) = 45 Periods

Text Books:

1	Carl C. Koch (ed.), " Nanostructured Materials", Processing, Properties and Potential Applications, Noyes Publications, Norwich, New York, U.S.A.

2	A.S. Edelstein and R.C. Cammearata, eds., "Nanomaterials: Synthesis, Properties and Applications", Institute of Physics Publishing, Bristol and Philadelphia, 1996.
3	A Textbook of Nanoscience and Nanotechnology – T.Pradeep, Tata McGraw Hill edition.
Reference Books:	
1	Hari Singh Nalwa, "Encyclopedia of Nano Science and Nanotechnology", American Scientific Publishers, 2007.
2	Marie-Isabelle Baraton, "Synthesis, Functionalization and Surface Treatment of Nanoparticles", American Scientific Publishers, 2008.
3	Mark A. Ratner, Daniel Ratner, "Nanotechnology: A gentle introduction to the next Big Idea", Prentice Hall P7R, 1st Edition, 2002.
4	Charles P. Poole and Frank J. Owens, "Introduction to Nanotechnology", Wiley Interscience, 2003.

Course Outcomes: Upon completion of this course, the students will be able to:	
CO1	Will familiarize about the science of nanomaterials
CO2	Will demonstrate the preparation of nanomaterials
CO3	Use of difficult characterization techniques to study the fundamental properties.
CO4	To know the various industrial applications using nanomaterials.
CO5	Will familiarize about the science of nanomaterials

23PTMEE16	NUCLEAR ENGINEERING		Semester			VII
PREREQUISITES		Category	PE	Credit		3
		Hours/Week	L	T	P	TH
			3	0	0	3

Course Learning Objectives

1	To teach students fundamental physics about nuclear processes and a heat transfer techniques from nuclear energy.
2	To introduce students about the nuclear fuels with its properties and also extraction process of nuclear fuels.
3	To teach about the characteristics of spent fuel and reprocessing of solvent extraction.
4	To teach about the separation from nuclear reactor product.
5	To teach about the safety aspects to be used in nuclear process and disposal of nuclear waste.

Unit I	NUCLEAR REACTIONS	9	0	0	9

Mechanism of Nuclear Fission - Nuclides - Radioactivity – Decay Chains - Neutron Reactions - the Fission Process - Reactors - Types of Fast Breeding Reactor - Design and Construction of Nuclear reactors - Heat Transfer Techniques in Nuclear Reactors - Reactor Shielding.

Unit II	REACTOR MATERIALS	9	0	0	9

Nuclear Fuel Cycles - Characteristics of Nuclear Fuels - Uranium - Production and Purification of Uranium - Conversion to UF4 and UF6 - Other Fuels like Zirconium, Thorium - Beryllium.

Unit III	REPROCESSING	9	0	0	9

Nuclear Fuel Cycles - Spent Fuel Characteristics - Role of Solvent Extraction in Reprocessing - Solvent Extraction Equipment.

Unit IV	SEPARTION OF REACTOR PRODUCTS	9	0	0	9

Processes to be Considered - 'Fuel Element' Dissolution - Precipitation Process – Ion Exchange - Redox - Purex - TTA - Chelation - U235 - Hexone - TBP and Thorax Processes - Oxidative Slaging and Electro-Refining - Isotopes - Principles of Isotope Separation.

Unit V	WASTE DISPOSAL AND RADIATION PROTECTION	9	0	0	9

Wastes - Safety Control, Pollution Control and Abatement - International Convention on Types of Nuclear Safety Aspects - Radiation Hazards Prevention.

Total (45L) = 45 Periods

Text Books:	
1	Glasstone, S and Sesonske, A, "Nuclear Reactor Engineering", 3rd Edition, Von Nostrand, 1981.
2	Lamarsh, J.R., "Introduction to Nuclear Reactor Theory", Wesley, 1966.
Reference Books:	
1	Winterton, R.H.S., "Thermal Design of Nuclear Reactors", Pergamon Press, 1981.
2	Jelly N A, "Nuclear Engineering", Cambridge University Press, 2005.
3	Duderstadt, J.J and Hamiition, L.J, "Nuclear Reactor Analysis", John Wiley, 1976.
4	Walter, A.E and Reynolds, A.B, "Fast Breeder Reactor", Pergamon Press, 1981.
E-REFERENCES:	
1.	http://nptel.ac.in/courses/112101007/

Course Outcomes: Upon completion of this course, the students will be able to:	
CO1	To learn about the fundamental knowledge about nuclear physics and nuclear reactions.
CO2	To learn about the various nuclear fuels and its properties.
CO3	To study about the processing of nuclear fuel cycles
CO4	To learn about the by-product and its separation process in nuclear processing.
CO5	To study about safe disposal of nuclear wastes.

23PTMEE17	PRODUCT DESIGN AND COSTING		Semester			VII
PREREQUISITES		Category	PE	Credit		3
		Hours/Week	L	T	P	TH
			3	0	0	3

Course Learning Objectives

1	This course aims at introducing the students to the basic concepts of engineering design and product development with focus on the front end processes
2	At the end of this course the student is expected to demonstrate an understanding of the overview of all the product development processes and knowledge of concept generation and selection tools.

Unit I	PRODUCT DESIGN AND DEVELOPMENT	9	0	0	9

Principles of creativity in design- integrated product development and concurrent engineering – Product analysis – Criteria for product design – Market research – Design for customer and design for manufacture – Product life cycle.

Unit II	ECONOMICS OF DESIGN	9	0	0	9

Breaks even point - Selection of optimal materials and processes – Material layout planning – Value analysis – Re-engineering and its impact on product development.

Unit III	PRODUCT MODELING	9	0	0	9

Product modeling – Definition of concept - fundamental issues – Role and basic requirement of process chains and product models –Types of product models – model standardization efforts – types of process chains – industrial demands.

Unit IV	PRODUCT COSTING	9	0	0	9

Bill of materials – Outline Process charts – Concepts of operational standard time - Work measurement by analytical estimation and synthesis of time – Budgets times – Labor cost and material cost at every stage of manufacture – W.I.P. costing.

Unit V	RECENT ADVANCES AND CONCEPTS IN PRODUCT DESIGN	9	0	0	9

Fundamentals of FEM and its significance to product design – Product life cycle management – Intelligent information system – Concept of Knowledge based product and process design.

Total (45L) = 45 Periods

Text Books:

1	Karl T. Ulrich and Stephen D.Eppinger, “Product Design and Development”, McGraw Hill, 1994.
2	Sameul Eilon, “Elements of Production Planning and Control”, McMillan and Company, 1962.

Reference Books:

1	Jones S.W, "Product Dosing and Process Selection", Butterworth Publications, 1993.
2	Harry Nystrom, "Creativity and Innovation", John Wiley & Sons, 1979.
3	George E. Dieter, "Engineering Design Materials and Process Approach", Tata McGraw Hill, 1991.
4	Donald E. Carter, "Concurrent Engineering", Addison Wesley, 1992.

Course Outcomes:

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

CO1	Understand the basic concepts of engineering design and product development with focus on the front end processes.
CO2	Demonstrate the overview of all the product development processes and knowledge of concept generation and selection tools.
CO3	Understand the design process and to apply them in practice.
CO4	Train the student in the concept of product costing and other manufacturing economics in optimization of product design.
CO5	Knowledge of advancement and recently developed techniques in product design process.

PTMEE18	THERMAL TURBO MACHINES		Semester			VII
PREREQUISITES		Category	PE	Credit		3
		Hours/Week	L	T	P	TH
			3	0	0	3

Course Learning Objectives

1	To understand the various systems, principles, operations and applications of different types of turbo machinery components.

Unit I	INTRODUCTION TO TURBO MACHINES	9	0	0	9

Turbines, Pumps, Compressors, Fans and Blowers – Stages of Turbo machines – Energy transfer between fluid and rotor – Stage velocity triangles Thermal Turbo machines – Classification – General energy equation – Modified to turbo machines – compression and expansion process – Velocity triangles – Work – T-S and H-S diagram, Total – to – Total and Total – to – Static efficiencies. Dimensional analysis – Non dimensional parameters of compressible flow Turbo machines – Similarity laws, applications and limitations.

Unit II	CENTRIFUGAL FANS AND BLOWERS	9	0	0	9

Definition, selection and classifications –Types of blading design-velocity triangles - Stage Parameters – Flow analysis in impeller blades –Design parameter- Volute and Diffusers – Efficiencies and Losses – Fan noises – Causes and remedial measures. Centrifugal Compressors: - Constructional details – Stage velocity triangles — Stage work – Stage pressure rise – Stage efficiency – Degree of reaction – Slip factor – H-S diagram – Efficiencies – Performance characteristics.

Unit III	AXIAL FANS AND PROPELLERS	9	0	0	9

Definition and classifications – Stage parameters – Types of fan stages - performance characteristics. Cascade of blades – Cascade tunnel - Blade geometry - Cascade variables - Energy transfer and loss in terms of lift and drag. Axial Flow Compressors: definition and classifications – Constructional details – Stage velocity triangles – Stage work – Stage pressure rise – H-S diagram – Stage efficiencies and losses- Degree of reaction – Radial equilibrium-Surging and Stalling – Performance characteristics.

Unit IV	AXIAL FLOW TURBINES	9	0	0	9

Construction details –90° IFR turbine- Stage work – Stage Velocity triangles – Stage pressure rise – Impulse and reaction stage – Effect of degree of reaction – H-S diagram – Efficiencies and Losses – Performance characteristics.

Unit V	RADIAL FLOW TURBINES AND WIND TURBINES	9	0	0	9

Constructional details — Stage velocity triangles – H-S diagram – Stage efficiencies and losses – Performance characteristics. Wind turbines: definition and classifications – Constructional details – Horizontal axis wind turbine- Power developed – Axial thrust – Efficiency.

Total (45L) = 45 Periods

Text Books:

1	Yahya, S.M., “Turbines, Compressors and Fans”, Tata McGraw Hill Publishing Company, 1996.

2	Dixon S.L, "Fluid Mechanics, Thermodynamics of Turbo Machines", 2nd Edition, Pergamon press, 1990.
3	Kadambi V and Manohar Prasad, "An Introduction to Energy Conversion - Vol. III Turbo Machines", Wiley Eastern India Ltd, 1977.
4	Shepherd D.H, "Principles of Turbo Machinery" The Macmillan Company, 1969.
Reference Books:	
1	Rangwala A S, "Structural Dynamics of Turbo-Machines", New Age International, 2005.
2	Astashev VK, Babitsky VI and Kolovsky MZ, "Dynamics and Control of Machines", Springer Pub, 2000

Course Outcomes: Upon completion of this course, the students will be able to:	
CO1	Understand the Basic Concept of Compressors, Turbines, Fans and Blowers.
CO2	Understand HS and TS diagram for centrifugal fans and blowers.
CO3	Analyze the various types of velocities in velocity triangles of Axial fans and propellers.
CO4	Analyze the various types of velocities in velocity triangles of Axial flow turbines.
CO5	Analyze the various types of velocities in velocity triangles of Radial flow turbines and wind turbines.

23PTMEE19	COMPUTER INTEGRATED MANUFACTURING	Semester			VIII
PREREQUISITES	Category	PE	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	To gain knowledge on how computers are integrated at various levels of planning and manufacturing.
2	To understand the flexible manufacturing system and to handle the product data and various software used for manufacturing

Unit I	INTRODUCTION	9	0	0	9

The meaning and origin of CIM- the changing manufacturing and management scene - External communication - islands of automation and software-dedicated and open systems-manufacturing automation protocol - product related activities of a company- marketing engineering - production planning - plant operations - physical distribution- business and financial management.

Unit II	GROUP TECHNOLOGY AND COMPUTER AIDED PROCESS PLANNING	9	0	0	9

History of group technology- role of G.T. in CAD/CAM integration - part families - classification and coding - DCLASS and MICLASS and OPITZ coding systems-facility design using G.T. -benefits of G.T. - cellular manufacturing. Process planning - role of process planning in CAD/CAM integration - approaches to computer aided process planning -variant approach and generative approaches - CAPP and CMPP process planning systems.

Unit III	SHOP FLOOR CONTROL AND INTRODUCTION OF FMS	9	0	0	9

Shop floor control-phases -factory data collection system -automatic identification methods- Bar code technology-automated data collection system. FMS-components of FMS - types -FMS workstation - material handling and storage systems- FMS layout -computer control systems-application and benefits.

Unit IV	CIM IMPLEMENTATION AND DATA COMMUNICATION	9	0	0	9

CIM and company strategy - system modeling tools -IDEF models - activity cycle diagram - CIM open system architecture (CIMOSA) - manufacturing enterprise wheel-CIM architecture - Product data management-CIM implementation software. Communication fundamentals- local area networks - topology - LAN implementations - network management and installations.

Unit V	OPEN SYSTEM AND DATABASE FOR CIM	9	0	0	9

Open systems-open system inter connection - manufacturing automations protocol and technical office protocol (MAP /TOP). Development of databases -database terminology- architecture of database systems-data modeling and data associations -relational data bases - database operators - advantages of data base and relational database.

Total (45L) = 45 Periods

Text Books:	
1	Mikell.P.Groover, “Automation, Production Systems and Computer Integrated Manufacturing”, Pearson Education, 2008.
2	Roger Hanman, “Computer Integrated Manufacturing”, Addison –Wesley, 1997.
Reference Books:	
1	Ranky and Paul G., “Computer Integrated Manufacturing”, Prentice Hall International 1986.
2	David D.Bedworth, Mark R.Hendersan and Phillip M.Wolfe, “Computer Integrated Design and Manufacturing”, McGraw Hill Inc, 1998.
3	Kant Vajpayee S, “Principles of Computer Integrated Manufacturing”, Prentice Hall India,2003
4	Mikell. P.Groover and Emory Zimmers Jr, “CAD/CAM", Prentice Hall of India Pvt. Ltd, 1998
5	Yorem koren, “Computer Integrated Manufacturing system”, McGraw-Hill, 1983.

Course Outcomes: Upon completion of this course, the students will be able to:	
CO1	Recognize the manufacturing activities interrelated with computers.
CO2	Understand the concept of Group Technology and the various approaches of Computer Aided Process Planning.
CO3	Explain the phases of shop floor control activities.
CO4	Apply the system modeling tools in CIM.
CO5	Explain the applications of database and system protocol.

23PTMEE20	INTRODUCTION TO COMPUTATIONAL FLUID DYNAMICS	Semester			VIII
PREREQUISITES	Category	PE	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	To introduce numerical modeling and its role in the field of heat transfer and fluid flow.
2	To enable the students to understand the various discretization methods and solving methodologies.
3	To create confidence to solve complex problems in the field of heat transfer and fluid dynamics by using high speed computers.

Unit I	GOVERNING DIFFERENTIAL EQUATION AND FINITE DIFFERENCE METHOD	9	0	0	9

Classification, Initial and Boundary conditions, Initial and Boundary value problems. Finite difference method, Central, Forward, Backward difference, Uniform and non-uniform Grids, Numerical Errors, Grid Independence Test.

Unit II	CONDUCTION HEAT TRANSFER	9	0	0	9

Steady one-dimensional conduction, two and three dimensional steady state problems, Transient one-dimensional problem, Two-dimensional Transient Problems.

Unit III	INCOMPRESSIBLE FLUID FLOW	9	0	0	9

Governing Equations, Stream Function – Verticity method, Determination of pressure for viscous flow, simple Procedure of Patankar and Spalding, Computation of Boundary layer flow, Finite difference approach

Unit IV	CONVECTION HEAT TRANSFER AND FEM	9	0	0	9

Steady One-Dimensional and Two-Dimensional Convection – Diffusion, Unsteady one-dimensional convection – Diffusion, Unsteady two-dimensional convection – Diffusion – Introduction to finite element method – Solution of steady heat conduction by FEM – Incompressible flow – Simulation by FEM.

Unit V	TURBULENCE MODELS	9	0	0	9

Algebraic Models – One equation model, K - ∈ Models, Standard and High and Low Reynolds number models, Prediction of fluid flow and heat transfer using standard codes.

Total (45L) =45 Periods

Text Books:

1	Muralidhar, K.and Sundararajan, T., "Computational Fluid Flow and Heat Transfer", Narosa Publishing House, New Delhi, 1995

2	Ghoshdasdidar, P.S, "Computer Simulation of flow and heat transfer", Tata McGraw-Hill Publishing Company Ltd., 1998.
Reference Books:	
1	Fletcher, C.A.J. "Computational Techniques for Fluid Dynamics 2-Specific Techniques for Different Flow Categories", Springer and Verlag, 1987
2	Bose, T.X., "Numerical Fluid Dynamics", Narosa Publishing House, 1997
3	Subas, V, Patankar, "Numerical heat transfer fluid flow", Hemisphere Publishing Corporation, 1980.
4	Taylor, C and Hughes, J.B, "Finite Element Programming of the Navier Stock Equation", Pineridge Press Limited, U.K., 1981.

Course Outcomes:

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

CO1	Understand and be able to numerically solve the governing equations for fluid flow.
CO2	Solve computational problems related to heat transfer in 1D, 2D conduction.
CO3	Solve computational problem related to fluid flows.
CO4	Interpret the knowledge, capability of analyzing and solving heat convection problem.
CO5	Understand and apply turbulence models to engineering fluid flow problems.

23PTMEE21	MARKETING MANAGEMENT	Semester			VIII
PREREQUISITES	Category	PE	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	Make students have an understanding of the concepts of marketing and the marketing system
2	Make students understand evolution of marketing and the emphasis on each stage
3	Make students understand the marketing system and marketing environment
4	Make students have clear understanding of the marketing mix and functions
5	Develop the skills to critically analyse marketing situations facing organizations and also develop written and verbal presentational skills.

Unit I	MARKETING PROCESS	9	0	0	9

Definition - Marketing process, dynamics, needs, wants and demands - marketing concepts, environment, mix, types – Philosophies - selling versus marketing, organizations - industrial versus consumer marketing - consumer goods, industrial goods, product hierarchy.

Unit II	BUYING BEHAVIOUR AND MARKET SEGMENTATION	9	0	0	9

Cultural, demographic factors - motives, types - buying decisions - segmentation factors – demographic, Psycho graphic and geographic segmentation - process, patterns.

Unit III	PRODUCT PRICING AND MARKETING RESEARCH	9	0	0	9

Objectives – pricing - decisions and pricing methods - pricing management – Introduction – uses - process of marketing research.

Unit IV	MARKETING PLANNING AND STRATEGY FORMULATION	9	0	0	9

Components of marketing plan - strategy formulations and the marketing process, implementations - portfolio analysis - BCG, GEC grids.

Unit V	ADVERTISING, SALES PROMOTION AND DISTRIBUTION	9	0	0	9

Characteristics, impact, goals, types, and sales promotions - point of purchase - unique selling proposition - Characteristics, wholesaling, retailing - channel design, logistics and modern trends in retailing.

Total (45L) =45 Periods

Text Books:

1	Philip Kolter, “Marketing Management”, Pearson Education 2001.

2	Ramasamy and Nama kumari, “Marketing Environment: Planning, implementation and control the Indian context”, 1990.
Reference Books:	
1	Govindarajan. M, “Industrial marketing management”, Vikas Publishing Pvt. Ltd, 2003.
2	Green Paul.E and Donald Tull, “Research for Marketing Decisions”, Prentice Hall of India. 1995.
3	Donald S. Tull and Hawkins, “Marketing Research”, Prentice Hall of India, 1997.
4	Philip Kotler and Gary Armstrong “Principles of Marketing” Prentice Hall of India, 2000.
E-REFERENCES:	
1.	http://nptel.ac.in/courses/110104068/

Course Outcomes: Upon completion of this course, the students will be able to:	
CO1	To understand the various processes involved in Marketing and its Philosophy.
CO2	To learn the Psychology of consumers.
CO3	Apply the introduced conceptual frameworks, theory and techniques to various marketing contexts.
CO4	To synthesis ideas into a marketing plan.
CO5	To formulate strategies for advertising, pricing and selling.

23PTMEE22	MODERN CONCEPTS OF ENGINEERING DESIGN	Semester			VIII
PREREQUISITES	Category	PE	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	To teach about the parameters to be consider for design of product
2	To teach about the planning of new product by identify customer needs with standard specification
3	To teach about the concept of generation of new product and know about the measuring of requirement of product
4	To teach about the product architecture, principle of generation of prototype
5	To teach about the dynamic design with economic analysis and rules for obtaining the patent rights.

Unit I	PRODUCT DESIGN PROCESS	9	0	0	9

Importance of product design-Design process - Design considerations-Morphology of design - Marketing Organization for design - Computer aided engineering-Codes and standards-Design review-Technological innovation and design process-Product and process cycles-Societal considerations in design.

Unit II	PRODUCT PLANNING AND SPECIFICATION	9	0	0	9

Opportunities identification – evaluation - resource allocation - pre-project planning - customer needs identification - establishing target specification-setting the final specification.

Unit III	CONCEPT GENERATION, SELECTION AND TESTING	9	0	0	9

Activity of concept generation, Clarification of problem-External and internal searches-Concept exploration-Result analysis-Overview of selection methodologies-Concept screening-Concept scoring-Concept testing-Choice of survey population-Survey formats-measurement of customer response-Interpretation and analysis of results.

Unit IV	PRODUCT ARCHITECTURE, INDUSTRIAL DESIGN, DESIGN FOR MANUFACTURE AND PROTOTYPING	9	0	0	9

Product architecture-implications-establishment-platform planning-system level Design-Need for industrial design and its impact-The Industrial design process and its management-Assessment of quality-Overview of Design for Manufacture process-Steps in DFM-Basics principles of prototyping-Prototyping technologies-Planning for prototypes.

Unit V	ROBUST DESIGN AND PRODUCT DEVELOPMENT ECONOMICS AND INTELLECTUAL PROPERTY RIGHTS	9	0	0	9

Design of experiments-Steps in the robust design process-Elements of economic analysis-Steps in economic analysis process-Overview of patents-Utility patents-Steps in preparing disclosure.

Total (45L) =45 Periods

Text Books:	
1	Ulrich KT, and Eppinger S. D, "Product Design and Development", McGraw-Hill Book Company, International Edition, 2003.
2	Dieter G. E, "Engineering Design", McGraw-Hill Book Company, International Edition, 2000.
Reference Books:	
1	Otto, K.N., and Wood, K.L., "Product Design-Techniques in Reverse Engineering and New product Development", Pearson Education, First Indian Reprint, 2004.
2	Yousef Haik, "Engineering Design Process" Vikas Publishing House, 1999.
3	Ullman D.G, "The Mechanical Design Process", McGraw-Hill Book Co, Third Edition,
4	Mar K. N and Horensein, "Modern Concepts of Engineering Design", Prentice Hall, 2008.

Course Outcomes: Upon completion of this course, the students will be able to:	
CO1	To understand and develop a design process leading to a realizable product with an appreciation of the economics, environmental concerns, manufacturability and product life cycle management.
CO2	To provide an overview of the integrated design process with a practical bias.
CO3	To provide the knowledge about selection of product based on concept generation with customer opinion
CO4	To know about the need and planning of prototype in industries.
CO5	To understand about obtaining patents and its utilities

23PTMEE23	PROCESS PLANNING AND COSTING		Semester		
PREREQUISITES		Category		Credit	
		Hours/Week	L	T	P	TH
			3	0	0	3

Course Learning Objectives

1	To introduce the process planning concepts to make cost estimation for various products after process planning

Unit I	INTRODUCTION TO PROCESS PLANNING	9	0	0	9

Introduction- methods of process planning-Drawing interpretation-Material evaluation – steps in Process selection-.Production equipment and tooling selection.

Unit II	PROCESS PLANNING ACTIVITIES	9	0	0	9

Process parameters calculation for various production processes-Selection jigs and fixtures election of quality assurance methods - Set of documents for process planning-Economics of process planning- case studies.

Unit III	INTRODUCTION TO COST ESTIMATION	9	0	0	9

Importance of costing and estimation –methods of costing-elements of cost estimation –Types of estimates – Estimating procedure- Estimation labour cost, material cost- allocation of overhead charges-Calculation of depreciation cost.

Unit IV	PRODUCTION COST ESTIMATION	9	0	0	9

Estimation of Different Types of Jobs - Estimation of Forging Shop, Estimation of Welding Shop, Estimation of Foundry Shop.

Unit V	MACHINING TIME CALCULATION	9	0	0	9

Estimation of Machining Time - Importance of Machine Time Calculation- Calculation of Machining Time for Different Lathe Operations, Drilling and Boring - Machining Time Calculation for Milling, Shaping and Planning -Machining Time Calculation for Grinding.

Total (45L) =45 Periods

Text Books:

1	Peter scalon, “Process planning, Design/Manufacture Interface”, Elsevier science technology Books, Dec 2002.
2	Russell R.S and Tailor B.W, “Operations Management”, 4th Edition, PHI, 2003.

Reference Books:

1	Ostwalal P.F. and Munez J., “Manufacturing Processes and systems”, 9 th Edition, John Wiley, 1998.
2	Chitale A.V. and Gupta R.C., “Product Design and Manufacturing”, 2nd Edition, PHI, 2002.

Course Outcomes: Upon completion of this course, the students will be able to:	
CO1	Understand the process to plan and develop products.
CO2	Identify the process parameters of production processes and planning activities.
CO3	Realize the cost estimation procedure for various costs and its elements.
CO4	Enumerate the calculation of production cost in various processing sections.
CO5	Enumerate the calculation of machining time for various machines.

23PTMEE24	PRODUCTION PLANNING AND CONTROL	Semester			VIII
PREREQUISITES	Category	PE	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	Outline the fundamentals of production planning and production control.
2	Apply work measurement techniques and methods, study the procedures for productivity improvement.
3	Extend product information and infer steps in product planning.
4	Solve Problems related to Plant Layout and Material Handling system.
5	To discuss the effect of demand on inventories and outline recent trends in production process control

Unit I	WORK STUDY AND ERGONOMICS	9	0	0	9

Method study – Basic procedure - steps in method study, recording, selection and recording techniques – micro motion and memo motion study – techniques of work measurement - time study – production study - work sampling - ergonomics.

Unit II	PLANT LOCATION	9	0	0	9

Objective and subjective factors – break even analysis –single facility location problem – multi facility location problems – model for warehouse location problem - facility location model – Brown and Gibson model**.**

Unit III	PLANT LAYOUT AND MATERIAL HANDLING	9	0	0	9

Introduction – classification of layout – layout design procedures – CRAFT, ALDEP and CORELAP. Materials Handling –unit load concept – material handling principles – classification of material handling equipments.

Unit IV	PRODUCTION PLANNING	9	0	0	9

Demand forecasting - time series forecasting models - Delphi method of forecasting -forecast errors – Material resource planning (MRP) and Enterprise resource planning (ERP).

Unit V	PRODUCTION CONTROL	9	0	0	9

Functions of production control - product design and analysis – process planning and design – value analysis – standardization – simplification and specialization – make or buy decisions – Inventory control-need for inventory-purchase order model economic order quantity - model with and without shortages – simple problems in determination of EOQ.

Total (45L) =45 Periods

Text Books:	
1	Samuel Eilon, "Elements of Production Planning and Control", Universal Book Corporation, 1984.
2	Panneerselvam, R., "Production and Operations Management", 2nd edition, Prentice Hall of India, New Delhi, 2006.
Reference Books:	
1	Barnes, "Motion and Time study", John Wiley, New York, 1990.
2	Apple, J.M. "Plant Layout and Materials Handling", Ronald Press Company, New York, 1977.
3	ILO, "Introduction to work study", ILO, Geneva, 1974.
4	Buffa, E.S., "Modern Production/Operations Management", 7th edition, John Wiley sons, 1983.
5	Scheele et al. "Principles and Design of Production Control Systems", Prentice Hall Inc.,
E-REFERENCES:	
1.	NPTEL Videos/Tutorials

Course Outcomes: Upon completion of this course, the students will be able to:	
CO1	Knowledge about the techniques of work study, method study and time study.
CO2	Identify the appropriate type of plant location, layout and material handling techniques.
CO3	Apply and implement the manufacturing planning and control strategies in industry.
CO4	Apply the principles and techniques for planning and control of the production and service systems to optimize/make best use of resources.
CO5	Understand the importance and function of inventory and to be able to apply selected techniques for its control and management under dependent and independent demand circumstances.

23PTMEE25	PROFESSIONAL ETHICS AND HUMAN VALUES	Semester			VIII
PREREQUISITES	Category	PE	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	To create awareness on Engineering Ethics and providing basic knowledge about engineering ethics, variety of moral issues and professional ideals.
2	To provide basic familiarity about Engineers as responsible Experimenters, Codes of Ethics, Industrial Standards.
3	To inculcate knowledge and exposure on Safety and Risk, Risk Benefit Analysis.
4	To have an idea about the Collegiality and Loyalty, Collective Bargaining, Confidentiality, Occupational Crime, Professional, Employee, Intellectual Property Rights
5	To have an adequate knowledge about MNC's, Business, Environmental, Computer Ethics, Honesty, Moral Leadership, sample Code of Conduct

Unit I	HUMAN VALUES	9	0	0	9

Morals, Values and Ethics – Integrity – Work Ethic – Service Learning – Civic Virtue – Respect for Others – Living Peacefully – caring – Sharing – Honesty – Courage – Valuing Time – Co-operation – Commitment – Empathy – Self-Confidence – Character – Spirituality.

Unit II	ENGINEERING ETHICS	9	0	0	9

Senses of 'Engineering Ethics' - variety of moral issued - types of inquiry - moral dilemmas - moral autonomy - Kohlberg's theory - Gilligan's theory - consensus and controversy – Models of Professional Roles - theories about right action – Self-interest- customs and religion - uses of ethical theories.

Unit III	ENGINEERING AS SOCIAL EXPERIMENTATION	9	0	0	9

Engineering as experimentation - engineers as responsible experimenters - codes of ethics - a balanced outlook on law – the challenger case study.

Unit IV	SAFETY, RESPONSIBILITIES AND RIGHTS	9	0	0	9

Safety and risk - assessment of safety and risk - risk benefit analysis and reducing risk - the three mile island and Chernobyl case studies. Collegiality and loyalty - respect for authority - collective bargaining - confidentiality - conflicts of interest – occupational crime - professional rights - employee rights - Intellectual Property Rights (IPR) - discrimination.

Unit V	GLOBAL ISSUES	9	0	0	9

Multinational corporations - Environmental ethics - computer ethics - weapons development - engineers as managers consulting engineers-engineers as expert witnesses and advisors -moral leadership-sample code of Ethics like ASME,ASCE, IEEE, Institution of Engineers (India), Indian Institute of Materials Management, Institution of electronics and telecommunication engineers (IETE),India.

Total (45L) =45 Periods

Text Books:	
1	Mike Martin and Roland Schinzinger, “Ethics in Engineering”, McGraw-Hill, New York 2005.
2	Govindarajan M, Natarajan S, Senthil Kumar V. S, “Engineering Ethics”, Prentice Hall of India, New Delhi, 2004.
Reference Books:	
1	Tripathi A N, “Human values”, New Age international Pvt. Ltd., New Delhi, 2002.
2	Charles D. Fleddermann, “Engineering Ethics”, Pearson Education / Prentice Hall, New Jersey, 2004
3	Charles E Harris, Michael S. Protchard and Michael J Rabins, “Engineering Ethics – Concepts and Cases”, Wadsworth Thompson Learning, United States, 2000.
4	John R Boatright, “Ethics and the Conduct of Business”, Pearson Education, New Delhi, 2003.
E-REFERENCES:	
1.	NPTEL Videos/Tutorials

Course Outcomes: Upon completion of this course, the students will be able to:	
CO1	Exposed awareness on professional ethics, variety of moral issues and human values.
CO2	Understand the core values towards the ethical behaviour of an engineer.
CO3	Apply the ethical and moral principles in engineering experimentation
CO4	Expose the ethical and moral principles in engineering for safety and also apply standard codes of moral conduct towards the ethical behaviour.
CO5	Resolve global issues of ethics concerning weapon development and multinational companies.

23PTMEE26	ROBOTICS	Semester			VIII
PREREQUISITES	Category	PE	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	To explore concepts of Robot technologies that is playing vital role in manufacture.
2	Describe various Robot technology applications.
3	Develop an understanding of Robot Kinematics and dynamics.
4	Explain and summarize Robot End effectors and Sensors.
5	Explore conceptual understanding of Robot programming.

Unit I	FUNDAMENTALS OF ROBOT	9	0	0	9

Robot - definition - robot anatomy - co-ordinate systems - work envelope - types and classification - specifications – joint notations – types of joints - speed of motion - pay load - robot parts and their functions - need for robots in Indian scenario.

Unit II	ROBOT DRIVE SYSTEMS AND END EFFECTORS	9	0	0	9

Drives - hydraulic, pneumatic, mechanical and electrical - servo motors - stepper motors - salient features, application – end effectors – types: tools - grippers - mechanical grippers - pneumatic and hydraulic grippers, magnetic grippers, vacuum grippers, multiple grippers.

Unit III	SENSORS AND MACHINE VISION	9	0	0	9

Requirements of sensors – principles, types and applications of following types of sensors proximity (inductive, Hall effect, capacitive, ultrasonic and optical) – range (Triangulation, structured light approach, laser range) – speed, position (resolvers, optical encoders, pneumatic) – force – torque – touch sensors (binary, analog sensor) - introduction to machine vision -functions - image processing and analysis.

Unit IV	ROBOT KINEMATICS AND ROBOT PROGRAMMING	9	0	0	9

Forward kinematics and reverse kinematics of manipulators - two, three degrees of freedom (in 2 dimensional) – homogeneous transformation matrix - simple problems - lead through programming, robot programming languages - VAL programming –motion commands - sensor commands - end effecter commands - simple programs for loading, unloading and palletizing operations.

Unit V	APPLICATIONS, IMPLEMENTATION AND ROBOT ECONOMICS	9	0	0	9

Robot cell design – types - Application of robots in processing - assembly - inspection - material handling - loading -unloading - automobile - implementation of robots in industries - safety considerations for robot operations – economic analysis of robots - pay back method and rate of return method.

Total (45L) =45 Periods

Text Books:	
1	M.P.Groover, "Industrial Robotics – Technology, Programming and Applications", McGraw-Hill, 2001.
2	Fu.K.S. Gonzalz.R.C., and Lee C.S.G., "Robotics Control, Sensing, Vision and Intelligence", Mc Graw Hill Book Co., 1987.
Reference Books:	
1	Richard D.Klafter, Thomas A.Chmielewski and Micheal Negin, "Robotic engineering –An Integrated Approach", Prentice Hall Inc, Englewoods Cliffs, NJ, USA, 2005.
2	Janakiraman.P.A. "Robotics and Image Processing", Tata McGraw-Hill, 1995.
3	Yoram Koren, "Robotics for Engineers", McGraw-Hill Book Co., 1992.
4	A.K.Gupta and S.K.Arora, "Industrial Automation and Robotics", Laxmi Publications Pvt ltd, 2007.
E-REFERENCES:	
1.	NPTEL Videos/Tutorials

Course Outcomes: Upon completion of this course, the students will be able to:	
CO1	Understand the basic concepts, parts of robots and types of robots.
CO2	Familiar with the various drive systems for robot, sensors and their applications in robots, programming of robots.
CO3	Understand about the need of sensors in robots and also machine vision.
CO4	Discuss about the various applications of robots, justification, implementation and safety of robot.
CO5	Understand the potential applications of robots in industries as part of automation tool.

23PTMEE27	SAFETY ENGINEERING		Semester			VIII
PREREQUISITES		Category	PE	Credit		3
		Hours/Week	L	T	P	TH
			3	0	0	3

Course Learning Objectives

1	To provide indispensable guidance regarding statutory requirements and compliance with various Acts.

Unit I	**FACTORIES ACT – 1948**	**9**	**0**	**0**	**9**

Statutory authorities – inspecting staff, health, safety, provisions relating to hazardous processes, welfare, working hours, employment of young persons – special provisions – penalties and procedures - Tamil Nadu Factories Rules 1950 under Safety and health chapters of Factories Act 1948.

Unit II	**ENVIRONMENT ACT – 1986**	**9**	**0**	**0**	**9**

General powers of the central government, prevention, control and abatement of environmental pollution- Biomedical waste (Management and handling Rules, 1989 - The noise pollution (Regulation and control) Rules, 2000 - The Batteries (Management and Handling Rules) 2001 - No Objection certificate from statutory authorities like pollution control board. Introduction to Air Act 1981 and Water Act 1974.

Unit III	**MANUFACTURE, STORAGE AND IMPORT OF HAZARDOUS CHEMICAL RULES 1989**	**9**	**0**	**0**	**9**

Definitions – duties of authorities – responsibilities of occupier – notification of major accidents – information to be furnished – preparation of offsite and onsite plans – list of hazardous and toxic chemicals – safety reports – safety data sheets.

Unit IV	**OTHER ACTS AND RULES**	**9**	**0**	**0**	**9**

Indian Boiler Act 1923, Static and Mobile Pressure Vessel rules (SMPV), motor vehicle rules, mines act 1952, workman compensation act, rules – electricity act and rules – hazardous wastes (management and handling) rules, 1989, with amendments in 2000 - the building and other construction workers act 1996, Petroleum rules, Gas cylinder rules - Explosives Act 1983 - Pesticides Act.

Unit V	**INTERNATIONAL ACTS AND STANDARDS**	**9**	**0**	**0**	**9**

Occupational Safety and Health act of USA (The Williams Act of 1970) – Health And Safety At Work Act (HASAWA 1974, UK) – OSHAS 18000 – ISO 14000 – American National Standards Institute (ANSI).

Total (45L) =45 Periods

Text Books:	
1	The Environment Act (Protection), Commercial Law Publishers (India) Pvt. Ltd., New Delhi, 1986.
2	Ray Asfashl, and David W. Rieske, "Industrial Safety", Macdonald, 2004.
Reference Books:	
1	The Factories Act 1948, Madras Book Agency, Chennai, 2000.
2	Nicholas.P. Cheremisnoff, "Practical Guide to Industrial Safety" Marcel Dekker, 2001.
3	Roger L. Brauer, .Safety and Health for Engineers. Second Edition. Hoboken, New Jersey: John Wiley & Sons Inc.2006.
4	Marshall, Gilbert. Safety Engineering, Third Edition. Des Plaines Illinois; American Society of Safety Engineers.2000.
5	Hagan, Philip E., Montgomery, John F., O'Reilly, James T. Accident Prevention Manual for Business and Industry; Engineering & Technology, 13th Edition. Itasca, Illinois; National Safety Council.2009.

Course Outcomes: Upon completion of this course, the students will be able to:	
CO1	To list out important legislations related to health, Safety and Environment.
CO2	To list out requirements mentioned in factories act for the prevention of accidents.
CO3	To understand the health and welfare provisions given in factories act.
CO4	To understand the statutory requirements for an Industry on registration, license and its renewal.
CO5	To prepare onsite and offsite emergency plan.