ANNA UNIVERSITY, CHENNAI – 600 025

UNIVERSITY DEPARTMENTS

R - 2013

B.E. MECHANICAL ENGINEERING (Part-Time)

I - VII SEMESTER CURRICULA AND SYLLABI

SEMESTER I

CODE NO	COURSE TITLE	L	T	P	C
THEORY					
PTMA8151	Applied Mathematics	3	0	0	3
PTPH8151	Engineering Physics	**3**	**0**	**0**	**3**
PTCY8152	Engineering Chemistry	3	0	0	3
PTGE8153	Engineering Mechanics	3	0	0	3
PTGE8151	Computing Techniques	3	0	0	3
	TOTAL	**15**	**0**	**0**	**15**

SEMESTER II

CODE NO	COURSE TITLE	L	T	P	C
THEORY					
PTCE8251	Fluid Mechanics and Machinery	3	0	0	3
PTEC8251	**Electronics Engineering**	**3**	**0**	**0**	**3**
PTEE8252	Basic Electrical Engineering and Measurements	3	0	0	3
PTMA8253	Transforms and Partial Differential Equations	3	0	0	3
PTME8201	Engineering Thermodynamics	3	0	0	3
	TOTAL	**15**	**0**	**0**	**15**

SEMESTER III

CODE NO	COURSE TITLE	L	T	P	C
THEORY					
PTCE8252	Strength of Materials	3	0	0	3
PTGE8251	Environmental Science and Engineering	3	0	0	3
PTME8301	Kinematics of Machines	3	0	0	3
PTME8302	Manufacturing Technology–I	3	0	0	3
PTME8303	Thermal Engineering–I	3	0	0	3
	TOTAL	**15**	**0**	**0**	**15**

SEMESTER IV

CODE NO	COURSE TITLE	L	T	P	C
THEORY					
PTME8401	Dynamics of Machines	3	0	0	3
PME8402	Manufacturing Technology–II	3	0	0	3
PTME8403	Thermal Engineering–II	3	0	0	3
PTML8251	Engineering Materials and Metallurgy	3	0	0	3
PRACTICAL					
PTME8411	Thermal Engineering Laboratory–I	**0**	**0**	**3**	**2**
	TOTAL	**12**	**0**	**3**	**14**

SEMESTER V

CODE NO	COURSE TITLE	L	T	P	C
THEORY					
PTME8501	Computer Integrated Manufacturing	3	0	0	3
PTME8502	Design of Machine Elements	3	0	0	3
PTME8503	Metrology and Measurements	3	0	0	3
PTME8551	Computer Aided Design	3	0	0	3
PRACTICAL					
PTME8511	C.A.D. / C.A.M. Laboratory	0	0	3	2
	TOTAL	**12**	**0**	**3**	**14**

SEMESTER VI

CODE NO	COURSE TITLE	L	T	P	C
THEORY					
PTME8552	Finite Element Analysis	**3**	**0**	**0**	**3**
PTME8553	Industrial Management	3	0	0	3
PTME8601	Design of Transmission Systems	3	0	0	3
PTME8602	Heat and Mass Transfer	3	0	0	3
	Elective – I	3	0	0	3
	TOTAL	**15**	**0**	**0**	**15**

SEMESTER VII

CODE NO	COURSE TITLE	L	T	P	C
THEORY					
PTME8252	Power Plant Engineering	3	0	0	3
PTME8554	Mechatronics	3	0	0	3
	Elective – II	3	0	0	3
PRACTICAL					
PTME8711	Project Work	0	0	9	6
	TOTAL	**9**	**0**	**9**	**15**

TOTAL NO. OF CREDITS: 15+15+15+14+14+15+15 = 103

ELECTIVES

CODE NO	COURSE TITLE	L	T	P	C
THEORY					
PTGE8551	Engineering Ethics and Human Values	3	0	0	3
PTMA8252	Probability and Statistics	3	0	0	3
PTME8001	Advanced Internal Combustion Engineering	3	0	0	3
PTME8002	Automobile Engineering	3	0	0	3
PTME8003	Casting and Welding Processes	3	0	0	3
PTME8004	Composite Materials and Mechanics	3	0	0	3
PTME8005	Design of Heat Exchangers	3	0	0	3
PTME8006	Design of Pressure vessel and piping	3	0	0	3
PTME8007	Gas Dynamics and Space Propulsion	3	0	0	3
PTME8008	Marketing Management	3	0	0	3
PTME8009	Materials Science	3	0	0	3
PTME8010	Mechanical Vibrations and Noise Control	3	0	0	3
PTME8011	New and Renewable Sources of Energy	3	0	0	3
PTME8012	Non-traditional Machining Processes	3	0	0	3
PTME8013	Nondestructive Materials Evaluation	3	0	0	3
PTME8014	Refrigeration and Air-conditioning	3	0	0	3
PTME8015	Theory of Metal Forming	3	0	0	3
PTME8016	Turbo Machinery	3	0	0	3
PTME8071	Computational Fluid Dynamics	3	0	0	3

PTME8072	Design of Jigs, Fixtures and Press Tools	3	0	0	3
PTME8073	Energy Conservation in industries	3	0	0	3
PTME8074	Entrepreneurship Development	3	0	0	3
PTME8075	Reliability Concepts in Engineering	3	0	0	3
PTME8451	Hydraulics and Pneumatics	3	0	0	3
PTME8751	Design for Manufacturing	3	0	0	3
PTMF8071	Additive Manufacturing Technology	3	0	0	3
PTMF8074	MEMS and Micro System Fabrication	3	0	0	3
PTMF8076	Product Design and Development	3	0	0	3
PTMF8651	Operations Research	3	0	0	3
PTMF8652	Process planning and cost estimation	3	0	0	3
PTMF8751	Industrial Robotics	3	0	0	3
PTMG8651	Total Quality Management	3	0	0	3
PTGE8071	Disaster Management	3	0	0	3
PTGE8072	Human Rights	3	0	0	3

PTMA8151 APPLIED MATHEMATICS L T P C
(Common to all branches of B.E / B.Tech (PT) Programmes) 3 0 0 3

OBJECTIVES

- To facilitate the understanding of the principles and to cultivate the art of formulating physical problems in the language of mathematics.

UNIT I MATRICES 9

Characteristic equation – Eigenvalues and Eigenvectors of a real matrix – Properties of eigenvalues and eigenvectors – Cayley-Hamilton Theorem – Diagonalization of matrices - Reduction of a quadratic form to canonical form by orthogonal transformation.

UNIT II FUNCTIONS OF SEVERAL VARIABLES 9

Partial derivatives – Homogeneous functions and Euler's theorem – Total derivative – Differentiation of implicit functions – Change of variables – Jacobians – Partial differentiation of implicit functions – Taylor's series for functions of two variables - Maxima and minima of functions of two variables.

UNIT III ANALYTIC FUNCTION 9

Analytic functions – Necessary and sufficient conditions for analyticity – Properties – Harmonic conjugates – Construction of analytic function – Conformal Mapping – Mapping by functions w = a + z , az, 1/z, **-** Bilinear transformation.

UNIT IV COMPLEX INTEGRATION 9

Line Integral – Cauchy's theorem and integral formula – Taylor's and Laurent's Series – Singularities – Residues – Residue theorem – Application of Residue theorem for evaluation of real integrals – Use of circular contour and semicircular contour with no pole on real axis.

UNIT V LAPLACE TRANSFORMS 9

Existence conditions – Transforms of elementary functions – Basic properties – Transforms of derivatives and integrals –Inverse transforms – Convolution theorem – Transform of periodic functions – Application to solution of linear ordinary differential equations with constant coefficients.

TOTAL: 45 PERIODS

OUTCOMES

- To develop the use of matrix algebra techniques this is needed by engineers for practical applications.
- To familiarize the student with functions of several variables. This is needed in many branches of engineering.
- To develop an understanding of the standard techniques of complex variable theory so as to enable the student to apply them with confidence, in application areas such as heat conduction, elasticity, fluid dynamics and flow the of electric current.
- To make the student appreciate the purpose of using transforms to create a new domain in which it is easier to handle the problem that is being investigated.

BOOKS FOR STUDY

1. Grewal B.S., Higher Engineering Mathematics, Khanna Publishers, Forty Second Edition, Delhi, 2012.
2. Ramana, B.V. Higher Engineering Mathematics" Tata McGraw Hill Publishing Company, 2008.

REFERENCES

1. Glyn James, Advanced Modern Engineering Mathematics, Prentice Hall of India, Fouth Edition, 2011.
2. Veerarajan, T. Engineering Mathematics (For First Year), Tata McGraw-Hill Pub. Pvt. Ltd., New Delhi, 2007.

PTPH8151 ENGINEERING PHYSICS L T P C
3 0 0 3

OBJECTIVE:

- To introduce the basic physics concepts relevant to different branches of Engineering and Technology.

UNIT I PROPERTIES OF MATTER 9

Elasticity - Poisson's ratio and relationship between moduli (qualitative) - Stress-strain diagram - factors affecting elasticity - bending of beams - cantilever - bending moment - theory and experiment of Young's modulus determination - Uniform and non-uniform bending - I shaped girders - twisting couple - hollow cylinder - shaft - torsion pendulum - determination of rigidity modulus- moment of inertia of a body (regular and irregular).

UNIT II ACOUSTICS AND ULTRASONICS 9

Classification of sound - loudness and intensity - Weber-Fechner Law - standard intensity and intensity level - decibel - reverberation - reverberation time - rate of growth and decay of sound intensity - derivation of Sabine's formula - absorption coefficient and its determination - factors affecting acoustics of buildings : focussing, interference, echo, Echelon effect, resonance - noise and their remedies. Ultrasonics - production – magnetostriction and piezoelectric methods - detection of ultrasound - acoustic grating - industrial applications - NDT - Ultrasonic method: scan modes and practice.

UNIT III THERMAL PHYSICS 9

Thermal expansion - thermal stress - expansion joints - bimetallic strips - thermal conductivity - conductions in solids - Forbe's and Lees' disc methods - Rectilinear flow of heat through a rod - flow of heat through a compound materials - radical flow of heat through a spherical shell - thermal insulation of buildings – Laws of blackbody radiation: Kirchoffs law, Stephens law, Wiens law, Raleigh-Jean law and Planks law (derivation). Laws of thermodynamics - Otto and diesel engines and their efficiency - entropy - entropy of Carnot's cycle - reverse Carnot's cycle - refrigerator.

UNIT IV APPLIED OPTICS 9

Interference - Michelson interferometer: construction, working, determination of wave length and thickness - anti-reflection coating - air wedge and its application - Lasers - Einstein's coefficients - CO_2, Nd:YAG and semiconductor lasers - homo junction and hetro junction - construction and working - applications - Optical fibres - classification (index & mode based) - principle and propagation of light in optical fibres - acceptance angle and numerical aperture - fibre optic communication system - active and passive sensors.

UNIT V SOLID STATE PHYSICS 9

Nature of bonding - growth of single crystals (qualitative) - crystal systems - crystal planes and directions - expressions for interplanar distance - coordination number and packing factor for simple structures: SC, BCC, FCC and HCP - structure and significance of NaCl, ZnS, diamond and graphite - crystal imperfections: point defects, dislocations and stacking faults - unit cell, Bravais space lattices - miller indices.

TOTAL : 45 PERIODS

OUTCOMES:

- The students will have knowledge on the basics of physics related to properties of matter, optics, acoustics etc., and they will apply these fundamental principles to solve practical problems related to materials used for engineering applications.

TEXT BOOKS:

1. Gaur R.K., and Gupta, S.L., Engineering Physics, Dhanpat Raj Publications,2003.
2. Palanisamy, P.K., Engineering Physics, Scitech Publications (P) Ltd, 2006.
3. Arumugam, M., Engineering Physics, Anuradha Publications, 2000.

REFERENCES:

1. Sankar, B.N., Pillai.S.O., Engineering Physics, New Age International (P) Ltd., 2007.
2. Rajendran.V Engineering Physics, Tata McGraw-Hill, 2009.

PTCY8152 ENGINEERING CHEMISTRY L T P C
3 0 0 3

OBJECTIVES:

- To understand about the chemical thermodynamics.
- To impart knowledge in the basics of polymer chemistry.
- To develop sound knowledge on kinetics and catalysis.
- To impart basic knowledge on photochemistry and spectroscopy

UNIT I CHEMICAL THERMODYNAMICS 9

Second law: Entropy - entropy change for an ideal gas, reversible and irreversible processes; entropy of phase transitions; Clausius inequality. Free energy and work function: Criteria of spontaneity; Helmholtz and Gibbs free energy functions; Gibbs-Helmholtz equation; Clausius-Clapeyron equation; Maxwell relations – Van't Hoff isotherm and isochore. Chemical potential; Gibbs-Duhem equation – variation of chemical potential with temperature and pressure

UNIT II POLYMER CHEMISTRY 9

Introduction: Classification of polymers – Natural and Synthetic; Thermoplastic and Thermosetting. Functionality – Degree of polymerisation. Types and mechanism of polymerisation: Addition (Free Radical, cationic, anionic and living); condensation and copolymerisation. Properties of polymers: Tg, Tacticity, Molecular weight – weight average, number average and polydispersity index. Techniques of polymerisation: Bulk, emulsion, solution and suspension.

UNIT III KINETICS AND CATALYSIS 9

Introduction-reaction velocity, factors affecting reaction velocity, rate constant, order of reaction, molecularity, pseudo molecular reactions, zero, first, second, and third order reactions, reactions of fractional orders, determination of order of reactions. Catalysis: Auto catalysis - Enzyme Catalysis: Michaelis-Menton equation; factors affecting enzyme catalysis. Heterogeneous Catalysis: Types of adsorption isotherms: Langmuir–Hinselwood and Rideal–Eley Mechanism.

UNIT IV PHOTOCHEMISTRY AND SPECTROSCOPY 9

Photochemistry: Laws of photochemistry - Grotthuss–Draper law, Stark–Einstein law and Lambert-Beer Law. Photoprocesses - Internal Conversion, Inter-system crossing, Fluorescence, Phosphorescence, Chemiluminescence and Photo-sensitisation. Spectroscopy:

Electromagnetic spectrum - Absorption of radiation – Electronic, Vibrational and rotational transitions. Width and intensities of spectral lines. Spectrophotometric estimation of iron. UV-visible and IR spectroscopy – principles, instrumentation (Block diagram) and applications.

UNIT V NANOCHEMISTRY 9

Basics - distinction between molecules, nanoparticles and bulk materials; size-dependent properties. Nanoparticles: Nanocluster, nanorod, nanotube and nanowire. Synthesis: Precipitation, thermolysis, hydrothermal, solvothermal, electrodeposition, chemical vapour deposition, laser ablation; Properties and Applications. Risk discussion and Future perspectives.

TOTAL: 45 PERIODS

OUTCOMES:

- The knowledge gained on polymer chemistry, thermodynamics. spectroscopy, phase rule and nano materials will provide a strong platform to understand the concepts on these subjects for further learning.

TEXT BOOKS:

1. P. Kannan and A. Ravikrishnan, “Engineering Chemistry”, Sri Krishna Hitech Publishing Company Pvt. Ltd. Chennai, 2009.
2. S. Vairam, P. Kalyani and Suba Ramesh, “Engineering Chemistry”, Wiley India, 2011

REFERENCE BOOKS:

1. P.W. Atkins and de Paula Julio, “Physical Chemistry”, Oxford University Press, 8th Ed., (Indian Student Edition) (2009).
2. K. K. Rohatgi-Mukherjee, “Fundamental of Photochemistry” New Age International (P) Ltd., New Delhi, 1986.
3. G.A. Ozin and A.C. Arsenault, “Nanochemistry: A Chemical Approach to Nanomaterials”, RSC Publishing, 2005.
4. V.R.Gowariker, N.V.Viswanathan and Jayadev Sreedhar, “Polymer Science”, New Age International P (Ltd.,), Chennai, 2006

PTGE8153 ENGINEERING MECHANICS L T P C

3 0 0 3

OBJECTIVE

- To develop capacity to predict the effect of force and motion in the course of carrying out the design functions of engineering

UNIT I BASICS AND STATICS OF PARTICLES 9

Introduction – Units and Dimensions – Laws of Mechanics – Lami’s theorem, Parallelogram and triangular Law of forces — Vectorial representation of forces – Vector operations of forces - additions, subtraction, dot product, cross product – Coplanar Forces – rectangular components – Equilibrium of a particle – Forces in space – Equilibrium of a particle in space – Equivalent systems of forces – Principle of transmissibility .

UNIT II EQUILIBRIUM OF RIGID BODIES 9

Free body diagram – Types of supports –Action and reaction forces –stable equilibrium – Moments and Couples – Moment of a force about a point and about an axis – Vectorial representation of moments and couples – Scalar components of a moment – Varignon’s

theorem – Single equivalent force -Equilibrium of Rigid bodies in two dimensions – Equilibrium of Rigid bodies in three dimensions

UNIT III PROPERTIES OF SURFACES AND SOLIDS 9

Centroids and centre of mass– Centroids of lines and areas - Rectangular, circular, triangular areas by integration – T section, I section, - Angle section, Hollow section by using standard formula –Theorems of Pappus - Area moments of inertia of plane areas – Rectangular, circular, triangular areas by integration – T section, I section, Angle section, Hollow section by using standard formula – Parallel axis theorem and perpendicular axis theorem –Principal moments of inertia of plane areas – Principal axes of inertia-Mass moment of inertia –mass moment of inertia for prismatic, cylindrical and spherical solids from first principle – Relation to area moments of inertia.

UNIT IV DYNAMICS OF PARTICLES 9

Displacements, Velocity and acceleration, their relationship – Relative motion – Curvilinear motion -Newton's laws of motion – Work Energy Equation– Impulse and Momentum – Impact of elastic bodies.

UNIT V FRICTION AND ELEMENTS OF RIGID BODY DYNAMICS 9

Friction force – Laws of sliding friction – equilibrium analysis of simple systems with sliding friction –wedge friction-. Rolling resistance -Translation and Rotation of Rigid Bodies – Velocity and acceleration – General Plane motion of simple rigid bodies such as cylinder, disc/wheel and sphere.

TOTAL: 45 PERIODS

OUTCOMES:

- ability to explain the differential principles applies to solve engineering problems dealing with force, displacement, velocity and acceleration.
- ability to analyse the forces in any structures.
- ability to solve rigid body subjected to dynamic forces.

TEXT BOOKS:

1. Beer, F.P and Johnston Jr. E.R. "Vector Mechanics for Engineers (In SI Units): Statics and Dynamics", 8th Edition, Tata McGraw-Hill Publishing company, New Delhi (2004).
2. Vela Murali, "Engineering Mechanics", Oxford University Press (2010)

REFERENCES:

1. Hibbeller, R.C and Ashok Gupta, "Engineering Mechanics: Statics and Dynamics", 11th Edition, Pearson Education (2010).
2. Irving H. Shames and Krishna Mohana Rao. G., "Engineering Mechanics – Statics and Dynamics", 4th Edition, Pearson Education (2006)
3. J.L.Meriam and L.G.Kraige, " Engineering Mechanics- Statics - Volume 1, Dynamics- Volume 2,Third Edition, John Wiley & Sons,(1993)
4. Rajasekaran, S and Sankarasubramanian, G., "Engineering Mechanics Statics and Dynamics",3rd Edition, Vikas Publishing House Pvt. Ltd., (2005).
5. Bhavikatti, S.S and Rajashekarappa, K.G., "Engineering Mechanics", New Age International (P) Limited Publishers, (1998).
6. Kumar, K.L., "Engineering Mechanics", 3rd Revised Edition, Tata McGraw-Hill Publishing company, New Delhi (2008)

PTGE8151 COMPUTING TECHNIQUES L T P C
3 0 0 3

OBJECTIVES:

The students should be made to:

- Learn the organization of a digital computer.
- Be exposed to the number systems.
- Learn to think logically and write pseudo code or draw flow charts for problems.
- Be exposed to the syntax of C.
- Be familiar with programming in C.
- Learn to use arrays, strings, functions, pointers, structures and unions in C.

UNIT I INTRODUCTION 9

Generation and Classification of Computers- Basic Organization of a Computer –Number System – Binary – Decimal – Conversion – Problems. Need for logical analysis and thinking – Algorithm – Pseudo code – Flow Chart.

UNIT II C PROGRAMMING BASICS 9

Problem formulation – Problem Solving - Introduction to ' C' programming –fundamentals – structure of a 'C' program – compilation and linking processes – Constants, Variables – Data Types – Expressions using operators in 'C' – Managing Input and Output operations – Decision Making and Branching – Looping statements – solving simple scientific and statistical problems.

UNIT III ARRAYS AND STRINGS 9

Arrays – Initialization – Declaration – One dimensional and Two dimensional arrays. String- String operations – String Arrays. Simple programs- sorting- searching – matrix operations.

UNIT IV FUNCTIONS AND POINTERS 9

Function – definition of function – Declaration of function – Pass by value – Pass by reference – Recursion – Pointers - Definition – Initialization – Pointers arithmetic – Pointers and arrays- Example Problems.

UNIT V STRUCTURES AND UNIONS 9

Introduction – need for structure data type – structure definition – Structure declaration – Structure within a structure - Union - Programs using structures and Unions – Storage classes, Pre-processor directives.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course, the student should be able to:

- Design C Programs for problems.
- Write and execute C programs for simple applications.

TEXTBOOKS:

1. Pradip Dey, Manas Ghosh, "Fundamentals of Computing and Programming in C", First Edition, Oxford University Press, 2009
2. Ashok N. Kamthane, "Computer programming", Pearson Education, 2007.
3. Yashavant P. Kanetkar. " Let Us C", BPB Publications, 2011.

REFERENCES:

1. Kernighan,B.W and Ritchie,D.M, "The C Programming language", Second Edition, Pearson Education, 2006
2. Byron S Gottfried, " Programming with C", Schaum's Outlines, Second Edition, Tata McGraw-Hill, 2006.
3. R.G. Dromey, "How to Solve it by Computer", Pearson Education, Fourth Reprint, 2007

PTCE8251 FLUID MECHANICS AND MACHINERY L T P C
3 0 0 3

OBJECTIVE:

- The applications of the conservation laws to flow through pipes and hydraulic machines are studied .To understand the importance of dimensional analysis. To understand the importance of various types of flow in pumps and turbines.

UNIT I FLUID PROPERTIES AND FLOW CHARACTERISTICS 8

Units and dimensions- Properties of fluids- mass density, specific weight, specific volume, specific gravity, viscosity, compressibility, vapor pressure, capillarity and surface tension. Flow characteristics – concept of control volume - application of control volume to continuity equation, energy equation and momentum equation.

UNIT II FLOW THROUGH CIRCULAR CONDUITS 7

Hydraulic and energy gradient - Laminar flow through circular conduits and circular annuli- Boundary layer concepts – types of boundary layer thickness – Darcy Weisbach equation – friction factor- Moody diagram- commercial pipes- minor losses – Flow through pipes in series and parallel.

UNIT III DIMENSIONAL ANALYSIS 8

Need for dimensional analysis – methods of dimensional analysis – Similitude –types of similitude - Dimensionless parameters- application of dimensionless parameters – Model analysis.

UNIT IV PUMPS 12

Impact of jets - Euler's equation - Theory of rotodynamic machines – various efficiencies – velocity components at entry and exit of the rotor- velocity triangles - Centrifugal pumps – working principle - work done by the impeller - performance curves - Reciprocating pump - working principle – indicator diagram – work saved by fitting air vessels – Rotary pumps – classification – comparison of working principle with other pumps – advantages.

UNIT V TURBINES 10

Classification of turbines – heads and efficiencies – velocity triangles – axial, radial and mixed flow turbines – Pelton wheel and Francis turbine - working principles - work done by water on the runner – draft tube - specific speed - unit quantities – performance curves for turbines – governing of turbines.

TOTAL: 45 PERIODS

OUTCOMES:

- Upon completion of this course, the students can able to apply mathematical knowledge to predict the properties and characteristics of a fluid.
- Can critically analyse the performance of pumps and turbines.

TEXT BOOKS:

1. Streeter, V. L. and Wylie E. B., Fluid Mechanics, McGraw Hill Publishing Co.(2010)
2. Kumar K. L., Engineering Fluid Mechanics, Eurasia Publishing House(p) Ltd. New Delhi(2004)
3. Modi P.N. and Seth, S.M. Hydraulics and Fluid Mechanics, Standard Book House (2002), New Delhi

REFERENCES:

1. Robert W.Fox, Alan T. McDonald, Philip J.Pritchard, "Fluid Mechanics and Machinery", ISBN 978-0-470-54755-7, 2011.

PTEC8251 ELECTRONICS ENGINEERING L T P C
(Common to Mechanical, Industrial, Manufacturing and Printing) 3 0 0 3

OBJECTIVES:

- To provide knowledge in the basic concepts of Electronics Engineering including semiconductors, transistors,electronic devices, signal generators and digital electronics.

UNIT I SEMICONDUCTORS AND RECTIFIERS 9

Classification of solids based on energy band theory, Intrinsic semiconductors, Extrinsic semiconductors – P-type and N-type, P-N junction, VI Characteristics of PN junction diode, Half and Full wave rectifiers, Zener effect, Zene
r diode, Zener diode Characteristics, Zener diode as a regulator.

UNIT II TRANSISTOR AND AMPLIFIERS 9

Bipolar junction transistors – CB, CE, CC configurations and characteristics, Biasing circuits – Fixed bias, Voltage divider bias, CE amplifier, Concept of feedback, Negative feedback, voltage series feedback amplifier, Current series feedback amplifier.

UNIT III FET AND POWER ELECTRONIC DEVICES 9

FET – Configuration and characteristics, FET amplifier, Characteristics and simple applications of SCR, Diac, Triac and UJT.

UNIT IV SIGNAL GENERATORS AND LINEAR ICs 9

Positive feedback, Sinusoidal oscillators – RC phase shift, Hartley, Colpitts, Wein bridge oscillators, Operational amplifier – Adder, Inverting and Non-inverting amplifiers, integrator and differentiator, IC 555 based Astable and Monostable Multivibrators.

UNIT V DIGITAL ELECTRONICS 9

Boolean algebra, Logic Gates, , Half and Full adders, Decoder, Encoder, Multiplexer, Demultiplexer, Flip flops, Digital to Analog converters - R-2R and weighted resistor types, Analog to Digital converters - Successive approximation and Flash types.

TOTAL: 45 PERIODS

OUTCOMES:

- Ability to identify electronics components and use of them to design circuits.

TEXT BOOK:

1. Malvino, ‘Electronic Principles’, McGraw Book Co., 1993.

REFERENCES:

1. Grob. B and Schultz. M.E. ‘Basic Electronics’, Tata Mcgraw Hill, 2003.
2. Thomas L. Floyd, ‘Electronics Devices’, Pearson Education, 2002.
3. Thomas L. Floyd, ‘Digital Fundamentals’, Pearson Education, 2003.
4. Millman, Halkias Jacob, Jit Christos and Satyabrata, ‘Electronic devices and Circuits’, Tata McGraw Hill, 2nd Edition.

PTEE8252 BASIC ELECTRICAL ENGINEERING AND MEASUREMENTS L T P C
(Common to Mechanical and Printing) 3 0 0 3

OBJECTIVES

To impart knowledge on

I. Electric circuit laws

II. Principle of Electrical Machines
III. Various measuring instruments

UNIT I ELECTRICAL CIRCUITS 9

Ohms Law – Kirchhoff's Law-Steady state solution of DC circuits – introduction to AC circuits – waveforms and RMS value – Power and power factor- Three phase balanced and unbalanced circuits-Three phase Power measurement.

UNIT II ELECTRICAL MACHINES 9

Construction and Principle of operation DC machines- Characteristics of DC machines Construction and Principle of operation of single phase transformers, synchronous machines, three-phase and single-phase induction motors

UNIT III MEASUREMENT AND INSTRUMENTATION 9

Classification of instruments – moving coil and moving iron meters – Induction type, dynamometer type wattmeters – Energy meter – Megger – Instrument transformers (CT & PT) – Wheatstone's bridge for measurement of unknown resistance ,Maxwell's bridge for unknown inductance and Schering Bridge for unknown capacitance

UNIT IV TRANSDUCERS 9

Classification of transducers, strain, RTD, thermocouples, Piezo-electric transducer, LVDT, Turbine and electromagnetic flow meters, level transducers ultrasonic and fiber optic transducers, type of sensors, elastic sensors, viscosity, moisture and pH sensors, Digital transducers, vibrating wire instruments like load cells, stress meter, etc.

UNIT V SIGNAL CONDITIONING AND DISPLAY 9

Instrumentation amplifiers- Filters- A/D and D/A converters - Multiplexing and data acquisition - LED, LCD and CRT displays.

TOTAL: 45 PERIODS

OUTCOMES:

- Upon Completion of this subject, the students can able to explain different types of electrical machines and their performance

TEXT BOOKS:

1. Del Toro 'Electrical Engineering Fundamentals' Pearson Education, New Delhi, 2007.
2. V.K Mehta and Rohit Mehta ' Principle of Electrical Engineering' S Chand &Company,2008
3. Alan S. Moris, Principles of Measurements and Instruments, Printice-Hall of India Pvt. Ltd., New Delhi, 1999.
4. Smarjit Ghosh 'Fundmentals of Electrical and Electronics Engineering, Second Edition 2007

REFERENCES:

1. Rajendra Prasad 'Fundamentals of Electrical engineering' Prentice Hall of India, 2006.
2. Thereja .B.L 'Fundamentals of Electrical Engineering and Electronics' S chand & Co Ltd, 2008.
3. Sanjeev Sharma 'basics of Electrical Engineering' S.K International Publishers, New Delhi 2007.
4. John Bird, Electrical Circuits theory and Technology, Elsevier, First India Edition, 2006.
5. Doebeling, E.O., Measurements Systems – Application and Design', McGrawHill Publishing Co, 1990.

PTMA8253 TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS L T P C
(Common to Textile, Chemical, Mech, Civil, ECE) 3 0 0 3

OBJECTIVES

- To facilitate the understanding of the principles and to cultivate the art of formulating physical problems in the language of mathematics.

OUTCOMES

- To introduce Fourier series analysis which is central to many applications in engineering apart from its use in solving boundary value problems.
- To acquaint the student with Fourier transform techniques used in wide variety of situations in which the functions used are not periodic.
- To introduce the effective mathematical tools for the solutions of partial differential equations that model physical processes.
- To develop Z- transform techniques which will perform the same task for discrete time systems as Laplace Transform, a valuable aid in analysis of continuous time systems.

UNIT I FOURIER SERIES 9

Dirichlet's conditions – General Fourier series – Odd and even functions – Half-range Sine and Cosine series –Parseval's identity – Harmonic Analysis.

UNIT II FOURIER TRANSFORM 9

Fourier integral theorem – Fourier transform pair-Sine and Cosine transforms – Properties – Transform of elementary functions – Convolution theorem – Parseval's identity.

UNIT III PARTIAL DIFFERENTIAL EQUATIONS 9

Formation – Solutions of first order equations – Standard types and Equations reducible to standard types – Singular solutions – Lagrange's Linear equation –Solution of homogenous linear equations of higher order with constant coefficients.

UNIT IV APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS 9

Method of separation of Variables – Solutions of one dimensional wave equation and one-dimensional heat equation – Steady state solution of two-dimensional heat equation.

UNIT V Z – TRANSFORM AND DIFFERENCE EQUATIONS 9

Z-transform – Elementary properties – Inverse Z-transform – Convolution theorem –Formation of difference equation – Solution of difference equation using Z-transform.

TOTAL: 45 PERIODS

OUTCOMES

- The understanding of the mathematical principles on transforms and partial differential equations would provide them the ability to formulate and solve some of the physical problems of engineering.

BOOK FOR STUDY

1. Grewal B.S., Higher Engineering Mathematics, Khanna Publishers, Forty Second Edition, Delhi, 2012

REFERENCES

1. Glyn James, Advanced Modern Engineering Mathematics, Prentice Hall of India, Fouth Edition, 2011
2. Ramana, B.V. Higher Engineering Mathematics" Tata McGraw Hill Publishing Company, 2008.
3. Bali, N.P. and Manish Goyal, A Text Book of Engineering Mathematics, Lakshmi Publications Pvt. Ltd., New Delhi, 2006.

PTME8201 ENGINEERING THERMODYNAMICS L T P C
3 0 0 3

OBJECTIVE:

- To familiarize the students to understand the fundamentals of thermodynamics and to perform thermal analysison their behavior and performance.

UNIT I BASIC CONCEPTS AND FIRST LAW 9

Basic concepts - concept of continuum, comparison of microscopic and macroscopic approach.Path and point functions.Intensive and extensive, total and specific quantities.System, surrounding, boundary and their types.Thermodynamic Equilibrium.State, path and process.Quasi-static, reversible and irreversible processes. Heat and work transfer, definition and comparison, sign convention. Displacement work and other modes of work.P-V diagram.
Zeroth law of thermodynamics – concept of temperature and thermal equilibrium– relationship between temperature scales –new temperature scales. First law of thermodynamics – application to closed and open systems – steady and unsteady flow processes.

UNIT II SECOND LAW AND AVAILABILITY ANALYSIS 9

Hear Reservoirs, source and sink. Heat Engine, Refrigerator, Heat pump. Statements of second law and its corollaries. Carnot cycle reversed Carnot cycle, Performance. Clausius inequality. Concept of entropy, T-s diagram, Tds Equations, entropy change for - pure substance, ideal gases - different processes, principle of increase in entropy.Applications of II Law.
High and low grade energy. Available and non-available energy of a source and finite body.Exergy and irreversibility.Expressions for the exergy of a closed system and open systems.Exergy balance and entropy generation.Irreversibility. I and II law Efficiency.

UNIT III PROPERTIES OF PURE SUBSTANCE AND STEAM POWER CYCLE 9

Formation of steam and its thermodynamic properties, p-v, p-T, T-v, T-s, h-s diagrams. PVT surface.Use of Steam Table and Mollier Chart.Determination of dryness fraction.Application of I and II law for pure substances. Ideal and actualRankine cycles, Cycle Improvement Methods - Reheat and regenerative cycles, Economiser, Air preheater, Binary and Combined cycles.

UNIT IV IDEAL AND REAL GASES, THERMODYNAMIC RELATIONS 9

Properties of Ideal gas.Ideal and real gas comparison.Equations of state for ideal and real gases.Reduced properties.Compressibility factor.Principle of Corresponding states.Generalised Compressibility Chart and its use. Maxwell relations, Tds Equations, Difference and ratio of heat capacities, Energy equation, Joule-Thomson Coefficient, ClausiusClapeyron equation Phase Change Processes. Simple Calculations.

UNIT V GAS MIXTURES AND PSYCHROMETRY 9

Mole and Mass fraction, Dalton's and Amagat's Law.Properties of gas mixture – Molar mass, gas constant, density, change in internal energy, enthalpy, entropy and Gibbs function.
Psychrometric properties, Psychrometric charts. Property calculations of air vapour mixtures by using chart and expressions. Psychrometric process – adiabatic saturation, sensible heatingandcooling, humidification, dehumidification, evaporative cooling and adiabatic mixing. Simple Applications

TOTAL: 45 PERIODS

(Use of Steam tables, Mollier chart andPsychrometric chart permitted)

OUTCOMES:

- Upon completion of this course, the students can able to apply the Thermodynamic Principles to Mechanical Engineering Application.
- Apply mathematical fundamentals to study the properties of steam, gas and gas mixtures.

TEXT BOOKS :

1. Y Cengal and MBoles, Thermodynamics - An Engineering Approach, Tata McGrawHill, 7th Edition, 2010.
2. Natarajan E., Engineering Thermodynamics: Fundamentals and Applications, Anuragam Publications, Chennai,2012.

REFERENCES :

1. Nag.P.K., "Engineering Thermodynamics", 4th Edition, Tata McGraw-Hill, New Delhi, 2008.
2. Venkatesh,A, "Basic Engineering Thermodynamics",Universities Press (India) Limited, 2007.
3. Holman.J.P., Thermodynamics, 3rd Ed. McGraw-Hill, 1995.
4. E.Rathakrishnan, Fundamentals of Engineering Thermodynamics, 2nd Edition, Prentice – Hall of India Pvt. Ltd, 2006
5. Chattopadhyay, P, Engineering Thermodynamics, Oxford University Press, 2010.
6. Arora C.P, " Thermodynamics", Tata McGraw-Hill, New Delhi, 2003.
7. Van Wylen and Sonntag, "Classical Thermodynamics", Wiley Eastern, 1987

PTCE8252 STRENGTH OF MATERIALS L T P C
(Common to Mechanical, Manufacturing, Industrial and Printing) 3 0 0 3

OBJECTIVE:

To understand the stresses developed in bars, compounds bars, beams, shafts, cylinders and spheres.

UNIT I STRESS, STRAIN AND DEFORMATION OF SOLIDS 9

Rigid bodies and deformable solids – Tension, Compression and Shear Stresses – Deformation of simple and compound bars – Thermal stresses – Elastic constants – Volumertric strains – Stresses on inclined planes – principal stresses and principal planes – Mohr's circle of stress.

UNIT II TRANSVERSE LOADING ON BEAMS AND STRESSES IN BEAM 9

Beams – types transverse loading on beams – Shear force and bending moment in beams – Cantilevers – Simply supported beams and over – hanging beams. Theory of simple bending – bending stress distribution – Load carrying capacity – Proportioning of sections – Flitched beams – Shear stress distribution.

UNIT III TORSION 9

Torsion formulation stresses and deformation in circular and hollows shafts – Stepped shafts – Deflection in shafts fixed at the both ends – Stresses in helical springs – Deflection of helical springs, carriage springs.

UNIT IV DEFLECTION OF BEAMS 9

Double Integration method – Macaulay's method – Area moment Theorems for computation of slopes and deflections in beams - Conjugate beam and strain energy – Maxwell's reciprocal theorems.

UNIT V THIN CYLINDERS, SPHERES AND THICK CYLINDERS 9

Stresses in thin cylindrical shell due to internal pressure circumferential and longitudinal stresses and deformation in thin cylinders – spherical shells subjected to internal pressure – Deformation in spherical shells – Lame's theory – Application of theories of failure.

TOTAL: 45 PERIODS

OUTCOMES:

- Upon completion of this course, the students can able to apply mathematical knowledge to calculate the deformation behavior of simple structures.
- Critically analyse problem and solve the problems related to mechanical elements and analyse the deformation behavior for different types of loads.

TEXT BOOKS:

1. Bansal, R.K., Strength of Materials, Laxmi Publications (P) Ltd., 2007
2. Jindal U.C., Strength of Materials, Asian Books Pvt. Ltd., New Delhi, 2007

REFERENCES:

1. Egor. P.Popov " Engineering Mechanics of Solids" Prentice Hall of India, New Delhi, 2001
2. Subramanian R., Strength of Materials, oxford University Press, Oxford Higher Education Series, 2007.
3. Hibbeler, R.C., Mechanics of Materials, Pearson Education, Low Price Edition, 2007
4. Ferdinand P. Been, Russell Johnson, J.r. and John J. Dewole Mechanics of Materials, Tata Mcgraw Hill publishing 'co. Ltd., New Delhi.

PTGE8251 ENVIRONMENTAL SCIENCE AND ENGINEERING L T P C
(Common to Manufacturing, Mechanical,Printing, Production, EEE, CSE,IT,Civil,Textile,Chemical,Industrial) 3 0 0 3

OBJECTIVES:

To the study of nature and the facts about environment.

- To finding and implementing scientific, technological, economic and political solutions to environmental problems.
- To study the interrelationship between living organism and environment.
- To appreciate the importance of environment by assessing its impact on the human world; envision the surrounding environment, its functions and its value.
- To study the dynamic processes and understand the features of the earth's interior and surface.
- To study the integrated themes and biodiversity, natural resources, pollution control and waste management.

UNIT I ENVIRONMENT, ECOSYSTEMS AND BIODIVERSITY 14

Definition, scope and importance of environment – need for public awareness - concept of an ecosystem – structure and function of an ecosystem – producers, consumers and decomposers – energy flow in the ecosystem – ecological succession – food chains, food webs and ecological pyramids – Introduction, types, characteristic features, structure and function of the (a) forest ecosystem (b) grassland ecosystem (c) desert ecosystem (d) aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries) – Introduction to biodiversity definition: genetic, species and ecosystem diversity – biogeographical classification of India – value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values – Biodiversity at global, national and local levels – India as a mega-diversity nation – hot-spots of biodiversity – threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – endangered and endemic species of India – conservation of biodiversity: In-situ and ex-situ conservation of biodiversity.

Field study of common plants, insects, birds

Field study of simple ecosystems – pond, river, hill slopes, etc.

UNIT II ENVIRONMENTAL POLLUTION 8

Definition – causes, effects and control measures of: (a) Air pollution (b) Water pollution (c) Soil pollution (d) Marine pollution (e) Noise pollution (f) Thermal pollution (g) Nuclear hazards – soil waste management: causes, effects and control measures of municipal solid wastes – role of an individual in prevention of pollution – pollution case studies – disaster management: floods, earthquake, cyclone and landslides.

Field study of local polluted site – Urban / Rural / Industrial / Agricultural.

UNIT III NATURAL RESOURCES 10

Forest resources: Use and over-exploitation, deforestation, case studies- timber extraction, mining, dams and their effects on forests and tribal people – Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems – Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies – Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies – Energy resources: Growing energy needs, renewable and non renewable energy sources, use of alternate energy sources. case studies – Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification – role of an individual in conservation of natural resources – Equitable use of resources for sustainable lifestyles.

Field study of local area to document environmental assets – river / forest / grassland / hill / mountain.

UNIT IV SOCIAL ISSUES AND THE ENVIRONMENT 7

From unsustainable to sustainable development – urban problems related to energy – water conservation, rain water harvesting, watershed management – resettlement and rehabilitation of people; its problems and concerns, case studies – role of non-governmental organization- environmental ethics: Issues and possible solutions – climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust, case studies. – wasteland reclamation – consumerism and waste products – environment production act – Air (Prevention and Control of Pollution) act – Water (Prevention and control of Pollution) act – Wildlife protection act – Forest conservation act – enforcement machinery involved in environmental legislation- central and state pollution control boards- Public awareness.

UNIT V HUMAN POPULATION AND THE ENVIRONMENT 6

Population growth, variation among nations – population explosion – family welfare programme – environment and human health – human rights – value education – HIV / AIDS – women and child welfare – role of information technology in environment and human health – Case studies.

TOTAL: 45 PERIODS

OUTCOMES:

Environmental Pollution or problems cannot be solved by mere laws. Public participation is an important aspect which serves the environmental Protection. One will obtain knowledge on the following after completing the course.

- Public awareness of environmental is at infant stage.
- Ignorance and incomplete knowledge has lead to misconceptions
- Development and improvement in std. of living has lead to serious environmental disasters

TEXT BOOKS:

1. Gilbert M.Masters, 'Introduction to Environmental Engineering and Science', 2nd edition, Pearson Education (2004).

2. Benny Joseph, 'Environmental Science and Engineering', Tata McGraw-Hill, New Delhi, (2006).

REFERENCE BOOKS

1. R.K. Trivedi, 'Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards', Vol. I and II, Enviro Media.
2. Cunningham, W.P. Cooper, T.H. Gorhani, 'Environmental Encyclopedia',Jaico Publ., House, Mumbai, 2001.
3. Dharmendra S. Sengar, 'Environmental law', Prentice hall of India PVT LTD,New Delhi, 2007.
4. Rajagopalan, R, 'Environmental Studies-From Crisis to Cure', Oxford University Press (2005)

PTME8301 KINEMATICS OF MACHINES L T P C
3 0 0 3

OBJECTIVE

- To understand the basic components and layout of linkages in the assembly of a System / machine.
- 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.
- To understand the motion resulting from a specified set of linkages, design few linkage mechanisms and cam mechanisms for specified output motions.
- 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

Classification of mechanisms – Basic kinematic concepts and definitions – Degree of freedom, Mobility – Kutzbach criterion, Gruebler's criterion – Grashof's Law – Kinematic inversions of four-bar chain and slider crank chains – Limit positions – Mechanical advantage – Transmission Angle – Description of some common mechanisms – Quick return mechanisms, Straight line generators, Dwell mechanisms, Ratchets and Escapements, Universal Joint – Basic structures of Robot Manipulators (serial & parallel) – Design of quick return crank-rocker mechanisms.

UNIT II KINEMATICS OF LINKAGE MECHANISMS 9

Displacement, velocity and acceleration analysis of simple mechanisms – Graphical method – Velocity and acceleration polygons – Velocity analysis using instantaneous centres – Kinematic analysis by complex algebra methods – Vector approach – Computer applications in the kinematic analysis of simple mechanisms – Coincident points – Coriolis component of Acceleration – Introduction to linkage synthesis problem.

UNIT III KINEMATICS OF CAM MECHANISMS 9

Classification of cams and followers – Terminology and definitions – Displacement diagrams – Uniform velocity, parabolic, simple harmonic, cycloidal and polynomial motions – Derivatives of follower motions – Layout of plate cam profiles – Specified contour cams – Circular arc and tangent cams – Pressure angle and undercutting – sizing of cams.

UNIT IV GEARS AND GEAR TRAINS 9

Law of toothed gearing – Involutes and cycloidal tooth profiles –Spur Gear terminology and definitions –Gear tooth action – contact ratio – Interference and undercutting – Non-standard gear teeth – Helical, Bevel, Worm, Rack and Pinion gears [Basics only] – Gear trains – Speed ratio, train value – Parallel axis gear trains – Epicyclic Gear Trains – Differentials – Automobile gear box.

UNIT V FRICTION IN MACHINE ELEMENTS 9

Surface contacts – Sliding and Rolling friction – Friction drives – Friction in screw threads – Bearings and lubrication – Friction clutches – Belt and rope drives – Friction aspects in brakes – Friction in vehicle propulsion and braking.

TOTAL : 45 PERIODS

OUTCOMES:

- Upon completion of this course, the students can able to apply fundamentals of mechanism for the design of new mechanisms and analyse them for optimum design.

TEXT BOOK:

1. Uicker, J.J., Pennock G.R and Shigley, J.E., "Theory of Machines and Mechanisms",3rd Edition, Oxford University Press, 2009.

REFERENCES:

1. Rattan, S.S, "Theory of Machines", 3rd Edition, Tata McGraw-Hill, 2009.
2. Thomas Bevan, 'Theory of Machines', 3rd Edition, CBS Publishers and Distributors, 2005.
3. Cleghorn. W. L, "Mechanisms of Machines", Oxford University Press, 2005
4. Robert L. Norton, Kinematics and Dynamics of Machinery, Tata McGraw-Hill, 2009.
5. Allen S. Hall Jr., "Kinematics and Linkage Design", Prentice Hall, 1961
6. Ghosh. A and Mallick, A.K., "Theory of Mechanisms and Machines', Affiliated East-West Pvt. Ltd., New Delhi, 1988.
7. Rao.J.S. and Dukkipati.R.V. 'Mechanisms and Machine Theory', Wiley-Eastern Ltd., New Delhi, 1992.
8. John Hannah and Stephens R.C., 'Mechanics of Machines', Viva Low-Prices Student Edition, 1999.
9. V.Ramamurthi, Mechanics of Machines, Narosa Publishing House, 2002.
10. Khurmi, R.S.,"Theory of Machines",14th Edition, S Chand Publications.

STANDARDS:

IS 2458 : 2001, Vocabulary of Gear Terms – Definitions related to Geometry.
IS 3756 : 2002, Method of Gear Correction – Addendum modification for External cylindrical gears with parallel axes.
IS 5267 : 2002 Vocabulary of Gear Terms – Definitions Related to Worm Gear Geometry.
IS 12328 : Part 1: 1988 Bevel Gear Systems Part – 1 Straight Bevel Gears.
IS 12328 : 1988 Bevel Systems Part – 2 Spiral Bevel Gears.

PTME8302 MANUFACTURING TECHNOLOGY – I L T P C
3 0 0 3

OBJECTIVE:

- To introduce the students on the concepts of basic manufacturing processes and fabrication techniques, such as metal casting, metal joining, metal forming and manufacture of plastic components.

UNIT I METAL CASTING PROCESSES 9

Sand Casting – Sand Mould – Type of patterns - Pattern Materials – Pattern allowances – Moulding sand Properties and testing – Cores –Types and applications – Moulding machines – Types and applications– Melting furnaces – Principle of special casting processes- Shell, investment – Ceramic mould – Pressure die casting – Centrifugal Casting - CO2 process – Stir castings - Defects in Sand casting

UNIT II JOINING PROCESSES 9

Fusion welding processes – Type of Gas welding – Flame characteristics – Filler and Flux materials – Arc welding ,Electrodes , Coating and specifications – Principles and types of Resistance welding – Gas metal arc welding – Submerged arc welding – Electro slag welding – TIG welding – Principle and application of special welding processes – Plasma arc welding – Thermit welding – Electron beam welding – Friction welding – Diffusion welding – Weld defects – Brazing and soldering – methods and process capabilities –Adhesive bonding ,Types and applications

UNIT III BULK DEFORMATION PROCESSES 9

Hot working and cold working of metals – Forging processes – Open, impression and closed die forging – Characteristics of the processes – Typical forging operations – rolling of metals – Types of Rolling – Flat strip rolling – shape rolling operations – Defects in rolled parts – Principle of rod and wire drawing – Tube drawing – Principles of Extrusion – Types – Hot and Cold extrusion

UNIT IV SHEET METAL PROCESSES 9

Sheet metal characteristics – Typical shearing, bending and drawi9ng operations – Stretch forming operations – Formability of sheet metal – Test methods –special forming processes- Working principle and applications – Hydro forming – Rubber pad forming – Metal spinning – Introduction of Explosive forming, magnetic pulse forming, peen forming, Super plastic forming – Micro forming

UNIT V MANUFACTURE OF PLASTIC COMPONENTS 9

Types and characteristics of plastics – Moulding of thermoplastics – working principles and typical applications – injection moulding – Plunger and screw machines – Compression moulding, Transfer Moulding – Typical industrial applications – introduction to blow moulding – Rotational moulding – Film blowing – Extrusion – Thermoforming – Bonding of Thermoplastics.

TOTAL: 45 PERIODS

OUTCOMES:

- Upon completion of this course, the students can able to apply the different manufacturing process and use this in industry for component production

TEXT BOOKS:

1. Kalpakjian. S, “Manufacturing Engineering and Technology”, Pearson Education India Edition, 2006
2. S. Gowri P. Hariharan, A.Suresh Babu, Manufacturing Technology I, Pearson Education, 2008

REFERENCES:

1. Roy. A. Lindberg, Processes and materials of manufacture, PHI / Pearson education, 2006
2. Hajra Chouldhary S.K and Hajra Choudhury. AK., Elements of workshop Technology, volume I and II, Media promoters and Publishers Private Limited, Mumbai, 1997
3. Paul Degarma E, Black J.T and Ronald A. Kosher, Eligth Edition, Materials and Processes, in Manufacturing prentice – Hall of India, 1997.
4. Sharma, P.C., A Text book of production Technology, S.Chand and Co. Ltd., 2004.

5. P.N. Rao, Manufacturing Technology Foundry, Forming and Welding, TMH-2003; 2nd Edition, 2003

PTME8303 THERMAL ENGINEERING-I L T P C
3 0 0 3

OBJECTIVE:

- To apply the concepts and laws of thermodynamics for cycle analysis and performance of heat engines - Internal Combustion(IC) engines and Gas Turbines.

UNIT I GAS POWER CYCLES 9

Air Standard Cycles - Otto, Diesel, Dual, Brayton – cycle Analysis and performance calculations.

UNIT II AIR COMPRESSOR 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. Types of compressors and their comparison.

UNIT III INTERNAL COMBUSTION ENGINES AND ITS SYSTEMS 9

IC engine Classification, components and functions. Actual and theoretical - valve and port timing diagrams, p-v diagrams - for two stroke and four stroke engines. Comparison of two stroke & four stroke engines and SI & CI engines.

UNIT IV INTERNAL COMBUSTION ENGINE FUELS, COMBUSTION & PERFORMANCE 9

Comparison of petrol and diesel engine fuel properties and qualities. Air-fuel ratio calculation – lean and rich mixtures. Combustion in SI & CI Engines – abnormal combustion – phenomenon and control. Ignition, lubrication and cooling systems. Exhaust gas analysis. Performance calculations.

UNIT V GAS TURBINES 9

Open and closed Gas turbine cycle analysis - methods of cycle improvement. Regenerative, intercooled, reheated cycles and their combinations. Performance calculations.

TOTAL: 45 PERIODS

OUTCOMES:

- Ability to understand the various thermal equipment and their cycles of operation
- Knowledge in working of Air Compressors and IC Engines
- Understanding of IC Fuels and their performance
- Knowledge in principle of operations of gas turbines and performance measurements of gas turbines.

TEXT BOOKS:

1. Rajput, R.K., Thermal Engineering, 8th Edition, Laxmi Publications, 2010
2. Ballaney, P.L., “Thermal Engineering” , Khanna Publishers, 24th Edition, 2003.

REFERENCES:

1. Rathore, M.M, Thermal Engineering, McGraw Hill, 2010.
2. Rudramoorthy, R., Thermal Engineering, 4th Edition, Tata McGraw Hill, New Delhi, 2006.
3. Domkundwar, Kothandaraman, and Domkundwar, A Course in Thermal Engineering, Dhanpat Raj & Sons, Fifth edition, 2002.

4. Sarkar B K, Thermal Engineering, McGraw Hill, 2001
5. Zucro,n.j., Principles of jet propulsion and gas turbines, John Wiley, New York, 1970.
6. Ganesan.V, Gas turbines, Tata McGraw-Hill Publication, New Delhi, 1999.
7. Somasundaram, Gas Dynamic and Jet propulsion, New Age Internatiolnal, 996.l

PTME8401 DYNAMICS OF MACHINES L T P C
3 0 0 3

OBJECTIVES:

- To understand the force-motion relationship in components subjected to external forces and analysis of standard mechanisms.
- To understand the undesirable effects of unbalances resulting from prescribed motions in mechanism.
- To understand the effect of Dynamics of undesirable vibrations.
- To understand the principles in mechanisms used for governing of machines.

UNIT I FORCE ANALYSIS 9

Applied and constraint forces – Free body diagrams – Static equilibrium conditions – Static force analysis of simple mechanisms – Dynamic force analysis – Inertia force and Inertia torque – D Alembert's principle –Dynamic Analysis in reciprocating engines – Gas forces – Inertia effect of connecting rod– Bearing loads – Crank shaft torque – Turning moment diagrams – Fly Wheels – Flywheels of punching presses- Dynamics of Cam-follower mechanism.

UNIT II BALANCING 9

Static and dynamic balancing – Balancing of rotating masses – Balancing a single cylinder engine – Balancing of Multi-cylinder inline, V-engines – Partial balancing in engines – Balancing of linkages – Balancing machines-Field balancing of discs and rotors.

UNIT III SINGLE DEGREE FREE VIBRATION 9

Basic features of vibratory systems – Degrees of freedom – single degree of freedom – Free vibration – Equations of motion – Natural frequency – Types of Damping – Damped vibration – Torsional vibration of shaft – Critical speeds of shafts – Torsional vibration – Two and three rotor torsional systems.

UNIT IV FORCED VIBRATION 9

Response of one degree freedom systems to periodic forcing – Harmonic disturbances – Disturbance caused by unbalance – Support motion –transmissibility – Vibration isolation-vibration measurement.

UNIT V MECHANISM FOR CONTROL 9

Governors – Types – Centrifugal governors – Gravity controlled and spring controlled centrifugal governors – Characteristics – Effect of friction – Controlling force. Gyroscopes – Gyroscopic forces and torques – Gyroscopic stabilization – Gyroscopic effects in Automobiles, ships and airplanes.

TOTAL : 45 PERIODS

OUTCOMES:

- Upon completion of this course, the Students can able to predict the force analysis in mechanical system and related vibration issues and can able to solve the problem

TEXT BOOK:

1. Uicker, J.J., Pennock G.R and Shigley, J.E., "Theory of Machines and Mechanisms",3rd Edition, Oxford University Press, 2009.

REFERENCES:

1. Rattan, S.S, "Theory of Machines", 3rd Edition, Tata McGraw-Hill, 2009.
2. Thomas Bevan, 'Theory of Machines', 3rd Edition, CBS Publishers and Distributors, 2005.
3. Cleghorn. W. L, "Mechanisms of Machines", Oxford University Press, 2005
4. Benson H. Tongue, "Principles of Vibrations", Oxford University Press, 2nd Edition, 2007
5. Robert L. Norton, Kinematics and Dynamics of Machinery, Tata McGraw-Hill, 2009.
6. Allen S. Hall Jr., "Kinematics and Linkage Design", Prentice Hall, 1961
7. Ghosh. A and Mallick, A.K., "Theory of Mechanisms and Machines', Affiliated East-West Pvt. Ltd., New Delhi, 1988.
8. Rao.J.S. and Dukkipati.R.V. 'Mechanisms and Machine Theory', Wiley-Eastern Ltd., New Delhi, 1992.
9. John Hannah and Stephens R.C., 'Mechanics of Machines', Viva Low-Prices Student Edition, 1999.
10. Grover. G.T., "Mechanical Vibrations", Nem Chand and Bros., 1996
11. William T. Thomson, Marie Dillon Dahleh, Chandramouli Padmanabhan, "Theory of Vibration with Application", 5th edition Pearson Education, 2011
12. V.Ramamurthi, Mechanics of Machines, Narosa Publishing House, 2002.
13. Khurmi, R.S.,"Theory of Machines",14th Edition, S Chand Publications.

PTME8402 MANUFACTURING TECHNOLOGY – II L T P C
3 0 0 3

OBJECTIVES:

- 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. To understand the basic concepts of Computer Numerical Control (CNC) of machine tools and CNC Programming

UNIT I THEORY OF METAL CUTTING 9

Mechanics of chip formation, single point cutting tool, forces in machining, Types of chip, cutting tools – nomenclature, orthogonal metal cutting, thermal aspects, cutting tool materials, tool wear, tool life, surface finish, cutting fluids and Machinability.

UNIT II TURNING MACHINES 9

Centre lathe, constructional features, specification, operations – taper turning methods, thread cutting methods, special attachments, machining time and power estimation. Capstan and turret lathes- tool layout – automatic lathes: semi automatic – single spindle : Swiss type, automatic screw type – multi spindle:

UNIT III RECIPROCATING, MILLING AND GEAR CUTTING MACHINES 9

Reciprocating machine tools: shaper, planer, slotter: Types and operations- Hole making : Drilling ,reaming,boring,Tapping, Milling operations-types of milling cutter –attachments-machining time calculations -,Gear cutting – forming and generation principle, gear milling , hobbing and gear shaping – micro finishing methods

UNIT IV ABRASIVE PROCESS AND BROACHING 9

Abrasive processes: grinding wheel – specifications and selection, types of grinding process – cylindrical grinding, surface grinding, centreless grinding, internal grinding- micro finishing methods - Typical applications – concepts of surface integrity, broaching machines: broach construction – push, pull, surface and continuous broaching machines

UNIT V ADVANCED MANUFACTURING TECHNIQUES 9

Numerical Control(NC) machine tools – CNC types, constructional details, special features, machining centre, part programming fundamentals CNC – manual part programming – micro machining – wafer machining

TOTAL : 45 PERIODS

OUTCOMES:

- Upon completion of this course, the students can able to understand and compare the functions and applications of different metal cutting tools and also demonstrate the programming in CNC machining.

TEXT BOOKS:

1. Roy. A.Lindberg, "Process and materials of manufacture," PHI/Pearson Education fourth, Edition 2006.
2. Rao. P.N "Manufacturing Technology," Metal Cutting and Machine Tools, Tata McGraw- Hill, New Delhi, 2003.

REFERENCES:

1. Richerd R kibbe, John E. Neely, Roland O.Merges and Warren J.White "Machine Tool Practices", Prentice Hall of India, 1998
2. HMT – Production Technology, Tata Mc Graw Hill, 1998.
3. Hajra Choudhury. Elements of Workshop Technology – Vol.II. Media Promoters
4. Geofrey Boothroyd, Fundamentals of Metal Machining and Machine Tools, Mc Graw Hill, 1984

PTME8403 THERMAL ENGINEERING - II L T P C
3 0 0 3

OBJECTIVES:

- To integrate the concepts, laws and methodologies from the first course in thermodynamics into the analysis of cyclic processes.
- To apply the thermodynamic concepts into various thermal applications like Boilers, Compressors and Refrigeration and Air Conditioning Systems and Waste heat recovery systems.

UNIT I STEAM NOZZLE 9

Types of nozzles, Flow of steam through nozzles, Shapes of nozzles, Effect of friction, Critical pressure ratio, Metastable flow.

UNIT II BOILERS 9

Types of boilers, Thermal calculations, Heat balance, Mountings and Accessories, Boiler trial, Boiler code, Basic Rankine cycle.

UNIT III STEAM TURBINES 9

Types, Impulse and reaction principles, Compoundings, Velocity diagrams for impulse and reaction blades, Work done on turbine blades and efficiency of components, Speed regulations, Governors.

UNIT IV COGENERATION AND WASTE HEAT RECOVERY 9

Cogeneration Principles, Cycle Analysis, Applications, Source and utilization of waste heat, Systems, Heat exchangers, Economic Analysis.

UNIT V REFRIGERATION AND AIR – CONDITIONING 9

Vapour compression Refrigeration cycle, Superheat, Sub cooling, Performance calculations, Working principle of vapour absorption system, Air cycle refrigeration, Thermo electric refrigeration, Psychrometry and Psychrometric properties, Psychrometric chart, Instrumentation, Cooling load calculations and circulating systems, concept of RSHF, GSHF and ESHF, Air conditioning systems.

TOTAL: 45 PERIODS

OUTCOMES:

- Knowing the types and flow characteristics of nozzles
- understanding the types and working of boilers and steam turbines, cogeneration and heat recovery
- Knowledge of refrigeration and air conditioning system

TEXT BOOKS:

1. Rajput, “Thermal Engineering”, 8th Edition, Laxmi Publications, 2010.
2. Rudramoorthy R, “Thermal Engineering”, Tata MC Graw Hill, New Delhi, 2003.

REFERENCES:

1. Kothandaraman, C.P., Domkundwar .S and Domkundwar A.V.,” A course in Thermal Engineering”, Dhanpal Rai & Sons, Fifth Edition, 2002.
2. Holman .J.P., “Thermodynamics”, McGraw Hill, 1985.
3. Arora .C.P., “Refrigeration and Air Conditioning”, TMH, 1994.
4. Charles H Butler : Cogeneration” McGraw Hill, 1984.
5. Sydney Reiter “Industrial and Commercial Heat Recovery Systems” Van Nostrand Reinhols, 1985.
6. David Gunn, Robert Horton, Industrial Boilers – Longman Scientific and Technical Publication, 1986.

PTML8251 ENGINEERING MATERIALS AND METALLURGY L T P C
(Common to Mechanical and Manufacturing) 3 0 0 3

OBJECTIVE:

To impart knowledge on the structure, properties, treatment, testing and applications of metals and non-metallic materials so as to identify and select suitable materials for various engineering applications.

UNIT I ALLOYS AND PHASE DIAGRAMS 10

Constitution of alloys – Solid solutions, substitutional and interstitial – phase diagrams, Isomorphous, eutectic, eutectoid, peritectic, and peritectoid reactions, Iron – Iron carbide equilibrium diagram. Classification of steel and cast Iron microstructure, properties and application.

UNIT II HEAT TREATMENT 11

Definition – Full annealing, stress relief, recrystallisation and spheroidising – normalising, hardening and Tempering of steel. Isothermal transformation diagrams – cooling curves

superimposed on I.T. diagram CCR – Hardenability, Jominy end quench test - Austempering, martempering – case hardening, carburizing, Nitriding, cyaniding, carbonitriding – Flame and Induction hardening – Vacuum and Plasma hardening – Current trends, Thermo-mechanical treatments, elementary ideas on sintering.

UNIT III FERROUS AND NON-FERROUS METALS 9

Effect of alloying additions on steel- α and β stabilisers– stainless and tool steels – HSLA, Maraging steels – Grey, white, malleable, spheroidal – alloy cast irons, Copper and copper alloys – Brass, Bronze and Cupronickel – Aluminium and Al-Cu – precipitation strengthening treatment – Bearing alloys, Mg-alloys, Ni-based super alloys, special non-ferrous metals and alloys of low coefficient of the thermal expansion, high corrosion resistance, heat resistant etc.E

UNIT IV NON-METALLIC MATERIALS 9

Polymers – types of polymer, commodity and engineering polymers – Properties and applications of various thermosetting and thermoplastic polymers (PP, PS, PVC, PMMA, PET, PC, PA, ABS, PI, PAI, PPO, PPS, PEEK, PTFE, Polymers – Urea and Phenol formaldehydes) - Engineering Ceramics – Properties and applications of Al_2O_3, SiC, Si_3N_4, PSZ and SIALON – Composites-Classifications- Matrix and reinforcement Materials- Applications of Composites-Nano composites.

UNIT V MECHANICAL PROPERTIES AND DEFORMATION MECHANISMS 6

Mechanisms of plastic deformation, slip and twinning – Types of fracture – Testing of materials under tension, compression and shear loads – Hardness tests (Brinell, Vickers and Rockwell), Micro and nano-hardness tests, Impact test lzod and charpy, fatigue and creep failure mechanisms.

TOTAL: 45 PERIODS

OUTCOMES:

- Upon completion of this course, the students can able to apply the different materials, their processing, heat treatments in suitable application in mechanical engineering fields.

TEXT BOOKS:

1. Kenneth G.Budinski and Michael K. Budinski, “Engineering Materials”, Prentice Hall of India Private Limited, 4th Indian Reprint 2002.
2. Williams D Callister, “Material Science and Engineering” Wiley India Pvt Ltd, Revised Indian edition 2007

REFERENCES:

1. Raghavan.V, “Materials Science and Engineering”, Prentice Hall of India Pvt.Ltd., 1999.
2. Sydney H.Avner, “Introduction to Physical Metallurgy”, McGraw Hill Book Company, 1994.
3. G.S. Upadhyay and Anish Upadhyay, “Materials Science and Engineering”, Viva Books Pvt.Ltd., New Delhi, 2006.

PTME8411 THERMAL ENGINEERING LABORATORY – II L T P C
0 0 3 2

LIST OF EXPERIMENTS:

OBJECTIVES

- To study the heat transfer phenomena predict the relevant coefficient using implementation
- To study the performance of refrigeration cycle / components

HEAT TRANSFER: **30**

1. Thermal conductivity measurement using guarded plate apparatus.
2. Thermal conductivity measurement of pipe insulation using lagged pipe apparatus.
3. Determination of heat transfer coefficient under natural convection from a vertical cylinder.
4. Determination of heat transfer coefficient under forced convection from a tube.
5. Determination of Thermal conductivity of composite wall.
6. Determination of Thermal conductivity of insulating powder.
7. Heat transfer from pin-fin apparatus (natural & forced convection modes)
8. Determination of Stefan – Boltzmann constant.
9. Determination of emissivity of a grey surface.
10. Effectiveness of Parallel / counter flow heat exchanger.

REFRIGERATION AND AIR CONDITIONING LAB **15**

1. Determination of COP of a refrigeration system
2. Experiments on Psychrometric processes
3. Performance test on a reciprocating air compressor
4. Performance test in a HC Refrigeration System
5. Performance test in a fluidized Bed Cooling Tower

TOTAL: 45 PERIODS

OUTCOMES

- Ability to demonstrate the fundamentals of heat and predict the coefficient used in that transfer application and also design refrigeration cycle.

PTME8501 COMPUTER INTEGRATED MANUFACTURING **L T P C**
3 0 0 3

OBJECTIVE:

- To understand the application of computers in various aspects of Manufacturing viz., Design, Proper planning, Manufacturing cost, Layout & Material Handling system.

UNIT I INTRODUCTION **10**

Brief introduction to CAD and CAM – Manufacturing Planning, Manufacturing control-Introduction to CAD/CAM – Concurrent Engineering-CIM concepts – Computerised elements of CIM system –Types of production - Manufacturing models and Metrics – Mathematical models of Production Performance – Simple problems – Manufacturing Control – Simple Problems – Basic Elements of an Automated system – Levels of Automation – Lean Production and Just-In-Time Production.

UNIT II PRODUCTION PLANNING AND CONTROL AND COMPUTERISED PROCESS PLANNING **10**

Process planning – Computer Aided Process Planning (CAPP) – Logical steps in Computer Aided Process Planning – Aggregate Production Planning and the Master Production Schedule – Material Requirement planning – Capacity Planning- Control Systems-Shop Floor Control-Inventory Control – Brief on Manufacturing Resource Planning-II (MRP-II) & Enterprise Resource Planning (ERP) - Simple Problems.

UNIT III CELLULAR MANUFACTURING **9**

Group Technology(GT), Part Families – Parts Classification and coding – Simple Problems in Opitz Part Coding system – Production flow Analysis – Cellular Manufacturing – Composite part

concept – Machine cell design and layout – Quantitative analysis in Cellular Manufacturing – Rank Order Clustering Method - Arranging Machines in a GT cell – Hollier Method – Simple Problems.

UNIT IV FLEXIBLE MANUFACTURING SYSTEM (FMS) AND AUTOMATED GUIDED VEHICLE SYSTEM (AGVS) 8

Types of Flexibility - FMS – FMS Components – FMS Application & Benefits – FMS Planning and Control– Quantitative analysis in FMS – Simple Problems. Automated Guided Vehicle System (AGVS) – AGVS Application – Vehicle Guidance technology – Vehicle Management & Safety.

UNIT V INDUSTRIAL ROBOTICS 8

Robot Anatomy and Related Attributes – Classification of Robots- Robot Control systems – End Effectors – Sensors in Robotics – Robot Accuracy and Repeatability - Industrial Robot Applications – Robot Part Programming – Robot Accuracy and Repeatability – Simple Problems.

TOTAL : 45 PERIODS

OUTCOMES:

- Knowledge gained in usage of computers and software's in various manufacturing activities
- Understanding of product and process classifications in electronic automation of shop floor
- Knowledge in FMS and AGVS in manufacturing automation
- Usage of Robots and programming of Robots

TEXT BOOK:

1. Mikell.P.Groover “Automation, Production Systems and Computer Integrated Manufacturing”, Prentice Hall of India, 2008.

REFERENCES:

1. Kant Vajpayee S, “Principles of Computer Integrated Manufacturing”, Prentice Hall India, 2003.
2. Radhakrishnan P, Subramanyan S.and Raju V., “CAD/CAM/CIM”, 2nd Edition, New Age International (P) Ltd, New Delhi, 2000.
3. Gideon Halevi and Roland Weill, “Principles of Process Planning – A Logical Approach” Chapman & Hall, London, 1995.
4. P Rao, N Tewari & T.K. Kundra, “Computer Aided Manufacturing”, Tata McGraw Hill Publishing Company, 2000.

PTME8502 DESIGN OF MACHINE ELEMENTS L T P C
3 0 0 3

OBJECTIVES

- To familiarize the various steps involved in the Design Process
- To understand the principles involved in evaluating the shape and dimensions of a component to satisfy functional and strength requirements.
- To learn to use standard practices and standard data
- To learn to use catalogues and standard machine components

UNIT I STEADY STRESSES AND VARIABLE STRESSES IN MACHINE MEMBERS 10

Introduction to the design process - factor influencing machine design, selection of materials based on mechanical properties - Preferred numbers, fits and tolerances – Direct, Bending and torsional stress equations – Impact and shock loading – calculation of principle stresses for various load combinations, eccentric loading – curved beams – crane hook and 'C' frame - Factor of safety - theories of failure – Design based on strength and stiffness –Concepts of reliability based design - stress concentration – Introduction to creep and design against creep - Design for finite and infinite life under variable loading.

Cylinders and Pressure vessels for industrial applications – Thin and thick cylinders – Spherical vessels

UNIT II SHAFTS AND COUPLINGS 8

Design of solid and hollow shafts based on strength, rigidity and critical speed – Keys, key ways and splines – crankshafts - Rigid and flexible couplings.

UNIT III TEMPORARY AND PERMANENT JOINTS 9

Threaded fastners - Bolted joints including eccentric loading, Knuckle joints, Cotter joints – Welded joints, riveted joints for structures - theory of bonded joints.

UNIT IV ENERGY STORING ELEMENTS AND ENGINE COMPONENTS 9

Various types of springs, optimization of helical springs - rubber springs - Flywheels considering stresses in rims and arms for engines and punching machines- Connecting Rods and crank shafts.

UNIT V BEARINGS 9

Sliding contact and rolling contact bearings - Hydrodynamic journal bearings, McKee's Eqn., Sommerfield Number, Raimondi & Boyd graphs, -- Selection of Rolling Contact bearings - Seals and Gaskets

TOTAL: 45 PERIODS

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

OUTCOMES:

- Upon completion of this course, the students can able to successfully design machine components

TEXT BOOK:

1. Bhandari V, "Design of Machine Elements", 3rd Edition, Tata McGraw-Hill Book Co, 2010.

REFERENCES:

1. Sundararajamoorthy T. V. Shanmugam .N, "Machine Design", Anuradha Publications, Chennai, 2003.
2. Joseph Shigley,Charles Mischke,Richard Budynas and Keith Nisbett "Mechanical Engineering Design", 8th Edition, Tata McGraw-Hill , 2008.
3. Robert C. Juvinall and Kurt M. Marshek, "Fundamentals of Machine Design",4th Edition, Wiley, 2005
4. Alfred Hall, Halowenko, A and Laughlin, H., "Machine Design", Tata McGraw-Hill Book Co.(Schaum's Outline), 2010
5. Bernard Hamrock,Steven Schmid,Bo Jacobson, "Fundamentals of Machine Elements", 2nd Edition, Tata McGraw-Hill Book Co., 2006.
6. Orthwein W, "Machine Component Design", Jaico Publishing Co, 2003.

7. Ansel Ugural, “Mechanical Design – An Integral Approach, 1st Edition, Tata McGraw-Hill Book Co, 2003.
8. Merhyle F. Spotts, Terry E. Shoup and Lee E. Hornberger, “Design of Machine Elements” 8th Edition, Printice Hall, 2003.

STANDARDS:

1. IS 10260 : Part 1 : 1982 Terms, definitions and classification of Plain bearings Part 1 : Construction.
2. IS 10260 : Part 1 : 1982 Terms, definitions and classification of Plain bearings Part 2 : Friction and Wear.
3. IS 10260 : Part 1 : 1982 Terms, definitions and classification of Plain bearings Part 3 : Lubrication.

PTME8503 METROLOGY AND MEASUREMENTS L T P C
3 0 0 3

OBJECTIVE:

- To provide knowledge on the various Metrological equipments available to measure the dimension of the components and the correct procedure to be adopted while using these instruments.

UNIT I INTRODUCTION 5

Introduction to Metrology-Standards-Calibration-Terminologies in Measurement-Errors in Measurement-Care of Measuring Instuments- Reliability

UNIT II LINEAR AND ANGULAR MEASUREMENTS 10

Linear Measuring Instruments – Evolution – Types – Classification – Limits ,Fits and Tolerences terminology – gauge design - concepts of interchangeability and selective assembly – Comparators-Angular measuring instruments – Types – Bevel protractor, clinometers, angle gauges, spirit levels ,sine bar – Alignment telescope – Autocollimator-Angle Dekkor – Applications.

UNIT III ADVANCES IN METROLOGY 12

Interferometry – laser interferometers – types – Applications –-Computer Aided Inspection-Basic concept of CMM – Types of CMM – Constructional features – Probes – Accessories – Software – Applications – Basic concepts of Machine Vision System – Elements – Applications.

UNIT IV THREAD, GEAR METROLOGY AND FORM MEASUREMENT 10

Thread ,Gear Metrology – Form measurement-Straightness-Flatness, Roundness.Surfacefinish measurement.

UNIT V MEASUREMENT OF POWER, FLOW AND TEMPERATURE 8

Force, Torque, Pressure, Power – Mechanical, Pneumatic, Hydraulic and Electrical type. Flow measurement: Venturimeter, Orifice meter, Rotameter, Pitot tube – Temperature: bimetallic strip, thermocouples, electrical resistance thermometer .

TOTAL : 45 PERIODS

OUTCOMES:

- Upon completion of this course, the Students can demonstrate different measurement technologies and use of them in Industrial Components

TEXT BOOKS :

1. Gupta.I.C., “Engineering Metrology”, Dhanpatrai Publications, 2005.
2. Jain R.K., “Engineering Metrology”, Khanna Publishers, 2005

REFERENCES:

1. Shotbolt, “Metrology for Engineers, McGraw Hill, 1990.
2. Beckwith, Marangoni, Lienhard, “Mechanical Measurements”, Pearson Education, 2006.
3. Ernest O.Doebelin, McGraw Hill, Measurement Systems (Application and Design)

PTME8551 COMPUTER AIDED DESIGN L T P C
(Common to Mechanical and Manufacturing) 3 0 0 3

OBJECTIVES:

- To provide an overview of how computers are being used in design

UNIT I FUNDAMENTALS OF COMPUTER GRAPHICS 9

Product cycle- Design process- sequential and concurrent engineering- Computer aided design – CAD system architecture- Computer graphics – co-ordinate systems- 2D and 3D transformations- homogeneous coordinates - Line drawing -Clipping- viewing transformation

UNIT II GEOMETRIC MODELLING 9

Representation of curves- Hermite curve- Bezier curve- B-spline curves-rational curves- Techniques for surface modelling – surface patch- Coons and bicubic patches- Bezier and B-spline surfaces. Solid modelling techniques- CSG and B-rep

UNIT III VISUAL REALISM 9

Hidden – Line-Surface-Solid removal algorithms – shading – colouring – computer animation.

UNIT IV ASSEMBLY OF PARTS 9

Assembly modelling – interferences of positions and orientation – tolerance analysis-mass property calculations – mechanism simulation and interference checking.

UNIT V CAD STANDARDS 9

Standards for computer graphics- Graphical Kernel System (GKS) - standards for exchange images- Open Graphics Library **(**OpenGL**)** - Data exchange standards - IGES, STEP, CALS etc. - communication standards.

TOTAL : 45 PERIODS

OUTCOMES:

- Upon completion of this course, the students can able to use computer and CAD software's for modeling of mechanical components

TEXT BOOKS:

1. Ibrahim Zeid “Mastering CAD CAM” Tata McGraw-Hill Publishing Co.2007

REFERENCES:

1. Chris McMahon and Jimmie Browne “CAD/CAM Principles, practice and manufacturing management “ (Second edition) -Pearson Education
2. William M Neumann and Robert F.Sproul "Principles of Computer Graphics", Mc Graw Hill Book Co. Singapore, 1989.
3. Donald Hearn and M. Pauline Baker "Computer Graphics"'. Prentice Hall, Inc, 1992.

4. Foley, Wan Dam, Feiner and Hughes - Computer graphics principles & practice Pearson Education - 2003.

PTME8511 CAD / CAM LAB L T P C
0 0 3 2

OBJECTIVES:

- To gain practical experience in handling 2D drafting and 3D modelling software systems.
- To study the features of CNC Machine Tool.
- To expose students to modern control systems (Fanuc, Siemens etc.,)
- To know the application of various CNC machines like CNC lathe, CNC Vertical Machining centre, CNC EDM and CNC wire-cut and studying of Rapid prototyping.

1. 3D GEOMETRIC MODELLING 24 PERIODS

List of Experiments

1. Introduction of 3D Modelling software

Creation of 3D assembly model of following machine elements using 3D Modelling software

2. Flange Coupling
3. Plummer Block
4. Screw Jack
5. Lathe Tailstock
6. Universal Joint
7. Machine Vice
8. Stuffing box
9. Crosshead
10. Safety Valves
11. Non-return valves
12. Connecting rod
13. Piston
14. Crankshaft

1. Manual Part Programming. 21 PERIODS

(i)Part Programming - CNC Machining Centre

a) Linear Cutting.
b) Circular cutting.
c) Cutter Radius Compensation.
d) Canned Cycle Operations.

(ii) Part Programming - CNC Turning Centre

a) Straight, Taper and Radius Turning.
b) Thread Cutting.
c) Rough and Finish Turning Cycle.
d) Drilling and Tapping Cycle.

3. **Computer Aided Part Programming**

e) CL Data and Post process generation using CAM packages.
f) Application of CAPP in Machining and Turning Centre.

4. **Study of CNC EDM, CNC EDM wire-cut and Rapid prototyping**.

TOTAL: 45 PERIODS

OUTCOMES

- Ability to develop 2D and 3D models using modeling softwares.
- Ability to understand the CNC control in modern manufacturing system.
- Ability to prepare CNC part programming and perform manufacturing.

PTME8552 FINITE ELEMENT ANALYSIS L T P C
(Common to Mechanical and Manufacturing) 3 0 0 3

OBJECTIVES:

- To introduce the concepts of Mathematical Modeling of Engineering Problems.
- To appreciate the use of FEM to a range of Engineering Problems.

UNIT I INTRODUCTION 9

Historical Background – Mathematical Modeling of field problems in Engineering – Governing Equations – Discrete and continuous models – Boundary, Initial and Eigen Value problems – Weighted Residual Methods – Variational Formulation of Boundary Value Problems – Ritz Technique – Basic concepts of the Finite Element Method.

UNIT II ONE-DIMENSIONAL PROBLEMS 9

One Dimensional Second Order Equations – Discretization – Element types- Linear and Higher order Elements – Derivation of Shape functions and Stiffness matrices and force vectors- Assembly of Matrices - Solution of problems from solid mechanics and heat transfer. Longitudinal vibration frequencies and mode shapes. Fourth Order Beam Equation – Transverse deflections and Natural frequencies of beams.

UNIT III TWO DIMENSIONAL SCALAR VARIABLE PROBLEMS 9

Second Order 2D Equations involving Scalar Variable Functions – Variational formulation – Finite Element formulation – Triangular elements – Shape functions and element matrices and vectors. Application to Field Problems - Thermal problems – Torsion of Non circular shafts – Quadrilateral elements – Higher Order Elements.

UNIT IV TWO DIMENSIONAL VECTOR VARIABLE PROBLEMS 9

Equations of elasticity – Plane stress, plane strain and axisymmetric problems – Body forces and temperature effects – Stress calculations - Plate and shell elements.

UNIT V ISOPARAMETRIC FORMULATION AND ADVANCED TOPICS 9

Natural co-ordinate systems – Isoparametric elements – Shape functions for isoparametric elements – One and two dimensions – Serendipity elements – Numerical integration and application to plane stress problems - Matrix solution techniques – Solutions Techniques to Dynamic problems – Introduction to Analysis Software.

TOTAL: 45 PERIODS

OUTCOMES:

- Upon completion of this course, the students can able to understand different mathematical Techniques used in FEM analysis and use of them in Structural and thermal problem

TEXT BOOK:

1. J.N.Reddy, “An Introduction to the Finite Element Method”, 3rd Edition, Tata McGraw-Hill, 2005

REFERENCE BOOKS:

1. Seshu, P, "Text Book of Finite Element Analysis", Prentice-Hall of India Pvt. Ltd., New Delhi, 2007.
2. Logan, D.L., "A first course in Finite Element Method", Thomson Asia Pvt. Ltd., 2002
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. Rao, S.S., "The Finite Element Method in Engineering", 3rd Edition, Butter worth Heinemann, 2004
5. Chandrupatla & Belagundu, "Introduction to Finite Elements in Engineering", 3rd Edition, Prentice Hall College Div, 1990

PTME8553 INDUSTRIAL MANAGEMENT L T P C
(Common to Mechanical and Manufacturing) 3 0 0 3

OBJECTIVES:

- To develop modern concepts of Industrial Management

UNIT I INTRODUCTION 9

Technology Management - Definition – Functions – Evolution of Modern Management – Scientific management Development of management Thought. Approaches to the study of management, Forms of organization – Individual Ownership- partnership – Joint Stock companies – co-operative Enterprises- Public sector Undertakings, Corporate frame Work – Share Holders- Board of Directors- Committees – Chief Executive – Line and functional Managers, Constraints – Environmental – Financial – Legal- Trade Union

UNIT II FUNCTIONS OF MANAGEMENT 9

Planning – nature and purpose – objectives – strategies – policies and planning premises – Decision making – Organizing – Nature and process – premises – Departmentalization – line and staff – Decentralization – organizational culture, Staffing – selection and training – placement – performance appraisal – career strategy – organizational development. Leading managing human factor – Leadership – communication, Controlling – process of Controlling – Controlling Techniques – productivity and inventory management systems-Tools of Techniques– Prevention control, industrial safety

UNIT III ORGANIZATIONAL BEHAVIOUR 9

Definition – Organization – Managerial Role and functions – organizational approaches, individual behavior – causes – Environmental Effect – Behavior and performance, perception – organizational Implications. Personality – Contributing factors – Dimension – Need Theories – process Theories – Job satisfaction, Learning and Behavior- Learning Curves, work design and approaches

UNIT IV GROUP DYNAMICS 9

Group Behavior – Groups – Contributing factors – Group Norms, Communication – Process – Barriers to communication – Effective Communication, leadership- Formal and informal characteristics- Managerial Grid – Leadership Styles – Group Decision making – Leadership Role in Group Decision, Group Conflicts – Types – Causes – Conflict Resolution – Inter group relations and conflict, Organizational centralization and decentralization – Formal and informal – organizational structures – organizational change and development – Change process – Resistance to change – culture and ethics

UNIT V MODERN CONCEPTS 9

Management by objectives (MBO) – Strategic Management – SWOT analysis – Evolving development strategies, information technology in management – Decision support system – Management Games – Business Process Re-engineering (BPR) – supply chain management (SCM) –Global Perspective – Principles and Steps – Advantages and Disadvantages

TOTAL : 45 PERIODS

OUTCOMES :

- Students gain knowledge on the basic management principles to become management(s) professional.

TEXT BOOKS:

1. Herald Koontz and Heinz Weihrich, 'Essentials of Management', McGraw Hill Publishing Company, Singapore International Edition, 1980.
2. M.Govindarajan and S.Natarajan, Principles of Management, Prentice Hall of India Pvt.Ltd. New Delhi 2007

REFERENCE BOOKS:

1. S.Chandran, Organizational Behaviors, Vikas Publishing House Pvt., Ltd, 1994
2. Ties, AF,Stoner and R.Edward Freeman, 'Management' Prentice Hall of India Pvt. Ltd. New Delhi 110011, 1992.
3. Joseph J,Massie, 'Essentials of Management' Prentice Hall of India. Ltd.1985

PTME8601 DESIGN OF TRANSMISSION SYSTEMS L T P C
3 0 0 3

OBJECTIVES:

- To gain knowledge on the principles and procedure for the design of Mechanical power Transmission components.
- To understand the standard procedure available for Design of Transmission of Mechanical elements
- To learn to use standard data and catalogues

UNIT I SELECTION OF PRIME MOVERS AND DESIGN FOR FLEXIBLE ELEMENTS 9

Electric motor classification, Alternating current motors, Polyphase motors, Universal motors, Motor selection: Speed-Torque curves for AC& DC motors, Speed control of electrical motors, Driven machine speed-Torque curves, Motor selection: Matching the motor to the driven machine, Time to accelerate operating speed, Gasoline and diesel engines. Design of Flat belts and pulleys - Selection of V belts and pulleys – Selection of hoisting wire ropes and pulleys – Design of Transmission chains and Sprockets. Selection of pulleys and sprockets for the above transmission systems.

UNIT II SPUR GEARS AND PARALLEL AXIS HELICAL GEARS 9

Speed ratios and number of teeth-Force analysis -Tooth stresses - Dynamic effects - Fatigue strength - Factor of safety - Gear materials – Design of straight tooth spur & helical gears based on strength and wear considerations – Pressure angle in the normal and transverse plane-Equivalent number of teeth-forces for helical gears.

UNIT II BEVEL, WORM AND CROSS HELICAL GEARS 9

Straight bevel gear: Tooth terminology, tooth forces and stresses, equivalent number of teeth. Estimating the dimensions of pair of straight bevel gears.

Worm Gear: Merits and demerits- terminology. Thermal capacity, materials-forces and stresses, efficiency, estimating the size of the worm gear pair.

Cross helical: Terminology-helix angles-Estimating the size of the pair of cross helical gears.

UNIT IV GEAR BOXES 9

Geometric progression - Standard step ratio - Ray diagram, kinematics layout -Design of sliding mesh gear box -Constant mesh gear box. – Design of multi speed gear box for machine tool applications – Variable speed gear box, Fluid Couplings, Torque Converters for automotive applications.

UNIT V CAMS CLUTCHES AND BRAKES 9

Cam Design: Types-pressure angle and under cutting base circle determination-forces and surface stresses. Design of plate clutches –axial clutches-cone clutches-internal expanding rim clutches-shoe and band brakes - external shoe brakes – Internal expanding shoe brake - Electromagnetic clutches

TOTAL : 45 PERIODS

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

OUTCOMES:

- Upon completion of this course, the students can able to successfully design transmission components used in Engine and machines

TEXT BOOK:

1. Bhandari V, “Design of Machine Elements”, 3rd Edition, Tata McGraw-Hill Book Co, 2010.

REFERENCES:

1. Sundararajamoorthy T. V, Shanmugam .N, "Machine Design", Anuradha Publications, Chennai, 2003.
2. Joseph Shigley,Charles Mischke,Richard Budynas and Keith Nisbett “Mechanical Engineering Design”, 8th Edition, Tata McGraw-Hill, 2008.
3. Gitin Maitra,L. Prasad “Hand book of Mechanical Design”, 2nd Edition, Tata McGraw-Hill, 2001.
4. Prabhu. T.J., “Design of Transmission Elements”, Mani Offset, Chennai, 2000.
5. C.S.Sharma, Kamlesh Purohit, “Design of Machine Elements”, Prentice Hall of India, Pvt. Ltd., 2003.
6. Bernard Hamrock,Steven Schmid,Bo Jacobson, “Fundamentals of Machine Elements”, 2nd Edition, Tata McGraw-Hill Book Co., 2006.
7. Robert C. Juvinall and Kurt M. Marshek, “Fundamentals of Machine Design”,4th Edition, Wiley, 2005
8. Alfred Hall, Halowenko, A and Laughlin, H., “Machine Design”, Tata McGraw-Hill Book Co.(Schaum’s Outline), 2010
9. Orthwein W, “Machine Component Design”, Jaico Publishing Co, 2003.
10. Ansel Ugural, “Mechanical Design – An Integral Approach, 1st Edition, Tata McGraw-Hill Book Co, 2003.
11. Merhyle F. Spotts, Terry E. Shoup and Lee E. Hornberger, “Design of Machine Elements” 8th Edition, Printice Hall, 2003.

STANDARDS:

1. IS 4460 : Parts 1 to 3 : 1995, Gears – Spur and Helical Gears – Calculation of Load Capacity.

2. IS 7443 : 2002, Methods of Load Rating of Worm Gears
3. IS 15151: 2002, Belt Drives – Pulleys and V-Ribbed belts for Industrial applications – PH, PJ, PK, Pl and PM Profiles : Dimensions
4. IS 2122 : Part 1: 1973, Code of practice for selection, storage, installation and maintenance of belting for power transmission : Part 1 Flat Belt Drives.
5. IS 2122: Part 2: 1991, Code of practice for selection, storage, installation and maintenance of belting for power transmission: Part 2 V-Belt Drives.

PTME8602 HEAT AND MASS TRANSFER L T P C
3 0 0 3

OBJECTIVES:

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

UNIT I CONDUCTION 8+3

General Differential equation of Heat Conduction– Cartesian and Polar Coordinates – One Dimensional Steady State Heat Conduction –– plane and Composite Systems – Conduction with Internal Heat Generation – Extended Surfaces – Unsteady Heat Conduction – Lumped Analysis –Semi Infinite and Infinite Solids –Use of Heisler's charts. One dimensional Numerical analysis in conduction.

UNIT II CONVECTION 7+3

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+3

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

UNIT IV RADIATION 9+3

Black Body Radiation – Grey body radiation - Shape Factor – Electrical Analogy – Radiation Shields. Radiation through gases.

UNIT V MASS TRANSFER 6+3

Basic Concepts – Diffusion Mass Transfer – Fick's Law of Diffusion – Steady state Molecular Diffusion – Convective Mass Transfer – Momentum, Heat and Mass Transfer Analogy – Convective Mass Transfer Correlations.

L : 45 , T : 15, TOTAL : 60 PERIODS

OUTCOMES:

- Upon completion of this course, the students can able to understand and apply different heat and mass transfer principles of different applications.

TEXT BOOK:

1. Yunus A. Cengel, Heat Transfer A Practical Approach – Tata McGraw Hill - 2010

REFERENCE BOOKS:

1. Frank P. Incropera and David P. Dewitt, Fundamentals of Heat and Mass Transfer, John Wiley & Sons, 1998.
2. S.P. Venkateshan, Heat Transfer, Ane Books, New Delhi, 2004.
3. Ghoshdastidar, P.S, Heat Transfer, Oxford, 2004,
4. Nag, P.K., Heat Transfer, Tata McGraw Hill, New Delhi, 2002
5. Holman, J.P., Heat and Mass Transfer, Tata McGraw Hill, 2000
6. Ozisik, M.N., Heat Transfer, McGraw Hill Book Co., 1994.
7. Kothandaraman, C.P., Fundamentals of Heat and Mass Transfer, New Age International, New Delhi, 1998.
8. Yadav, R., Heat and Mass Transfer, Central Publishing House, 1995.

PTME8252 POWER PLANT ENGINEERING L T P C
3 0 0 3

OBJECTIVE:

Providing an overview of Power Plants and detailing the role of Mechanical Engineers in their operation and maintenance.

UNIT I COAL BASED THERMAL POWER PLANTS 10

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

UNIT II DIESEL, GAS TURBINE AND COMBINED CYCLE POWER PLANTS 10

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

UNIT III NUCLEAR POWER PLANTS 7

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 10

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

UNIT V ENERGY, ECONOMIC AND ENVIRONMENTAL ISSUES OF POWER PLANTS 8

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

TOTAL: 45 PERIODS

OUTCOMES:

- Upon completion of this course, the students can able to understand different types of power plant, and its functions and their flow lines and issues related to them.
- Analyse and solve energy and economic related issues in power sectors.

TEXT BOOK:

1. Power Plant Engineering, P.K. Nag, Tata McGraw – Hill Publishing Company Ltd., Third Edition, 2008.

REFERENCES:

1. Power Plant Technology, M.M. El-Wakil, Tata McGraw – Hill Publishing Company Ltd., 2010.
2. Power Plant Engineering, Black & Veatch, Springer, 1996.
3. Standard Handbook of Power Plant Engineering, Thomas C. Elliott, Kao Chen and Robert C. Swanekamp, Second Edition, McGraw – Hill, 1998.
4. Renewable energy, Godfrey Boyle, Open University, Oxford University Press in association with the Open University, 2004**.**

PTME8554 MECHATRONICS L T P C
(Common to Mechanical and Manufacturing) 3 0 0 3

OBJECTIVES:

- This syllabus is formed to impart knowledge for the students about the elements and techniques involved in Mechatronics systems which are very much essential to understand the emerging field of automation.

UNIT I INTRODUCTION 12

Introduction to Mechatronics – Systems – Concepts of Mechatronics approach – Need for Mechatronics – Emerging areas of Mechatronics – Classification of Mechatronics.

Sensors and Transducers**:** Static and dynamic Characteristics of Sensor, Potentiometers – LVDT – Capacitance sensors – Strain gauges – Eddy current sensor – Hall effect sensor – Temperature sensors – Light sensors

UNIT II 8085 MICROPROCESSOR 8

Introduction – Architecture of 8085 – Pin Configuration – Addressing Modes –Instruction set, Timing diagram of 8085.

UNIT III PROGRAMMABLE PERIPHERAL INTERFACE 10

Introduction – Architecture of 8255, Keyboard interfacing, LED display –interfacing, ADC and DAC interface, Temperature Control – Stepper Motor Control – Traffic Control interface.

UNIT IV PROGRAMMABLE LOGIC CONTROLLER 7

Introduction – Basic structure – Input and output processing – Programming – Mnemonics – Timers, counters and internal relays – Data handling – Selection of PLC.

UNIT V ACTUATORS AND MECHATRONIC SYSTEM DESIGN 8

Types of Stepper and Servo motors – Construction – Working Principle – Advantages and Disadvantages. Design process-stages of design process – Traditional and Mechatronics design concepts – Case studies of Mechatronics systems – Pick and place Robot – Engine Management system – Automatic car park barrier.

TOTAL : 45 PERIODS

OUTCOMES:

- Upon completion of this course, the students can able to design mechatronics system with the help of Microprocessor, PLC and other electrical and Electronics Circuits.

TEXT BOOKS:

1. Bolton, “Mechatronics”, Printice Hall, 2008
2. Ramesh S Gaonkar, “Microprocessor Architecture, Programming, and Applications with the 8085”, 5th Edition, Prentice Hall, 2008.

REFERENCES:

1. Michael B.Histand and Davis G.Alciatore, “Introduction to Mechatronics and Measurement systems”, McGraw Hill International edition, 2007.
2. Bradley D.A, Dawson D, Buru N.C and Loader A.J, “Mechatronics”, Chapman and Hall, 1993.
3. Smaili.A and Mrad.F , “Mechatronics Integrated Technologies for Intelligent Machines”,Oxford University Press, 2007.
4. Devadas Shetty and Richard A. Kolk, “Mechatronics Systems Design”, PWS publishing company, 2007.
5. Krishna Kant, “Microprocessors & Microcontrollers”, Prentice Hall of India, 2007.

ME8711	PROJECT WORK	L T P C 0 0 9 6

OBJECTIVES:

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

A project topic must be selected by the students in consultation with their guides. The aim of the project work is to deepen comprehension of principles by applying them to a new problem which may be the design and fabrication of a device for a specific application, a research project with a focus on an application needed by the industry/society, a computer project, a management project or a design project.

The progress of the project is evaluated based on a minimum of three reviews. The review committee may be constituted by the Head of the Department. A project report is required at the end of the semester. The project work is evaluated jointly by external and internal examiners constituted by the Head of the Department based on oral presentation and the project report.

OUTCOMES:

- On Completion of the project work students will be in a position to take up any challenging practical problems and find solution by formulating proper methodology.

PTGE8551	ENGINEERING ETHICS AND HUMAN VALUES (Common to CSE, EEE, ECE, Civil, Mechanical, Industrial, Textile, Printing and Automobile)	L T P C 3 0 0 3

OBJECTIVES:

- To enable the students to create an awareness on Engineering Ethics and Human Values, to instill Moral and Social Values and Loyalty and to appreciate the rights of others.

UNIT I HUMAN VALUES 10

Morals, values and Ethics – Integrity – Work ethic – Service learning – Civic virtue – Respect for others – Living peacefully – Caring – Sharing – Honesty – Courage – Valuing time – Cooperation – Commitment – Empathy – Self confidence – Character – Spirituality.

UNIT II ENGINEERING ETHICS 9

Senses of 'Engineering Ethics' – Variety of moral issues – 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

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

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 8

Multinational Corporations – Environmental Ethics – Computer Ethics – Weapons Development – Engineers as Managers – Consulting Engineers – Engineers as Expert Witnesses and Advisors – Moral Leadership – Sample Code of Conduct

TOTAL: 45 PERIODS

OUTCOMES :

- Upon completion of the course, the student should be able to apply ethics in society, discuss the ethical issues related to engineering and realize the responsibilities and rights in the society

TEXTBOOK

1. Mike W. Martin and Roland Schinzinger, "Ethics in Engineering", Tata McGraw Hill, New Delhi, 2003.
2. M.Govindarajan, S.Natarajan and V.S. Senthil Kumar- published by PHI revised edition - 2012

REFERENCES:

1. Charles B. Fleddermann, "Engineering Ethics", Pearson Prentice Hall, New Jersey, 2004.
2. Charles E. Harris, Michael S. Pritchard and Michael J. Rabins, "Engineering Ethics – Concepts and Cases", Thompson Wadsworth, A Division of Thomson Learning Inc., United States, 2000
3. John R Boatright, "Ethics and the Conduct of Business", Pearson Education, New Delhi, 2003
4. Edmund G Seebauer and Robert L Barry, "Fundametals of Ethics for Scientists and Engineers", Oxford University Press, Oxford, 2001

WEB SOURCES:

1. www.onlineethics.org
2. www.nspe.org
3. www.globalethics.org
4. www.ethics.org

PTMA8252 PROBABILITY AND STATISTICS L T P C
(Common to EEE, Textile, Mechanical, Industrial, Printing and Manufacturing) 3 0 0 3

OBJECTIVES:

- To make the students acquire a sound knowledge in statistical techniques that model engineering problems.
- The Students will have a fundamental knowledge of the concepts of probability.

UNIT I RANDOM VARIABLES 9

Discrete and Continuous random variables – Moments – Moment generating functions – Binomial, Poisson, Geometric, Uniform, Exponential, Gamma, Weibull and Normal distributions - Functions of a random variable.

UNIT II TWO-DIMENSIONAL RANDOM VARIABLES 9

Joint distributions – Marginal and Conditional distributions – Covariance – Correlation and Linear regression – Transformation of random variables – Central limit theorem (for independent and identically distributed random variables).

UNIT III TESTS OF SIGNIFICANCE 9

Sampling distributions - Tests for single mean, proportion, Difference of means (large and small samples) – Tests for single variance and equality of variances – $\chi 2$-test for goodness of fit – Independence of attributes – Non-parametric tests: Test for Randomness and Rank-sum test (Wilcoxon test).

UNIT IV DESIGN OF EXPERIMENTS 9

Completely randomized design – Randomized block design – Latin square design - 2^2 - factorial design - Taguchi's robust parameter design.

UNIT V STATISTICAL QUALITY CONTROL 9+3

Control charts for measurements ($\overline{X}$ and R charts) – Control charts for attributes (p, c and np charts) – Tolerance limits - Acceptance sampling.

TOTAL: 45 PERIODS

OUTCOMES :

After successfully completing the course, students should be able to do the following:

- Use statistical methodology and tools in the engineering problem-solving process.
- Compute and interpret descriptive statistics using numerical and graphical techniques.
- Understand the basic concepts of probability, random variables, probability distribution, and joint probability distribution.
- Compute point estimation of parameters, explain sampling distributions, and understand the central limit theorem.

TEXT BOOKS:

1. Milton, J. S. and Arnold, J.C., "Introduction to Probability and Statistics", Tata McGraw Hill, New Delhi, 4th Edition, 3rd Reprint, 2008.
2. Johnson, R.A. and Gupta, C.B., "Miller and Freund's Probability and Statistics for Engineers", Pearson Education, Asia, 8th Edition, 2011.

REFERENCES:

1. Devore, J.L., "Probability and Statistics for Engineering and the Sciences", Thomson Brooks/Cole, International Student Edition, New Delhi, 7th Edition, 2008.
2. Walpole, R.E., Myers, R.H., Myers, S.L. and Ye, K., "Probability and Statisticsfor Engineers and Scientists", Pearson Education, Asia, 8th Edition, 2007.
3. Ross, S.M., "Introduction to Probability and Statistics for Engineers and Scientists", Elsevier,

New Delhi, 3rd Edition, 2004.
4. Spiegel, M.R., Schiller, J. and Srinivasan, R.A., "Schaum's Outline of Theory and Problems of Probability and Statistics", Tata McGraw Hill, New Delhi, 2004.

PTME8001 ADVANCED INTERNAL COMBUSTION ENGINEERING L T P C
3 0 0 3

OBJECTIVE:

- To understand the underlying principles of operation of different IC Engines and components.
- To provide knowledge on pollutant formation, control, alternate fuel etc.

UNIT I SPARK IGNITION ENGINES 9

Mixture requirements – Fuel injection systems – Monopoint, Multipoint & Direct injection - Stages of combustion – Normal and Abnormal combustion – Knock - Factors affecting knock – Combustion chambers.

UNIT II COMPRESSION IGNITION ENGINES 9

Diesel Fuel Injection Systems - Stages of combustion – Knocking – Factors affecting knock – Direct and Indirect injection systems – Combustion chambers – Fuel Spray behaviour – Spray structure and spray penetration – Air motion - Introduction to Turbocharging.

UNIT III POLLUTANT FORMATION AND CONTROL 9

Pollutant – Sources – Formation of Carbon Monoxide, Unburnt hydrocarbon, Oxides of Nitrogen, Smoke and Particulate matter – Methods of controlling Emissions – Catalytic converters, Selective Catalytic Reduction and Particulate Traps – Methods of measurement – Emission norms and Driving cycles.

UNIT IV ALTERNATIVE FUELS 9

Alcohol, Hydrogen, Compressed Natural Gas, Liquefied Petroleum Gas and Bio Diesel - Properties, Suitability, Merits and Demerits - Engine Modifications.

UNIT V RECENT TRENDS 9

Air assisted Combustion, Homogeneous charge compression ignition engines – Variable Geometry turbochargers – Common Rail Direct Injection Systems - Hybrid Electric Vehicles – NO_x Adsorbers - Onboard Diagnostics.

TOTAL : 45 PERIODS

OUTCOME:

- Upon completion of this course, the students can able to compare the operations of different IC Engine and components and can evaluate the pollutant formation, control, alternate fuel

TEXT BOOKS:

1.K.K. Ramalingam, Internal Combustion Engine Fundamentals, Scitech Publications, 2002.
2.Ganesan, Internal Combustion Engines, II Edition, TMH, 2002.

REFERENCES:

1. R.B. Mathur and R.P. Sharma, Internal Combustion Engines., Dhanpat Rai & Sons 2007.
2. Duffy Smith, Auto Fuel Systems, The Good Heart Willcox Company, Inc., 1987.
3. Eric Chowenitz, Automobile Electronics, SAE Publications, 1995.

PTME8002 AUTOMOBILE ENGINEERING L T P C
3 0 0 3

OBJECTIVE:
To provide a first course of teaching such that the learners are able to visualise the scope of Automobile Engineering.

UNIT I INTRODUCTON TO AUTOMOTIVES 10
An overview of different types of automobiles and their power sources.Specifications, Performance Parameters, Quality standards, Trends in automobile design.

UNIT II POWER SOURCE FEATURES 10
Reciprocating Engine systems, Rotary Engine systems, Gas Turbine systems, Hybrid systems. Pollutant emissions and their control; Catalytic converter systems, Electronic Engine Management systems.

UNIT III TRANSMISSION, SUSPENSION AND BREAKING SYSTEMS 10
Clutch system, Gear box system, propeller shafting, differential, axles, wheels and tyres and prelimineries of suspension systems

UNIT IV OTHER AUXILIARY SYSTEMS 10
Electrical and electronic systems, safety systems, Heating, Ventilation, and Air Conditioning (HVAC) systems, Vehicle Thermal Management System and vehicle body design features.

UNIT V TESTS, SERVICE AND MAINTENANCE 5
Engine Tuning, vehicle maintenance, engine and Chassis Dynamometry Pollutants and emissions check, Wind Tunnel Tests, preliminaries of engine and vehicle testing.

TOTAL: 45 PERIODS

OUTCOMES:
- Upon completion of this course, the students will be able to identify the different components in automobile engineering.
- Have clear understanding on different auxiliary and transmission systems usual.

TEXT BOOK:
1. Automotive Mechanics, William H. Course and Donals L. Anglin,Tata McGraw – Hill Publishing Company Ltd., 2004, Tenth Edition.

REFERENCES:
1. Automotive Handbook, Bosch, Robert Bosch GmbH, Germany, 2004, Sixth Edition.
2. Automotive Technology – A Systems Approach, Jack Erjavek, Thomson Learning, 3rd Edition, 1999.

PTME8003 CASTING AND WELDING PROCESSES L T P C
3 0 0 3

OBJECTIVE:
- The objective of the course is to impart knowledge on Design of Gating system for castings, Foundry Practice of Ferrous, Non Ferrous alloys, Foundry Mechanisation Welding Processes and Welding Metallurgy.

UNIT I DESIGN OF GATING SYSTEM 11

Gating System design pouring Time – Choke Area – Sprue – Other gating elements – Risering design - Caines – modulus – Naval research Laboratory method – feeding distances – Chills feeding Aids – design of Castings.

UNIT II FERROUS AND NON FERROUS CASTINGS 10

Steel Casting – The family of cast iron – melting of steels and cast irons – Grey iron foundry practice – Ductile iron – Malleable Iron casting design – Considerations Aluminium ,Magnesium,Copper,Zinc. ,Duplex Stainless Steel and Titanium alloys foundry practice.

UNIT III FOUNDRY MECHANISATION 8

Mechanical equipments in foundry – plant site location, layout – Plant Engineering – Maintenance – Services – Practical aspects.

UNIT IV WELDING PROCESS AND TECHNOLOGY 8

Friction Welding Process – effect of speed and pressure – explosive welding – plasma arc welding – Electon beam welding – High frequency induction welding - Laser beam weding.

UNIT V WELDING METALLURGY 8

Weld thermal cycles – Heat Affected Zone(HAZ) – Weldability of steels – Cast Iron – Stainless steel,aluminium – Copper and Titanium alloys – Hydrogen embrittlement – Pro and post weld heat Treatments – weld defects – Testing of Welds.

TOTAL: 45 PERIODS

OUTCOMES:

- Upon completion of this course, the students can able to compare different types of casting and welding process for effective casting and Welding of Structural components.

TEXT BOOK:

1. P.N.Rao , Manufacturing Technology , Tata McGraw Hill, 2008.

REFERENCES:

1. Heine , Loper and Rosenthal, Principles of Metal Casting ,Tata McGraw Hill,2001
2. A.K.Chakrabarti, Casting Technology and Cast Alloys, Prentice –Hall Of India Ltd, 2005
3. T.V.Rama Rao, Metal casting Principles and Practice, New Age International,2010
4. R.S Parmar, Welding Engineering and Technology, Khanna Publishers,2002

PTME8004 COMPOSITE MATERIALS AND MECHANICS L T P C
3 0 0 3

OBJECTIVES

- To understand the fundamentals of composite material strength and its mechanical behavior Understanding the analysis of fiber reinforced Laminate design for different
- To understand fabrication and properties of different composites
- Combinations of plies with different orientations of the fiber.
- Thermo-mechanical behavior and study of residual stresses in Laminates during processing. Implementation of Classical Laminate Theory (CLT) to study and analysis for residual stresses in an isotropic layered structure such as electronic chips.

UNIT I INTRODUCTION TO COMPOSITE MATERIALS 10

Definition-Matrix materials-polymers-metals-ceramics - Reinforcements: Particles, whiskers, inorganic fibers, metal filaments- ceramic fibers- fiber fabrication- natural composite wood, Jute - Advantages and drawbacks of composites over monolithic materials. Mechanical properties and applications of composites, Particulate-Reinforced composite Materials, Dispersion-Strengthened composite, Fiber-reinforced composites Rule of mixtures-Characteristics of fiber-Reinforced composites, Manufacturing fiber and composites,

UNIT II PROCESSING OF COMPOSITES 10

Processing of PMCs-handlay-up, spray technique, filament winding,Pultrusion,RTM, bag molding, injection moulding,SMC -Processing of MMCs-solid state, liquid state,vapour state processing, Processing of CMCs –hot pressing-reaction bonding process-infiltration technique, direct oxidation- interfaces

UNIT III INTRODUCTION, LAMINA CONSTITUTIVE EQUATIONS 12

Lamina Constitutive Equations: Lamina Assumptions – Macroscopic Viewpoint. Generalized Hooke's Law. Reduction to Homogeneous Orthotropic Lamina – Isotropic limit case, Orthotropic Stiffness matrix (Q_{ij}), Definition of stress and Moment Resultants. Strain Displacement relations. Basic Assumptions of Laminated anisotropic plates. Laminate Constitutive Equations – Coupling Interactions, Balanced Laminates, Symmetric Laminates, Angle Ply Laminates, Cross Ply Laminates. Laminate Structural Moduli.

Evaluation of Lamina Properties from Laminate Tests. Quasi-Isotropic Laminates. Determination of Lamina stresses within Laminates.

UNIT IV LAMINA STRENGTH ANALYSIS 5

Introduction - Maximum Stress and Strain Criteria. Von-Misses Yield criterion for Isotropic Materials. Generalized Hill's Criterion for Anisotropic materials. Tsai-Hill's Failure Criterion for Composites. Tensor Polynomial (Tsai-Wu) Failure criterion. Prediction of laminate Failure

UNIT V THERMAL ANALYSIS 8

Assumption of Constant Co-efficient of Thermal Expansion (C.T.E.) - Modification of Hooke's Law. Modification of Laminate Constitutive Equations. Orthotropic Lamina C.T.E's. C.T.E's for special Laminate Configurations – Unidirectional, Off-axis, Symmetric Balanced Laminates, Zero C.T.E laminates, Thermally Quasi-Isotropic Laminates

TOTAL: 45 PERIODS

OUTCOMES:

- Upon completion of this course, the students can able to analyse the fiber reinforced Laminate for optimum design
- Apply classical laminate theory to study and analyse the residual stresses in Laminate.

TEXT BOOKS:

1. Gibson, R.F., Principles of Composite Material Mechanics, McGraw-Hill, Second Edition - CRC press in progress, 1994
2. Krishnan K.Chawla , Composite Materials:Science and Engineering, Springer, Second Edition, 2008

REFERENCES:

1. Hyer, M.W., "Stress Analysis of Fiber – Reinforced Composite Materials", McGraw-Hill, 1998
2. Issac M. Daniel and Ori Ishai, "Engineering Mechanics of Composite Materials", Oxford University Press-2006, First Indian Edition - 2007

3. Mallick, P.K., Fiber –"Reinforced Composites: Materials, Manufacturing and Design", Maneel Dekker Inc, 1993.
4. Halpin, J.C., "Primer on Composite Materials, Analysis", Techomic Publishing Co., 1984.
5. Agarwal, B.D., and Broutman L.J., "Analysis and Performance of Fiber Composites", John Wiley and Sons, New York, 1990.
6. Mallick, P.K. and Newman, S., (edition), "Composite Materials Technology: Processes and Properties", Hansen Publisher, Munish, 1990.

PTME8005 DESIGN OF HEAT EXCHANGERS L T P C
3 0 0 3

OBJECTIVES:

- To learn the thermal and stress analysis on various parts of the heat exchangers
- To analyze the sizing and rating of the heat exchangers for various applications

UNIT I INTRODUCTION 9

Types of heat exchangers, shell and tube heat exchangers – regenerators and recuperators - Temperature distribution and its implications - Parts description, Classification as per Tubular Exchanger Manufacturers Association (TEMA)

UNIT II PROCESS DESIGN OF HEAT EXCHANGERS 9

Heat transfer correlations, Overall heat transfer coefficient, analysis of heat exchangers – LMTD and effectiveness method. Sizing of finned tube heat exchangers, U tube heat exchangers, Design of shell and tube heat exchangers, fouling factors, pressure drop calculations.

UNIT III STRESS ANALYSIS 9

Stress in tubes – header sheets and pressure vessels – thermal stresses, shear stresses - types of failures, buckling of tubes, flow induced vibration.

UNIT IV COMPACT AND PLATE HEAT EXCHANGER 9

Types- Merits and Demerits- Design of compact heat exchangers, plate heat exchangers, performance influencing parameters, limitations.

UNIT V CONDENSERS AND COOLING TOWERS 9

Design of surface and evaporative condensers – cooling tower – performance characteristic.

TOTAL: 45 PERIODS

OUTCOMES:

- Upon completion of this course, the students can able to apply the mathematical knowledge for thermal and stress analysis on various parts of the heat exchangers components.

TEXT BOOKS:

1. SadikKakac and Hongtan Liu, Heat Exchangers Selection, Rating and Thermal Design, CRC Press, 2002.
2. Shah,R. K., Dušan P. Sekulić, Fundamentals of heat exchanger design, John Wiley & Sons,2003.

REFERENCES:

1. Robert W. Serth, Process heat transfer principles and applications, Academic press, Elesevier, 2007.
2. Sarit Kumar Das, Process heat transfer, Alpha Science International, 2005

3. John E. Hesselgreaves,Compact heat exchangers: selection, design, and operation, Elsevier science Ltd, 2001.
4. T. Kuppan, Heat exchanger design hand book, New York : Marcel Dekker, 2000.
5. Eric M. Smith, Advances in thermal design of heat exchangers: a numerical approach: direct-sizing, step-wise rating, and transients, John Wiley & Sons, 1999.
6. Arthur. P Frass, Heat Exchanger Design, John Wiley & Sons, 1989

PTME8006 DESIGN OF PRESSURE VESSELS AND PIPING L T P C
3 0 0 3

OBJECTIVES:

- To understand the Mathematical knowledge to design pressure vessels and piping
- To understand the ability to carry of stress analysis in pressure vessels and piping

UNIT I INTRODUCTION 3

Methods for determining stresses – Terminology and Ligament Efficiency – Applications.

UNIT II STRESSES IN PRESSURE VESSELS 15

Introduction – Stresses in a circular ring, cylinder –Dilation of pressure vessels, Membrane stress Analysis of Vessel – Cylindrical, spherical and, conical heads – Thermal Stresses – Discontinuity stresses in pressure vessels.

UNIT III DESIGN OF VESSELS 15

Design of Tall cylindrical self supporting process columns – Supports for short vertical vessels – Stress concentration at a variable Thickness transition section in a cylindrical vessel, about a circular hole, elliptical openings. Theory of Reinforcement – Pressure Vessel Design.

UNIT IV BUCKLING AND FRACTURE ANALYSIS IN VESSELS 8

Buckling phenomenon – Elastic Buckling of circular ring and cylinders under external pressure – collapse of thick walled cylinders or tubes under external pressure – Effect of supports on Elastic Buckling of Cylinders – Buckling under combined External pressure and axial loading.

UNIT V PIPING 4

Introduction – Flow diagram – piping layout and piping stress Analysis.

TOTAL: 45 PERIODS

OUTCOMES:

- Upon completion of this course, the students can able to apply the mathematical fundamental for the design of pressure vessels and pipes. Further they can able to analyse and design of pressure vessels and piping.

TEXT BOOK:

1. John F. Harvey, Theory and Design of Pressure Vessels, CBS Publishers and Distributors, 1987.

REFERENCES

1. Henry H. Bedner, “Pressure Vessels, Design Hand Book, CBS publishers and Distributors, 1987.
2. Stanley, M. Wales, “Chemical process equipment, selection and Design. Buterworths series in Chemical Engineering, 1988.

3. William. J., Bees, “Approximate Methods in the Design and Analysis of Pressure Vessels and Piping”, Pre ASME Pressure Vessels and Piping Conference, 1997.
4. Sam Kannapan, “Introduction to Pipe Stress Analysis”. John Wiley and Sons, 1985.

PTME8007 GAS DYNAMICS AND SPACE PROPULSION L T P C
3 0 0 3

OBJECTIVES:

- To understand the differences between incompressible and compressible flow.
- To understand the phenomenon of shock waves and its effect on flow.
- To gain basic knowledge about jet propulsion and rocket propulsion.

UNIT I BASIC CONCEPTS AND ISENTROPIC FLOWS 9

Energy and momentum equations of compressible fluid flows – isentropic flow - mach waves and mach cone. Flow regimes, effect of Mach number on compressibility. Stagnation, static, critical properties and their interelationship. Isentropic flow through variable area ducts – nozzles and diffusers. Use of Gas tables.

UNIT II FLOW THROUGH DUCTS 6

Flows through constant area ducts with heat transfer (Rayleigh flow) and Friction (Fanno flow) – variation of flow properties. Use of tables and charts.

UNIT III NORMAL AND OBLIQUE SHOCKS 10

Governing equations - Rankine-Hugoniot Relation. Variation of flow parameters across the normal and oblique shocks. Prandtl – Meyer expansion and relation. Use of table and charts.

UNIT IV JET PROPULSION 10

Theory of jet propulsion – thrust equation – thrust power and propulsive efficiency. Operation, cycle analysis and performance of ram jet, turbojet, turbofan and turbo prop engines.

UNIT V SPACE PROPULSION 10

Types of rocket engines and propellants. Characteristic velocity. Theory of single and multistage rocket propulsion. Liquid fuel feeding systems. Solid propellant geometries. Space flights – orbital and escape velocity. Rocket performance calculations.

TOTAL: 45 PERIODS

OUTCOMES:

- Upon completion of this course, the students can able to successfully apply gas dynamics principles in the Jet and Space Propulsion

TEXT BOOKS:

1. Anderson, J.D., Modern Compressible flow, McGraw Hill, 2004.
2. S.M. Yahya, Fundamentals of Compressible Flow with Aircraft and Rocket propulsion, New Age International (P) Limited, 4th Edition, 2010.
3. Saravanamutto HIH, Cohen H., Rogers CEC. & Straznicky PV, Gas Turbine Theory, 6th Edition, Printice Hall, 2009..
4. Sutton, G.P. Rocket Propulsion Elements, John wiley, 2010, New York

REFERENCES:

1. Radhakrishnan, E., Gas Dynamics, Printice Hall of India, 2008

2. Shapiro, Dynamics and Thermodynamics of Compressible fluid Flow, , John wiley, 1953.
3. Hill and Peterson, Mechanics and Thermodynamics of Propulsion, Addison – Wesley, 1992.
4. Zucrow, N.J., Aircraft and Missile Propulsion, vol.1 & II, John Wiley, 1975

ME8008 MARKETING MANAGEMENT L T P C
3 0 0 3

OBJECTIVE:

• To understand the various processes involved in Marketing and its Philosophy.
• To learn the Psychology of consumers.
• To formulate strategies for advertising, pricing and selling

UNIT I MARKETING PROCESS 9

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

UNIT II BUYING BEHAVIOUR AND MARKET SEGMENTATION 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

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

UNIT IV PLANNING AND STRATEGY FORMULATION 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

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: 45 PERIODS

OUTCOMES :

- The learning skills of Marketing will enhance the knowledge about Marketer's Practices and create insights on Advertising, Branding, Retailing and Marketing Research.

TEXT BOOKS:

1. Govindarajan. M, "Marketing management – concepts, cases, challenges and trends", Prentice hall of India, second edition 2007.
2. Philip Kolter,Koshy Jha "Marketing Management", Pearson Education ,Indian adapted edition.2007

REFERENCES:

1. Ramasamy and Nama kumari, "Marketing Environment: Planning, implementation and control the Indian context", 1990.
2. Czinkota&Kotabe, "Marketing management", Thomson learning, Indian edition 2007

3. Adrain palmer, " Introduction to marketing theory and practice", Oxford university press IE 2004.
4. Donald S. Tull and Hawkins, "Marketing Reasearch", Prentice Hall of Inida-1997.
5. Philip Kotler and Gary Armstrong "Principles of Marketing" Prentice Hall of India, 2000.
6. Steven J.Skinner, "Marketing", All India Publishers and Distributes Ltd. 1998.
7. Graeme Drummond and John Ensor, Introduction to marketing concepts, Elsevier, Indian Reprint, 2002

PH8009 MATERIALS SCIENCE L T P C
(Common to Manufacturing, Industrial, Mining, Mechanical, Aeronautical, Automobile and Production Engineering) 3 0 0 3

OBJECTIVE:

To introduce the essential principles of materials science for mechanical and related Engineering applications.

UNIT I MECHANICAL PROPERTIES 9

Introduction to mechanical properties - tensile test - plastic deformation mechanisms - slip and twinning - role of dislocations in slip - strengthening methods - strain hardening - refinement of the grain size - solid solution strengthening - precipitation hardening - creep resistance - creep curves - mechanisms of creep - creep-resistant materials - fracture - the Griffith criterion - critical stress intensity factor and its determination - fatigue failure - fatigue tests - methods of increasing fatigue life - hardness - Rockwell and Brinell hardness - Knoop and Vickers microhardness.

UNIT II PHASE DIAGRAMS 9

Solid solutions - Hume Rothery's rules - free energy of solid solution - intermediate phases - The phase rule - single component system - one-component system of iron - binary phase diagrams - isomorphous systems - the tie-line rule - the level rule - application to isomorphous system - eutectic phase diagram - peritectic phase diagram - other invariant reactions - microstructural change during cooling.

UNIT III FERROUS ALLOYS AND HEAT TREATMENT 9

The iron-carbon equilibrium diagram - phases, invariant reactions - microstructue of slowly cooled steels - eutectoid steel, hypo and hypereutectoid steels - effect of alloying elements on the Fe-C system - diffusion in solids - Fick's law - phase transformations - pearlitic transformations - T-T-T-diagram for eutectoid steel - baintic and martensitic transformations - tempering of martensite - heat treatment of steels - annealing - normalizing - quenching and tempering - case hardening - induction, flame and laser hardening - carburizing, cyaniding, carbonitriding and nitriding.

UNIT IV ELECTRONIC MATERIALS 9

Classification of solids - energy bands - concept of Fermi level - conductor, semiconductor, insulator - Semiconductors: intrinsic, extrinsic - carrier concentration expression (qualitative) - compound semiconductors (qualitative) - dielectric materials - polarization mechanisms - dielectric breakdown - magnetic materials - ferromagnetic materials &hysterisis - ferrites - superconducting materials, properties, types and applications.

UNIT V NEW MATERIALS AND APPLICATIONS 9

Introduction to Ceramics and its applications - Ceramic Fibres - Fibre reinforced Plastics – Fibre reinforced Metal – Metallic glasses – Shape memory alloys – Copper base alloys – Nickel – Titanium alloys – Relaxor- Ferroelectric materials – Electro and magneto rheological fluids - Sensors and Actuators – polymer semiconductos – photoconducting polymers – liquid crystals - Bio-sensors - Scintillation detectors (Position sensitive) –Bio materials – hydroxyapatite – PMMA – Silicone.

TOTAL: 45 PERIODS

OUTCOMES:

- Upon completion of this course, the students can able to apply the different materials, their processing, and heat treatments in suitable application in mechanical engineering fields

TEXT BOOKS:

1. Raghavan, V., Materials Science and Engineering, Prentice Hall of India, 2007.
2. Palanisamy, P.K., Applied Materials Science, Scitech, 2003.
3. Raghavan, V., Physical Metallurgy, Prentice Hall of India, 2002.

REFERENCE BOOKS:

1. Calister, W.D., Materials Science and Engineering an Introduction, John Wiley, 2003.
2. Rajendarn V and Marikani A, Materials Science, Tata McGraw Hill, 2006

PTME8010 MECHANICAL VIBRATION AND NOISE CONTROL L T P C
3 0 0 3

OBJECTIVE:

- The student will be able to understand the sources of vibration and noise in automobiles and make design modifications to reduce the vibration and noise and improve the life of the components

UNIT I BASICS OF VIBRATION 9

Introduction, classification of vibration: free and forced vibration, undamped and damped vibration, linear and non linear vibration, response of damped and undamped systems under harmonic force, analysis of single degree and two degree of freedom systems, torsional vibration, determination of natural frequencies.

UNIT II BASICS OF NOISE 9

Introduction, amplitude, frequency, wavelength and sound pressure level, addition, subtraction and averaging decibel levels, noise dose level, legislation, measurement and analysis of noise, measurement environment, equipment, frequency analysis, tracking analysis, sound quality analysis.

UNIT III AUTOMOTIVE NOISE SOURCES 9

Noise Characteristics of engines, engine overall noise levels, assessment of combustion noise, assessment of mechanical noise, engine radiated noise, intake and exhaust noise, engine necessary contributed noise, transmission noise, aerodynamic noise, tire noise, brake noise.

UNIT IV CONTROL TECHNIQUES 9

Vibration isolation, tuned absorbers, un-tuned viscous dampers, damping treatments, application dynamic forces generated by IC engines, engine isolation, crank shaft damping, modal analysis of the mass elastic model shock absorbers.

UNIT V SOURCE OF NOISE AND CONTROL 9

Methods for control of engine noise, combustion noise, mechanical noise, predictive analysis, palliative treatments and enclosures, automotive noise control principles, sound in enclosures, sound energy absorption, sound transmission through barriers

TOTAL: 45 PERIODS

OUTCOMES:

- Understanding causes, source and types of vibrations in machineries
- Gaining knowledge in sources and measurement standard of noise
- Ability to design and develop vibrations and noise control systems.

TEXT BOOKS:

1. Singiresu S.Rao - "Mechanical Vibrations", 5th Edition, Pearson Education, 2010

REFERENCES:

1. Benson H. Tongue, "Principles of Vibrations", 2nd Edition, Oxford University, 2007
2. David Bies and Colin Hansen, "Engineering Noise Control – Theory and Practice",4th Edition, E and FN Spon, Taylore& Francise e-Library, 2009
3. William T. Thomson, Marie Dillon Dahleh, Chandramouli Padmanabhan, "Theory of Vibration with Application", 5th edition Pearson Education, 2011
4. Grover. G.T., "Mechanical Vibrations", Nem Chand and Bros., 1996
5. Bernard Challen and Rodica Baranescu - "Diesel Engine Reference Book" – Second Edition - SAE International - ISBN 0-7680-0403-9 – 1999.
6. Julian Happian-Smith - "An Introduction to Modern Vehicle Design"- Butterworth-Heinemann, ISBN 0750-5044-3 – 2004
7. Rao, J.S and Gupta, K., "Introductory course on Theory and Practice of Mechanical Vibration", 2nd Edition, New Age International Publications, 2010
8. A.A. Shabana, "Theory of vibrations – An introduction", 2nd Edition, Springer, 2010
9. Balakumar Balachandran and Edward B. Magrab, "Fundamentals of Vibrations", 1st Editon, Cengage Learning, 2009
10. John Fenton, "Handbook of Automotive body Construction and Design Analysis – Professional Engineering Publishing, ISBN 1-86058-073- 1998.

PTME8011 NEW AND RENEWABLE SOURCES OF ENERGY L T P C
3 0 0 3

OBJECTIVE:

At the end of the course, the students are expected to identify the new methodologies / technologies for effective utilization of renewable energy sources.

UNIT I INTRODUCTION 9

World Energy Use – Reserves of Energy Resources – Environmental Aspects of Energy Utilisation – Renewable Energy Scenario in Tamilnadu, India and around the World - Potentials - Achievements / Applications – Economics of renewable energy systems.

UNIT II SOLAR ENERGY 9

Solar Radiation – Measurements of Solar Radiation - Flat Plate and Concentrating Collectors – Solar direct Thermal Applications – Solar thermal Power Generation - Fundamentals of Solar Photo Voltaic Conversion – Solar Cells – Solar PV Power Generation – Solar PV Applications.

UNIT III WIND ENERGY 9

Wind Data and Energy Estimation – Types of Wind Energy Systems – Performance - Site Selection – Details of Wind Turbine Generator – Safety and Environmental Aspects

UNIT IV BIO - ENERGY 9

Biomass direct combustion – Biomass gasifiers – Biogas plants – Digesters – Ethanol production – Bio diesel – Cogeneration - Biomass Applications

UNIT V OTHER RENEWABLE ENERGY SOURCES 9

Tidal energy – Wave Energy – Open and Closed OTEC Cycles – Small Hydro-Geothermal Energy – Hydrogen and Storage - Fuel Cell Systems – Hybrid Systems.

TOTAL : 45 PERIODS

OUTCOMES:

- Upon completion of this course, the students can able to identify the new methodologies / technologies for effective utilization of renewable energy sources.

TEXT BOOKS:

1. G.D. Rai, Non Conventional Energy Sources, Khanna Publishers, New Delhi, 2011.
2. Twidell, J.W. & Weir, A., Renewable Energy Sources, EFN Spon Ltd., UK, 2006.

REFERENCES:

1. S.P. Sukhatme, Solar Energy, Tata McGraw Hill Publishing Company Ltd., New Delhi, 1997.
2. Godfrey Boyle, Renewable Energy, Power for a Sustainable Future, Oxford University Press, U.K., 1996.
3. G.N. Tiwari, Solar Energy – Fundamentals Design, Modelling& Applications, Narosa Publishing House, New Delhi, 2002.
4. L.L. Freris, Wind Energy Conversion Systems, Prentice Hall, UK, 1990.
5. Johnson Gary, L. Wind Energy Systems, Prentice Hall, New York, 1985
6. David M. Mousdale – Introduction to Biofuels, CRC Press, Taylor & Francis Group, USA 2010
7. Chetan Singh Solanki, Solar Photovoltaics, Fundamentals, Technologies and Applications, PHI Learning Private Limited, New Delhi 2009.

PTME8012 NON-TRADITIONAL MACHINING PROCESSES L T P C
3 0 0 3

OBJECTIVES:

- To understand material removal by using various forms of energy and machining new materials and complex parts with high accuracy by using non-traditional machining.

UNIT I INTRODUCTION 7

Need of Non-Traditional Machining Processes – Classification Based on Energy, Mechanism, source of energy, transfer media and process - Process selection-Based on Physical Parameters, shapes to be machined, process capability and economics – Overview of all processes.

UNIT II MECHANICAL PROCESS 10

Ultrasonic Machining: Principle- Transducer types – Concentrators - Abrasive Slurry - Process Parameters – Tool Feed Mechanism – Advantages and Limitations – Applications. Abrasive Jet Machining: Process- Principle – Process Variables – Material Removal Rate - Advantages and Limitations – Applications. Water Jet Machining: Principle – Process Variables - Advantages and Limitations – Practical Applications – Abrasive water jet machining process.

UNIT III ELECTRICAL DISCHARGE MACHINING 10

Electrical Discharge Machining: Mechanism of metal removal – Dielectric Fluid – Flushing methods - Electrode Materials - Spark Erosion Generators – Electrode Feed System – Material Removal Rate – Process Parameters – Tool Electrode Design – Tool wear Characteristics of Spark Eroded Surfaces- Advantages and Limitations – Practical Applications. Electrical Discharge Wire Cut and Grinding: Principle – Wire Feed System - Advantages and Limitations – Practical Applications

UNIT IV CHEMICAL AND ELECTRO CHEMICAL MACHINING 10

Chemical Machining: fundamentals, Principle –classification and selection of Etchant -chemical milling, Engraving, Blanking - Advantages and limitations – Applications. Electro Chemical Machining: Electro-chemistry of the process-Electrolytes - Electrolyte and their Properties – Material Removal Rate – Tool Material – Tool Feed System – Design For Electrolyte Flow – Process Variables - Advantages and Limitations – Applications - Electro Chemical Grinding: Honing, cutting off, Deburring and turning.

UNIT V HIGH ENERGY MACHINING PROCESS 8

Electron Beam Machining: Principle –Generation and control of electron beam-Advantages and Limitations – Applications. Laser Beam Machining: Principle –Solid and Gas Laser Application – Thermal Features of LBM - Advantages and Limitations – Applications. Ion Beam Machining: Equipment – process characteristics - Advantages and Limitations – Applications. Plasma Arc Machining: Principle –Gas mixture– Types of Torches – Process Parameters - Advantages and Limitations – Applications. Ion Beam Machining – Principle – MRR – advantages, limitation, applications.

TOTAL : 45 PERIODS

OUTCOMES:

- Upon completion of this course, the students can able to demonstrate different unconventional machining processes and know the influence of difference process parameters on the performance and their applications.

TEXT BOOKS:

1. P.C Pandey And H.S. Shan, “Modern Machining Process”, Tata Mc Graw – Hill Publishing Company Limited, New Delhi, 2007
2. V.K. Jain, “ Advanced Machining Process”, Allied Publishers Pvt Limited 2007

REFERENCES:

1. Amithaba Bhattacharyya , “New Technology”, The Institution Of Engineers , (India) “Production Technology”, HMT Bangalore, Tata Mc Graw–Hill Publishing Company Limited, New Delhi, 2006.
2. Hassan El – Hofy “Advanced machining Processes” MC Graw-Hill, 2005.

PTME8013 NONDESTRUCTIVE MATERIALS EVALUATION L T P C
3 0 0 3

OBJECTIVE:
To study and understand the various Non Destructive Evaluation and Testing methods, theory and their industrial applications.

UNIT I OVERVIEW OF NDT 7
NDT Versus Mechanical testing, Overview of the Non Destructive Testing Methods for the detection of manufacturing defects as well as material characterisation. Relative merits and limitations, Various physical characteristics of materials and their applications in NDT., Visual inspection – Unaided and aided.

UNIT II SURFACE NDE METHODS 8
Liquid Penetrant Testing - Principles, types and properties of liquid penetrants, developers, advantages and limitations of various methods,Testing Procedure, Interpretation of results. Magnetic Particle Testing- Theory of magnetism, inspection materials Magnetisation methods, Interpretation and evaluation of test indications, Principles and methods of demagnetization, Residual magnetism.

UNIT III THERMOGRAPHY AND EDDY CURRENT TESTING (ET) 10
Thermography- Principles, Contact and non contact inspection methods, Techniques for applying liquid crystals, Advantages and limitation - infrared radiation and infrared detectors, Instrumentations and methods, applications.
Eddy Current Testing-Generation of eddy currents, Properties of eddy currents, Eddy current sensing elements, Probes, Instrumentation, Types of arrangement , Applications, advantages, Limitations, Interpretation/Evaluation.

UNIT IV ULTRASONIC TESTING (UT) AND ACOUSTIC EMISSION (AE) 10
Ultrasonic Testing-Principle, Transducers, transmission and pulse-echo method, straight beam and angle beam, instrumentation, data representation, A/Scan, B-scan, C-scan. Phased Array Ultrasound, Time of Flight Diffraction.
Acoustic Emission Technique –Principle, AE parameters, Applications.

UNIT V RADIOGRAPHY (RT) 10
Principle, interaction of X-Ray with matter, imaging, film and film less techniques, types and use of filters and screens, geometric factors, Inverse square, law, characteristics of films - graininess, density, speed, contrast, characteristic curves, Penetrameters, Exposure charts, Radiographic equivalence. Fluoroscopy- Xero-Radiography, Computed Radiography, Computed Tomography

TOTAL : 45 PERIODS

OUTCOMES:
- Upon completion of this course, the students can able to use the various Non Destructive Testing and Testing methods understand for defects and characterization of industrial components

TEXT BOOKS:

1. Baldev Raj, T.Jayakumar, M.Thavasimuthu “Practical Non-Destructive Testing”, Narosa Publishing House, 2009.
2. Ravi Prakash, “Non-Destructive Testing Techniques”, New Age International Publishers, 1st revised edition, 2010

REFERENCES:

1. ASM Metals Handbook,"Non-Destructive Evaluation and Quality Control", American Society of Metals, Metals Park, Ohio, USA, 200, Volume-17.
2. Paul E Mix, “Introduction to Non-destructive testing: a training guide”, Wiley, 2nd edition New Jersey, 2005
3. Charles, J. Hellier,“ Handbook of Nondestructive evaluation”, McGraw Hill, New York 2001.
4. ASNT, American Society for Non Destructive Testing, Columbus, Ohio, NDT Handbook, Vol. 1, Leak Testing, Vol. 2, Liquid Penetrant Testing, Vol. 3, Infrared and Thermal Testing Vol. 4, Radiographic Testing, Vol. 5, Electromagnetic Testing, Vol. 6, Acoustic Emission Testing, Vol. 7, Ultrasonic Testing

PTME8014 REFRIGERATION AND AIR CONDITIONING L T P C
3 0 0 3

OBJECTIVES:

- To understand the underlying principles of operation in different Refrigeration & Air conditioning systems and components.
- To provide knowledge on design aspects of Refrigeration & Air conditioning systems

UNIT I INTRODUCTION 5

Introduction to Refrigeration - Unit of Refrigeration and C.O.P.– Ideal cycles- Refrigerants Desirable properties – Classification - Nomenclature - ODP & GWP.

UNIT II VAPOUR COMPRESSION SYSTEM 10

Vapor 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. Equipments: Type of Compressors, Condensers, Expansion devices, Evaporators.

UNIT III OTHER REFRIGERATION SYSTEMS 8

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 10

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

UNIT V AIR CONDITIONING SYSTEMS AND LOAD ESTIMATION 12

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

TOTAL: 45 PERIODS

OUTCOMES:

- Upon completion of this course, the students can able to demonstrate the operations in different Refrigeration & Air conditioning systems and also able to design Refrigeration & Air conditioning systems .

TEXT BOOK:

1. Arora, C.P., Refrigeration and Air Conditioning, McGraw Hill, 3rd ed, New Delhi, 2010.

REFERENCES:

1. Roy J. Dossat, Principles of Refrigeration, Pearson Education Asia, 4th ed, 2009.
2. Stoecker, W.F. and Jones J. W., Refrigeration and Air Conditioning, McGraw Hill, New Delhi, 1986.
3. ASHRAE Hand book, Fundamentals 2010
4. Jones W.P., Air conditioning engineering, Elsevier Butterworth-Heinemann, 5th ed, 2001

PTME8015 THEORY OF METAL FORMING L T P C
3 0 0 3

OBJECTIVES:

This course aims to impart the knowledge about various metal forming processes. It deals with metal forming concepts like theory of plasticity and special metal forming techniques. After this course a student will have a good exposure about this subject. This also gives the recent trends in the metal forming processes.

UNIT I THEORY OF PLASTICITY 9

Theory of plastic deformation – Engineering stress and strain relationship – Strain rate – Stress tensor – Strain tensor – Yield criteria – Plastic stress strain relationship – Plastic work – Plastic anisotropy.

UNIT II CONSTITUTIVE RELATIONSHIPS AND INSTABILITY 7

Uniaxial tension test – Mechanical properties – Work hardening, Compression test, bulge test, plane strain compression, plastic instability in uniaxial tension stress, plastic instability in biaxial tension stress – Material models – Elasto plasticity, Rigid plasticity, visco plasticity.

UNIT III ANALYSIS OF METAL FORMING 12

Slab analysis – Slip line method, upper bound solutions, numerical methods, contact problems, effect of friction, thermo elastic- analysis of forging, rolling, extrusion and wire drawing processes – forming load – Net and Near net shape forming – Cold and Hot Forging.

UNIT IV SHEET METAL FORMING 8

Sheet Metal Forming methods – Bending – Drawing – Deep Drawing – Stretch Forming – Formability and workability – Forming limit diagram – Analysis of Sheet Metal Forming – HERF Techniques – Principles and Process Parameters – Superplastic Forming.

UNIT V SPECIAL METAL FORMING PROCESSES 9

Orbital forging, Isothermal forging, Warm forging, Hot and Cold isotrophical pressing, high speed extrusion, rubber pad forming, micro blanking – Overview of Powder Metal Techniques – Powder rolling.

TOTAL : 45 PERIODS

OUTCOMES:

- Students will learn how to determine the loading of the forming tool or machine, and how to determine the critical values of deformation

TEXT BOOKS:

1. Dieter G.E, "Mechanical Metallurgy" Mc Graw – Hill Co. S1. Edition 1995
2. Surender Kumar, "Technology of Metal Forming Processes", PHI, New Delhi, 2008.

REFERENCES:

1 Nagpal G.R "Metal Forming Process", Kanna Pub, New Delhi – 2000.
2 Wagoner, R.H and Chenot, JJ Metal Forming Analysis, Cambridge University Press, 2002.
3 Slater, R.A.C., Engineering Plasticity – Theory and Applications to Metal Forming, John Wiely and Sons, 1987.
4 Shiro Kobayshi, Altan. T, Metal Forming and Finite Element Method, Oxford University Press, 1989.
5 Hosford, W.F and Caddell, R.M., Metal Forming Mechanics and Metallurgy, Prentice Hall Eaglewood Cliffs, 1993.
6 Narayanaswamy. R, Theory of Metal Forming and Plasticity Narosa Publishers, 1999.
7 Kurt Lange, "Handbook of Metal Forming", Society of Manufacturing Engineers, Michigan, USA, 1988.
8 Avitzur, "Metal Forming – Process and Analysis", Tata McGraw-Hill Co., New Delhi, 1977.

PTME8016 TURBO MACHINERY L T P C
3 0 0 3

OBJECTIVE:

- To understand the operating principles of various turbomachines and analyse their use for various engineering applications.

UNIT I PRINCIPLES 9

Classification of Turbomachines. Energy transfer between fluid and rotor - Euler equation and its interpretation. Velocity triangles. Thermal, mechanical and overall efficiencies. Polytropic efficiency. Degree of reaction. Dimensionless parameters for Turbomachines.

UNIT II CENTRIFUGAL FANS AND BLOWERS 9

Types – components – working. Flow analysis in impeller blades-volute and diffusers. Velocity triangles - h-s diagram. Performance characteristic curves – various losses.

UNIT III CENTRIFUGAL COMPRESSOR 9

Construction details - Impeller types. Velocity triangles - h-s diagram. slip factor and power input factor. Performance characteristics and various losses. Geometry and performance calculation.

UNIT IV AXIAL FLOW COMPRESSOR 9

Construction details. Work done factor. Stage velocity diagrams - h-s diagram. Performance characteristics, efficiency and stage losses.

UNIT V AXIAL AND RADIAL FLOW TURBINES 9

Stage velocity diagrams - impulse and reaction stages. Performance coefficients and losses. Multistaging. Optimum conditions. Performance characteristics.

TOTAL: 45 PERIODS

OUTCOMES:

- Upon completion of this course, the students can able to explain the various systems, principles and applications and different types of turbo machinery components.

TEXT BOOKS*:*

1. Yahya, S.H., Turbines, Compressor and Fans, 3rd Edition, Tata McGraw Hill, 2005.
2. Ganesan, V., Gas Turbines, Tata McGraw Hill Pub. Co.2010.
3. Saravanamutto HIH, Cohen H., Rogers CEC. & Straznicky PV, Gas Turbine Theory, 6th Edition, Printice Hall, 2009.

REFERENCES:

1. Bruneck, Fans, Pergamom Press, 1973.
2. Dixon, S.I., Fluid Mechanics and Thermodynamics of Turbomachinery, Pergamon Press, 1990.
3. Shepherd, D.G., Principles of Turbomachinery, Macmillan, 1969.
4. Stepanpff, A.J., Blowers and Pumps, John Wiley and Sons Inc. 1965.
5. Gopalakrishnan .G and Prithvi Raj .D, A Treatise on Turbomachines, Scitech Publications (India) Pvt. Ltd., 2002.

PTME8071 COMPUTATIONAL FLUID DYNAMICS L T P C
3 0 0 3

OBJECTIVES:

- To introduce Governing Equations of viscous fluid flows
- To introduce numerical modeling and its role in the field of fluid flow and heat transfer
- To enable the students to understand the various discretization methods, solution procedures and turbulence modeling.
- To create confidence to solve complex problems in the field of fluid flow and heat transfer by using high speed computers.

UNIT I GOVERNING EQUATIONS AND BOUNDARY CONDITIONS 8

Basics of computational fluid dynamics – Governing equations of fluid dynamics – Continuity, Momentum and Energy equations – Chemical species transport – Physical boundary conditions – Time-averaged equations for Turbulent Flow – Turbulent–Kinetic Energy Equations – Mathematical behaviour of PDEs on CFD - Elliptic, Parabolic and Hyperbolic equations.

UNIT II FINITE DIFFERENCE AND FINITE VOLUME METHODS FOR DIFFUSION 9

Derivation of finite difference equations – Simple Methods – General Methods for first and second order accuracy – Finite volume formulation for steady state One, Two and Three - dimensional diffusion problems –Parabolic equations – Explicit and Implicit schemes – Example problems on elliptic and parabolic equations – Use of Finite Difference and Finite Volume methods.

UNIT III FINITE VOLUME METHOD FOR CONVECTION DIFFUSION 10

Steady one-dimensional convection and diffusion – Central, upwind differencing schemes-properties of discretization schemes – Conservativeness, Boundedness, Transportiveness, Hybrid, Power-law, QUICK Schemes.

UNIT IV FLOW FIELD ANALYSIS 9

Finite volume methods -Representation of the pressure gradient term and continuity equation – Staggered grid – Momentum equations – Pressure and Velocity corrections – Pressure Correction equation, SIMPLE algorithm and its variants – PISO Algorithms.

UNIT V TURBULENCE MODELS AND MESH GENERATION 9

Turbulence models, mixing length model, Two equation (k-Є) models – High and low Reynolds number models – Structured Grid generation – Unstructured Grid generation – Mesh refinement – Adaptive mesh – Software tools.

TOTAL: 45 PERIODS

OUTCOMES:

Upon completion of this course, the students can able

- To create numerical modeling and its role in the field of fluid flow and heat transfer
- To use the various discretization methods, solution procedures and turbulence modeling to solve flow and heat transfer problems.

TEXT BOOKS:

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

REFERENCES:

1. Patankar, S.V. Numerical Heat Transfer and Fluid Flow, Hemisphere Publishing Corporation, 2004.
2. Chung, T.J. Computational Fluid Dynamics, Cambridge University, Press, 2002.
3. Ghoshdastidar P.S., Heat Transfer, Oxford University Press, 2005
4. Muralidhar, K., and Sundararajan, T., Computational Fluid Flow and Heat Transfer, Narosa Publishing House, New Delhi, 1995.
5. ProdipNiyogi, Chakrabarty, S.K., Laha, M.K. Introduction to Computational Fluid Dynamics, Pearson Education, 2005.
6. Introduction to Computational Fluid Dynamics Anil W. Date Cambridge University Press, 2005.

PTME8072 DESIGN OF JIGS, FIXTURES AND PRESS TOOLS L T P C
3 0 0 3

OBJECTIVES:

- To understand the functions and design principles of Jigs, fixtures and press tools
- To gain proficiency in the development of required views of the final design.

UNIT I LOCATING AND CLAMPING PRINCIPLES: 8

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

UNIT II JIGS AND FIXTURES 10

Design and development of jigs and fixtures for given component- Types of Jigs – Post, Turnover, Channel, latch, box, pot, angular post jigs – Indexing jigs – General principles of milling, Lathe, boring, broaching and grinding fixtures – Assembly, Inspection and Welding fixtures – Modular fixturing systems- Quick change fixtures.

UNIT III PRESS WORKING TERMINOLOGIES AND ELEMENTS OF CUTTING DIES 10

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

UNIT IV BENDING AND DRAWING DIES 10

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

UNIT V OTHER FORMING TECHNIQUES 7

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

TOTAL: 45 PERIODS

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

OUTCOMES:

- Upon completion of this course, the students can able to design jigs, fixtures and press tools.

TEXT BOOK:

1. Joshi, P.H. “Jigs and Fixtures”, Second Edition, Tata McGraw Hill Publishing Co., Ltd., New Delhi, 2004.
2. JoshiP.H “Presstools – Design and Construction”, wheels publishing, 1996.

REFERENCES:

1. K. Venkataraman, “Design of Jigs Fixtures & Press Tools”, Tata McGraw Hill, New Delhi, 2005.
2. Donaldson, Lecain and Goold “Tool Design”, III rd Edition Tata McGraw Hill, 2000.
3. Kempster, “Jigs and Fixture Design”, Hoddes and Stoughton – Third Edition 1974.
4. Hoffman “Jigs and Fixture Design” – Thomson Delmar Learning, Singapore, 2004.
5. ASTME Fundamentals of Tool Design Prentice Hall of India.
6. Design Data Hand Book, PSG College of Technology, Coimbatore.

PTME8073 ENERGY CONSERVATION IN INDUSTRIES L T P C
3 0 0 3

OBJECTIVES:

At the end of the course, the student is expected to

- understand and analyse the energy data of industries
- carryout energy accounting and balancing
- conduct energy audit and suggest methodologies for energy savings and
- utilisethe available resources in optimal ways

UNIT I INTRODUCTION 8

Energy - Power – Past & Present scenario of World; National Energy consumption Data – Environmental aspects associated with energy utilization –Energy Auditing: Need, Types, Methodology and Barriers. Role of Energy Managers. Instruments for energy auditing.

UNIT II ELECTRICAL SYSTEMS 12

Components of EB billing – HT and LT supply, Transformers, Cable Sizing, Concept of Capacitors, Power Factor Improvement, Harmonics, Electric Motors - Motor Efficiency Computation, Energy Efficient Motors, Illumination – Lux, Lumens, Types of lighting, Efficacy, LED Lighting and scope of Encon in Illumination.

UNIT III THERMAL SYSTEMS 12

Stoichiometry, Boilers, Furnaces and Thermic Fluid Heaters – Efficiency computation and encon measures. Steam:Distribution &Usage: Steam Traps, Condensate Recovery, Flash Steam Utilization, Insulators & Refractories

UNIT IV ENERGY CONSERVATION IN MAJOR UTILITIES 8

Pumps, Fans, Blowers, Compressed Air Systems, Refrigeration and Air Conditioning Systems – Cooling Towers – D.G. sets

UNIT V ECONOMICS 5

Energy Economics – Discount Rate, Payback Period, Internal Rate of Return, Net Present Value, Life Cycle Costing –ESCO concept

TOTAL: 45 PERIODS

OUTCOMES:

Upon completion of this course, the students can able to analyse the energy data of industries.

- Can carryout energy accounting and balancing
- Can suggest methodologies for energy savings

TEXT BOOK*:*

1. Energy Manager Training Manual(4 Volumes) available at www.energymanagertraining.coma website administered by Bureau of Energy Efficiency (BEE), a statutory body under Ministry of Power, Government of India.2004.

REFERENCES:

1. L.C. Witte, P.S. Schmidt, D.R. Brown, “Industrial Energy Management and Utilisation” HemispherePubl, Washington, 1988.
2. Callaghn, P.W. “Design and Management for Energy Conservation”, Pergamon Press, Oxford, 1981.
3. I.G.C. Dryden, “The Efficient Use of Energy” Butterworths, London, 1982
4. W.C. turner, “Energy Management Hand book” Wiley, New York, 1982.
5. W.R. Murphy and G. Mc KAY “Energy Management” Butterworths, London 1987.

PTME8074 ENTREPRENEURSHIP DEVELOPMENT L T P C
(Common to Manufacturing and Mechanical) **3 0 0 3**

OBJECTIVE:

Study of this subject provides an understanding of the scope of an entrepreneur, key areas of development, financial assistance by the institutions, methods of taxation and tax benefits, etc.

UNIT I ENTREPRENEURSHIP 9

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

UNIT II MOTIVATION 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

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

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

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: 45 PERIODS

OUTCOMES :

- Upon completion of the course, students will be able to gain knowledge and skills needed to run a business successfully.

TEXT BOOKS:

1. S.S.Khanka “Entrepreneurial Development” S.Chand & Co. Ltd. Ram Nagar New Delhi, 1999.
2. Kuratko & Hodgetts, “Enterprenuership – Theory, process and practices”, Thomson learning 6th edition.

REFERENCES:

1. Hisrich R D and Peters M P, “Entrepreneurship” 5th Edition Tata McGraw-Hill, 2002.
2. Mathew J Manimala,” Enterprenuership theory at cross roads: paradigms and praxis” Dream tech 2nd edition 2006.
3. Rabindra N. Kanungo “Entrepreneurship and innovation”, Sage Publications, New Delhi, 1998.
4. EDII “ Faulty and External Experts – A Hand Book for New Entrepreneurs Publishers: Entrepreneurship Development” Institute of India, Ahmadabad, 1986.

PTME8075 RELIABILITY CONCEPTS IN ENGINEERING L T P C
3 0 0 3

OBJECTIVE:

- To impart knowledge in reliability concepts, reliability estimation methods and reliability improvement methods

UNIT I RELIABILITY CONCEPT 9

Reliability definition –Reliability parameters- f(t), F(t) and R(t) functions- Measures of central tendency – Bath tub curve – A priori and posteriori probabilities of failure – Component mortality - Useful life.

UNIT II LIFE DATA ANALYSIS 9

Data classification – Non parametric methods: Ungrouped, Grouped, Complete, Censored data – Time to failure distributions – Probability plotting: Exponential, Weibull - Goodness of fit tests – Survival graphs.

UNIT III RELIABILITY ESTIMATION 9

Series parallel configurations – Parallel redundancy – m/n system – Complex systems: RBD approach – Baye's method – Minimal path and cut sets - Fault Tree analysis – Standby system.

UNIT IV RELIABILITY MANAGEMENT 8

Reliability testing: Failure terminated test – Time terminated test – Upper and lower MTBFs – Sequential Testing – Reliability growth monitoring – Reliability allocation.

UNIT V RELIABILITY IMPROVEMENT 10

Analysis of downtime – Repair time distribution – Maintainability prediction – Measures of maintainability – Availability definitions – System Availability – Replacement decisions – Economic life.

TOTAL: 45 PERIODS

OUTCOMES:

- Upon successful completion of this course, the students can able to apply the concept for reliable component production

REFERENCES:

1. An Introduction to Reliability and Maintainability Engineering, Charles E.Ebeling, TMH, 2000.
2. Roy Billington and Ronald N. Allan, Reliability Evaluation of Engineering Systems, Springer, 2007.

PTME8451 HYDRAULICS AND PNEUMATICS L T P C
3 0 0 3

OBJECTIVE:

This course will give an appreciation of the fundamental principles, design and operation of hydraulic and pneumatic components and systems and their application in manufacturing and mechanical systems.

UNIT I FLUID POWER PRINCIPLES AND HYDRAULIC PUMPS 9

Introduction to Fluid power- Advantages and Applications- Fluid power systems – Types of fluids- Properties of fluids – Basics of Hydraulics – Pascal's Law- Principles of flow – Friction loss- Work, Power and Torque. Problems

Sources of Hydraulic power: Pumping Theory – Pump Classification- Construction, Working, Design, Advantages, Disadvantages, Performance, Selection criterion of Linear, Rotary- Fixed and Variable displacement pumps-Problems

UNIT II HYDRAULIC ACTUATORS AND VALVES 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 – Types of actuation. Accessories: Reservoirs, Pressure Switches- Applications- Fluid Power ANSI Symbols - Problems

UNIT III HYDRAULIC SYSTEMS 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 SYSTEMS 9

Properties of air– Perfect Gas Laws- Compressors- Filter, Regulator, Lubricator, Muffler, Air control Valves, Quick Exhaust valves, Pneumatic actuators, Design of pneumatic circuit-cascade method- Electro pneumatic circuits, Introduction to Fluidics, Pneumatic logic circuits.

UNIT V TROUBLE SHOOTING AND APPLICATIONS 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 a Pick and Place application and tool handling in a CNC machine. - Low cost Automation – Hydraulic and Pneumatic power packs- case studies.

TOTAL: 45 PERIODS

OUTCOMES:

- Identify hydraulic and pneumatics components.
- Ability to design hydraulic and pneumatic circuits.

TEXT BOOK:

1. Anthony Esposito, "Fluid Power with Applications", Prentice Hall, 2009.

REFERENCES:

1. Shanmugasundaram.K, "Hydraulic and Pneumatic controls", Chand & Co, 2006.
2. Majumdar, S.R., "Oil Hydraulics Systems- Principles and Maintenance", Tata McGraw Hill, 2001
3. Majumdar, S.R., "Pneumatic Systems – Principles and Maintenance", Tata McGraw Hill, 2007.
4. Dudelyt, A Pease and John J Pippenger, "Basic Fluid Power", Prentice Hall, 1987.
5. Srinivasan.R, "Hydraulic and Pneumatic Controls", Vijay Nicole Imprints, 2008.
6. Joji.P, "Pneumatic Controls", Wiley India, 2008.

PTME8751 DESIGN FOR MANUFACTURING L T P C
3 0 0 3

OBJECTIVES:

- To understand the principles of design such that the manufacturing of the product is possible.
- To educate students on various design aspects to be considered for manufacturing the products using different processes.

UNIT I MANUFACTURING METHODOLOGY AND PROCESESS 9

Methodologies and tools, design axioms, design for assembly and evaluation, minimum part assessment, Taguchi method, robustness assessment, manufacturing process rules, designer's tool kit, Computer Aided group Technology, failure mode effects analysis, Value Analysis, Design for minimum number of parts, development of modular design, minimizing part variations, design of parts to be multi-functional, multi-use, ease of fabrication, Poke Yoke principles.

UNIT II GEOMETRIC ANALYSIS 9

Surface finish, review of relationship between attainable tolerance grades and different machining processes, part features-feature of size-control from-placement material condition – MMC – LMC

UNIT III FORM DESIGN OF CASTINGS AND WELDMENTS 9

Redesign of castings based on parting line considerations, minimizing core requirements, redesigning cast members by welded structure , use of welding symbols.

UNIT IV MECHANICAL ASSEMBLY 9

Selective assembly, deciding the number of groups, control of axial play, examples,Grouped datum systems , different types, geometric analysis and applications, design features to facilitate automated assembly, Assembly analysis worst case Arithmetic method, Monte - Carlo method.

UNIT V TRUE POSITION THEORY 9

Virtual size concept, floating and fixed fasteners, projected tolerance zone, assembly with gasket, zero true position tolerance, functional gauges, paper layout gauging,examples. Operation sequence for typical shaft type of components. Preparation of process drawings for different operations, tolerance worksheets and centrality analysis, examples.

TOTAL : 45 PERIODS

OUTCOMES:

- Upon completion of the subject, students will be able to
- understand the concept of mass customization and product family design;
- apply appropriate methods to achieve quality in product design;
- analyze product design for assembly, manufacturing, and end-of-life issues;
- understand how global environmental requirements affect product design;
- analyze product design in terms of environmental impact and suggest improvements.

TEXT BOOKS :

1. Harry pack, "Designing for Manufacture", Pitman Publications, 1983.
2. Matousek, "Engineering Design, - A Systematic Approach" – Blackie & Son Ltd, London, 1974

REFERENCE BOOKS:

1. Spotts M.F. “Dimensioning and Tolerance for Quantity Production, Prentice Hall Inc.1983.
2. Oliver R. Wade, “Tolerance Control in Design and Manufacturing “. Industrial Press Inc. New York Publications. 1967.
3. James G. Bralla. “Hand Book of Product Design for Manufacturing”. McGraw Hill Publications, 1983.
4. Trucks H.E. “Design for Economic Production”. Society of Manufacturing Engineers, Michigan, 2nd edition, 1987.

PTMF8071 ADDITIVE MANUFACTURING TECHNOLOGY L T P C
3 0 0 3

OBJECTIVES:

- To know the principle methods, areas of usage, possibilities and limitations as well as environmental effects of the Additive Manufacturing technologies
- To be familiar with the characteristics of the different materials those are used in Additive Manufacturing.

UNIT I INTRODUCTION 10

Overview – History - Need-Classification -Additive Manufacturing Technology in product development-Materials for Additive Manufacturing Technology – Tooling - Applications.

UNIT II CAD & REVERSE ENGINEERING 10

Basic Concept – Digitization techniques – Model Reconstruction – Data Processing for Additive Manufacturing Technology: CAD model preparation – Part Orientation and support generation – Model Slicing –Tool path Generation – Softwares for Additive Manufacturing Technology: MIMICS, MAGICS.

UNIT III LIQUID BASED AND SOLID BASED ADDITIVE MANUFACTURING SYSTEMS 10

Classification – Liquid based system – Stereolithography Apparatus (SLA)- Principle, process, advantages and applications - Solid based system –Fused Deposition Modeling - Principle, process, advantages and applications, Laminated Object Manufacturing.

UNIT IV POWDER BASED ADDITIVE MANUFACTURING SYSTEMS 10

Selective Laser Sintering – Principles of SLS process - Process, advantages and applications, Three Dimensional Printing - Principle, process, advantages and applications- Laser Engineered Net Shaping (LENS), Electron Beam Melting.

UNIT V MEDICAL AND BIO-ADDITIVE MANUFACTURING 5

Customized implants and prosthesis: Design and production. Bio-Additive Manufacturing-Computer Aided Tissue Engineering (CATE) – Case studies.

TOTAL: 45 PERIODS

OUTCOMES:

- Upon completion of this course, the students can able to compare different method and discuss the effects of the Additive Manufacturing technologies and analyse the characteristics of the different materials in Additive Manufacturing.

TEXT BOOKS:

1. Chua C.K., Leong K.F., and Lim C.S., “Rapid prototyping: Principles and applications”, Third edition, World Scientific Publishers, 2010.
2. Gebhardt A., “Rapid prototyping”, Hanser Gardener Publications, 2003.

REFERENCES:

1. Liou L.W. and Liou F.W., “Rapid Prototyping and Engineering applications : A tool box for prototype development”, CRC Press, 2007.
2. Kamrani A.K. and Nasr E.A., “Rapid Prototyping: Theory and practice”, Springer, 2006.
3. Hilton P.D. and Jacobs P.F., “Rapid Tooling: Technologies and Industrial Applications”, CRC press, 2000.

PTMF8074 MEMS AND MICRO SYSTEM FABRICATION L T P C
3 0 0 3

OBJECTIVES:

- To understand the mechanics, scaling and design of micro system
- To learn various micro fabrication processes
- To impart knowledge on microsystems packaging and metrology of micro machined components

UNIT I INTRODUCTION 9

Overview of MEMS and Microsystems: MEMS and Microsystems, Evolution of Micro fabrication, Microsystems and Microelectronics, Microsystems and miniaturization-Materials for MEMS and Microsystems:substrates and wafers, active substrate materials,Silicon,Galium Arsenide, Piezoelectric Crystals, Polymers, Packaging materials-Working principles of Microsystems: micro sensors, micro actuation, MEMS with micro actuators, Micro accelerometers, micro fluidics-Applications of Microsystems in various industries

UNIT II MECHANICS, SCALING AND DESIGN 9

Engineering Mechanics for Microsystems design: Introduction, Static bending of Thin Plates, Mechanical Vibration, Thermomechanics, Thermofluid Engineering and micro system design, Laminar fluid flow, Incompressible fluid Flow, Heat conduction in solids-Scaling Laws in Miniaturization, Introduction to scaling, Scaling in (Electrostatic forces electromagnetic forces, Electricity, fluid mechanics, heat transfer)-Microsystems Design: Design Consideration, Process design, Mechanical Design, Design of Micro fluidic Network systems

UNIT III MICRO SYSTEM FABRICATION PROCESSES 12

Introduction- Photolithography- Ion implantation- Chemical Vapor deposition-Physical Vapor deposition - clean room- Bulk micromachining :etching, isotropic and anisotropic etching, wet and dry etching- Surface micro machining :process, mechanical problems associated with surface micro machining- LIGA process :general description, materials for substrates and photo resists-SLIGA process-Abrasive jet micro machining-Laser beam micro machining-Micro Electrical Discharge Micro Machining –Ultrasonic Micro Machining- Electro chemical spark micro machining- Electron beam micro machining-Focused Ion Beam machining

UNIT IV TOOL BASED MICROMACHINING 7

Theory of tool based micromachining-Chip formation-size effect in micromachining-micro turning, micro milling, and micro drilling- Micromachining tool design-Precision Grinding-Partial ductile mode grinding-Ultra precision grinding- Binderless wheel Free form optics.

UNIT V MICROSYSTEMS PACKAGING AND METROLOGY OF MICRO MACHINED COMPONENTS 8

Introduction -Microsystems Packaging-Interfaces in Microsystems Packaging-Essential Packaging Technologies-Three dimensional Packaging- Assembly of Microsystems- Signal Mapping and Transduction-Metrology of Micromachined components: SEM, optical microscopy, Scanning white light interferometry, Confocal Laser scanning microscopy, SPM, Molecular measuring machine, Micro coordinate measuring machine

TOTAL:45 PERIODS

OUTCOMES

- Ability to understand and apply basic science, circuit theory, Electro-magnetic field theory control theory and apply them to electrical engineering problems.
- Ability to understand and analyse, linear and digital electronic circuits.

TEXT BOOKS:

1. Hsu T.R., "MEMS & Microsystems Design and Manufacture", Tata McGraw Hill, 2002, ISBN: 9780070487093.
2. Jain V.K., "Introduction to Micromachining" Narosa Publishing House, 2010.

REFERENCES:

1. Jackson M.J., "Microfabrication and Nanomanufacturing" Taylor and Francis 2006.
2. McGeough J.A., "Micromachining of Engineering Materials", CRC Press, 2001, SBN:0824706447
3. Hak M.G., "MEMS Handbook", CRC Press, 2006.
4. Madou M.F. "Fundamentals of Micro fabrication", CRC Press, 2002, 2nd Edition.

PTMF8076 PRODUCT DESIGN AND DEVELOPMENT L T P C
3 0 0 3

OBJECTIVE:

- To Teach the students basic concepts of Product Design and Process Development. Expose the students to the importance, various stages, concepts, management and prototyping of Product Design and Process Development.

UNIT I INTRODUCTION 9

Strategic importance of Product development - integration of customer, designer, material supplier and process planner, Competitor and customer - behavior analysis. Understanding customer-promoting customer understanding-involve customer in development and managing requirements - Organization process management and improvement.

UNIT II CONCEPT GENERATION, SELECTION AND TESTING 9

Plan and establish product specifications. Task - Structured approaches - clarification - search-externally and internally-Explore systematically - reflect on the solutions and processes - concept selection - methodology - benefits. Implications - Product change - variety - component standardization - product performance – manufacturability.

UNIT III PRODUCT ARCHITECTURE 9

Product development management - establishing the architecture - creation - clustering - geometric layout development - Fundamental and incidental interactions - related system level design issues - secondary systems -architecture of the chunks - creating detailed interface specifications-Portfolio Architecture.

UNIT IV INDUSTRIAL DESIGN 9

Integrate process design - Managing costs - Robust design - Integrating CAE, CAD, CAM tools – Simulating product performance and manufacturing processes electronically - Need for industrial design-impact – design process - investigation of customer needs - conceptualization - refinement - management of the industrial design process.

UNIT V DESIGN FOR MANUFACTURING AND PRODUCT DEVELOPMENT 9

Definition - Estimation of Manufacturing cost-reducing the component costs and assembly costs – Minimize system complexity - Prototype basics - Principles of prototyping - Planning for prototypes - Economic Analysis.

TOTAL: 45 PERIODS

OUTCOME

The student would have the

- Ability to launch own ideas and the ideas of others, which enables them to manage to work with innovation and development in large companies
- Ability to apply new theories on innovation and change, including emerging paradigms such as user-driven innovation, open innovation and market forecasting in practice.

TEXT BOOK:

1. Ulrich K.T. and Eppinger S.D., “Product Design and Development” McGraw –Hill International Editions,1999.

REFERENCES:

1. Belz A., 36-Hour Course: “Product Development” McGraw-Hill, 2010.
2. Rosenthal S., “Effective Product Design and Development”, Business One Orwin, Homewood, 1992, ISBN 1-55623-603-4.
3. Pugh S., “Total Design – Integrated Methods for successful Product Engineering”, Addison Wesley Publishing, 1991, ISBN 0-202-41639-5.

PTMF8651 OPERATIONS RESEARCH L T P C

3 0 0 3

OBJECTIVE:

- To provide knowledge and training in using optimization techniques under limited resources for the engineering and business problems.

UNIT I LINEAR MODELS 15

The phase of an operation research study – Linear programming – Graphical method– Simplex algorithm – Duality formulation – Sensitivity analysis.

UNIT II TRANSPORTATION MODELS AND NETWORK MODELS 8

Transportation Assignment Models –Traveling Salesman problem-Networks models – Shortest route – Minimal spanning tree – Maximum flow models –Project network – CPM and PERT networks – Critical path scheduling – Sequencing models.

UNIT III INVENTORY MODELS 6

Inventory models – Economic order quantity models – Quantity discount models – Stochastic inventory models – Multi product models – Inventory control models in practice.

UNIT IV QUEUEING MODELS 6

Queueing models - Queueing systems and structures – Notation parameter – Single server and multi server models – Poisson input – Exponential service – Constant rate service – Infinite population – Simulation.

UNIT V DECISION MODELS 10

Decision models – Game theory – Two person zero sum games – Graphical solution- Algebraic solution – Linear Programming solution – Replacement models – Models based on service life – Economic life – Single / Multi variable search technique – Dynamic Programming – Simple Problem.

TOTAL: 45 PERIODS

OUTCOMES:

- Upon completion of this course, the students can able to use the optimization techniques for use engineering and Business problems

TEXT BOOK:

1. Taha H.A., "Operations Research", Prentice Hall of India, 2003, Sixth Edition.

REFERENCE BOOKS:

1. Shennoy G.V. and Srivastava U.K., "Operation Research for Management", Wiley Eastern, 1994.
2. Bazara M.J., Jarvis and Sherali H., "Linear Programming and Network Flows", John Wiley, 1990.
3. Philip D.T. and Ravindran A., "Operations Research", John Wiley, 1992.
4. Hillier and Libeberman, "Operations Research", Holden Day, 1986
5. Budnick F.S., "Principles of Operations Research for Management", Richard D Irwin, 1990.
6. Tulsian and Pasdey V., "Quantitative Techniques", Pearson – Asia 2002.

PTMF8652 PROCESS PLANNING AND COST ESTIMATION L T P C
3 0 0 3

OBJECTIVE:

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

UNIT I INTRODUCTION TO PROCESS PLANNING 10

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

UNIT II PROCESS PLANNING ACTIVITIES 10

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

UNIT III INTRODUCTION TO COST ESTIMATION 8

Importance of costing and estimation –methods of costing-elements of cost estimation –Types of estimates – Estimating procedure- Estimation labor cost, material cost- allocation of over head charges- Calculation of depreciation cost

UNIT IV PRODUCTION COST ESTIMATION 8

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

UNIT V MACHINING TIME CALCULATION 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: 45 PERIODS

OUTCOMES:

- Upon completion of this course, the students can able to use the concepts of process planning and cost estimation for various products.

TEXT BOOKS:

1. Peter scalon, "Process planning, Design/Manufacture interface", Elsevier science technology Books, Dec 2002.

REFERENCES:

1. Ostwalal P.F. and Munez J., "Manufacturing Processes and systems", John Wiley, 9th Edition, 1998.
2. Russell R.S and Tailor B.W, "Operations Management", PHI, 4th Edition, 2003.
3. Chitale A.V. and Gupta R.C., "Product Design and Manufacturing", PHI, 2nd Edition, 2002.

PTMF8751 INDUSTRIAL ROBOTICS L T P C
3 0 0 3

OBJECTIVES:

- To understand the functions of the basic components of a Robot.
- To study the use of various types of End of Effectors and Sensors
- To impart knowledge in Robot Kinematics and Programming
- To learn Robot safety issues and economics.

UNIT I FUNDAMENTALS OF ROBOT 6

Robot - Definition - Robot Anatomy - Co ordinate Systems, Work Envelope Types and Classification-Specifications-Pitch, Yaw, Roll, Joint Notations, Speed of Motion, Pay Load-Robot Parts and their Functions-Need for Robots-Different Applications.

UNIT II ROBOT DRIVE SYSTEMS AND END EFFECTORS 9

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

UNIT III SENSORS AND MACHINE VISION 12

Requirements of a sensor, Principles and Applications of the following types of sensors-Position sensors - Piezo Electric Sensor, LVDT, Resolvers, Optical Encoders, pneumatic Position Sensors, Range Sensors Triangulations Principles, Structured, Lighting Approach,

Time of Flight, Range Finders, Laser Range Meters, Touch Sensors ,binary Sensors., Analog Sensors, Wrist Sensors, Compliance Sensors, Slip Sensors, Camera, Frame Grabber, Sensing and Digitizing Image Data-Signal Conversion, Image Storage, Lighting Techniques, Image Processing and Analysis-Data Reduction, Segmentation, Feature Extraction, Object Recognition, Other Algorithms, Applications-Inspection, Identification, Visual Serving and Navigation.

UNIT IV ROBOT KINEMATICS AND ROBOT PROGRAMMING 13

Forward Kinematics, Inverse Kinematics and Difference; Forward Kinematics and Reverse Kinematics of manipulators with Two, Three Degrees of Freedom (in 2 Dimension), Four Degrees of freedom (in 3 Dimension) Jacobians, Velocity and Forces-Manipulator Dynamics, Trajectory Generator, Manipulator Mechanism Design-Derivations and problems. Lead through Programming, Robot programming Languages-VAL Programming-Motion Commands, Sensor Commands, End Effector commands and simple Programs.

UNIT V IMPLEMENTATION AND ROBOT ECONOMICS 5

RGV, AGV; Implementation of Robots in Industries-Various Steps; Safety Considerations for Robot Operations - Economic Analysis of Robots.

TOTAL: 45 PERIODS

OUTCOMES:

- Upon completion of this course, the students can able to apply the basic engineering knowledge for the design of robotics

TEXT BOOKS:

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

REFERENCE BOOKS:

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

PTMG8651 TOTAL QUALITY MANAGEMENT L T P C
(Common to Manufacturing, Mechanical, Printing, Production, CSE, Industrial, ECE, IT,EEE, Industrial, Leather, Automobile) 3 0 0 3

AIM

To provide comprehensive knowledge about the principles, practices, tools and techniques of Total quality management.

OBJECTIVES

- To understand the various principles, practices of TQM to achieve quality.
- To learn the various statistical approaches for Quality control.
- To understand the TQM tools for continuous process improvement.
- To learn the importance of ISO and Quality systems

UNIT I INTRODUCTION 9

Introduction - Need for quality - Evolution of quality - Definition of quality - Dimensions of product and service quality - Basic concepts of TQM – TQM Framework - Contributions of Quality Gurus – Barriers to TQM – Cost of Quality.

UNIT II TQM PRINCIPLES 9

Quality statements - Customer focus –Customer orientation, Customer satisfaction, Customer complaints, Customer retention - Continuous process improvement – PDCA cycle, 5s, Kaizen - Supplier partnership – Partnering, Supplier selection, Supplier Rating.

UNIT III TQM TOOLS & TECHNIQUES I 9

The seven traditional tools of quality – New management tools – Six-sigma: Concepts, methodology, applications to manufacturing, service sector including IT – Bench marking – Reason to bench mark, Bench marking process – FMEA – Stages, Types.

UNIT IV TQM TOOLS & TECHNIQUES II 9

Quality circles – Quality Function Deployment (QFD) – Taguchi quality loss function – TPM – Concepts, improvement needs – Performance measures - BPR.

UNIT V QUALITY SYSTEMS 9

Need for ISO 9000- ISO 9000-2000 Quality System – Elements, Documentation, Quality auditing- QS 9000 – ISO 14000 – Concepts, Requirements and Benefits –Quality Council – Leadership, Employee involvement – Motivation, Empowerment, Team and Teamwork, Recognition and Reward.

TOTAL : 45 PERIODS

OUTCOMES:

- The student would be able to apply the tools and techniques of quality management to manufacturing and services processes.

TEXT BOOK:

1. Dale H.Besterfiled, et al., “Total Quality Management”, Pearson Education Asia, Third Edition, Indian Reprint , 2006.

REFERENCE BOOKS:

1. James R. Evans and William M. Lindsay, “The Management and Control of Quality”, (6th Edition), South-Western (Thomson Learning), 2005.
2. Oakland, J.S. “TQM – Text with Cases”, Butterworth – Heinemann Ltd., Oxford, Third Edition , 2003.
3. Suganthi,L and Anand Samuel, “Total Quality Management”, Prentice Hall (India) Pvt. Ltd., 2006 .
4. Janakiraman,B and Gopal, R.K, “Total Quality Management – Text and Cases”,Prentice Hall (India) Pvt. Ltd., 2006.

PTGE8071 DISASTER MANAGEMENT L T P C
3 0 0 3

OBJECTIVES:

- To provide students an exposure to disasters, their significance and types.
- To ensure that students begin to understand the relationship between vulnerability, disasters, disaster prevention and risk reduction
- To gain a preliminary understanding of approaches of Disaster Risk Reduction (DRR)
- To enhance awareness of institutional processes in the country and
- To develop rudimentary ability to respond to their surroundings with potential disaster response in areas where they live, with due sensitivity

UNIT I INTRODUCTION TO DISASTERS 9

Definition: Disaster, Hazard, Vulnerability, Resilience, Risks – Disasters: Types of disasters – Earthquake, Landslide, Flood, Drought, Fire etc - Classification, Causes, Impacts including social, economic, political, environmental, health, psychosocial, etc.- Differential impacts- in terms of caste, class, gender, age, location, disability - Global trends in disasters: urban disasters, pandemics, complex emergencies, Climate change- Dos and Don'ts during various types of Disasters.

UNIT II APPROACHES TO DISASTER RISK REDUCTION (DRR) 9

Disaster cycle - Phases, Culture of safety, prevention, mitigation and preparedness community based DRR, Structural- nonstructural measures, Roles and responsibilities of- community, Panchayati Raj Institutions/Urban Local Bodies (PRIs/ULBs), States, Centre, and other stake-holders- Institutional Processess and Framework at State and Central Level- State Disaster Management Authority(SDMA) – Early Warning System – Advisories from Appropriate Agencies.

UNIT III INTER-RELATIONSHIP BETWEEN DISASTERS AND DEVELOPMENT 9

Factors affecting Vulnerabilities, differential impacts, impact of Development projects such as dams, embankments, changes in Land-use etc.- Climate Change Adaptation- IPCC Scenario and Scenarios in the context of India - Relevance of indigenous knowledge, appropriate technology and local resources.

UNIT IV DISASTER RISK MANAGEMENT IN INDIA 9

Hazard and Vulnerability profile of India, Components of Disaster Relief: Water, Food, Sanitation, Shelter, Health, Waste Management, Institutional arrangements (Mitigation, Response and Preparedness, Disaster Management Act and Policy - Other related policies, plans, programmes and legislation – Role of GIS and Information Technology Components in Preparedness, Risk Assessment, Response and Recovery Phases of Disaster – Disaster Damage Assessment.

UNIT V DISASTER MANAGEMENT: APPLICATIONS AND CASE STUDIES AND FIELD WORKS 9

Landslide Hazard Zonation: Case Studies, Earthquake Vulnerability Assessment of Buildings and Infrastructure: Case Studies, Drought Assessment: Case Studies, Coastal Flooding: Storm Surge Assessment, Floods: Fluvial and Pluvial Flooding: Case Studies; Forest Fire: Case Studies, Man Made disasters: Case Studies, Space Based Inputs for Disaster Mitigation and Management and field works related to disaster management.

TOTAL: 45 PERIODS

OUTCOMES:

The students will be able to

- Differentiate the types of disasters, causes and their impact on environment and society
- Assess vulnerability and various methods of risk reduction measures as well as mitigation.
- Draw the hazard and vulnerability profile of India, Scenarious in the Indian context, Disaster damage assessment and management.

TEXTBOOK:

1. Singhal J.P. "Disaster Management", Laxmi Publications, 2010. ISBN-10: 9380386427 ISBN-13: 978-9380386423
2. Tushar Bhattacharya, "Disaster Science and Management", McGraw Hill India Education Pvt. Ltd., 2012. **ISBN-10:** 1259007367, **ISBN-13:** 978-1259007361]
3. Gupta Anil K, Sreeja S. Nair. Environmental Knowledge for Disaster Risk Management, NIDM, New Delhi, 2011
4. Kapur Anu Vulnerable India: A Geographical Study of Disasters, IIAS and Sage Publishers, New Delhi, 2010.

REFERENCES

1. Govt. of India: Disaster Management Act , Government of India, New Delhi, 2005
2. Government of India, National Disaster Management Policy,2009.

PTGE8072 HUMAN RIGHTS L T P C
3 0 0 3

OBJECTIVES :

- To sensitize the Engineering students to various aspects of Human Rights.

UNIT I **9**

Human Rights – Meaning, origin and Development. Notion and classification of Rights – Natural, Moral and Legal Rights. Civil and Political Rights, Economic, Social and Cultural Rights; collective / Solidarity Rights.

UNIT II **9**

Evolution of the concept of Human Rights Magana carta – Geneva convention of 1864. Universal Declaration of Human Rights, 1948. Theories of Human Rights.

UNIT III **9**

Theories and perspectives of UN Laws – UN Agencies to monitor and compliance.

UNIT IV **9**

Human Rights in India – Constitutional Provisions / Guarantees.

UNIT V **9**

Human Rights of Disadvantaged People – Women, Children, Displaced persons and Disabled persons, including Aged and HIV Infected People. Implementation of Human Rights – National and State Human Rights Commission – Judiciary – Role of NGO's, Media, Educational Institutions, Social Movements.

TOTAL : 45 PERIODS

OUTCOME :

- Engineering students will acquire the basic knowledge of human rights.

REFERENCES:

1. Kapoor S.K., “Human Rights under International law and Indian Laws”, Central Law Agency, Allahabad, 2014.
2. Chandra U., “Human Rights”, Allahabad Law Agency, Allahabad, 2014.
3. Upendra Baxi, The Future of Human Rights, Oxford University Press, New Delhi.