



KARPAGAM UNIVERSITY
(Established Under Section 3 of UGC Act (1956))
COIMBATORE 641 021. INDIA

SYLLABUS 2012 ONWARDS

Part Time B.E. MECHANICAL ENGINEERING

SEMESTER I

12PBEME101 ENGINEERING MATHEMATICS – I

2 1 0 3 100

INTENDED OUTCOMES:

- To develop analytical skills for solving different engineering problems.
- To understand the concepts of Matrices and 3D analytical geometry.
- To solve problems by applying Differential Calculus and Differential equations.

UNIT-I MATRICES

Characteristic equation – Eigen values and Eigen vectors of a real matrix – Properties – Cayley-Hamilton theorem (excluding proof) – Orthogonal transformation of a symmetric matrix to diagonal form – Quadratic forms – Reduction to canonical form through orthogonal reduction.

UNIT- II THREE DIMENSIONAL ANALYTICAL GEOMETRY

Direction ratios of the Line Joining Two points-The plane- Plane through the intersection of two lines-The Straight Line- The Plane and the Straight Line-Shortest Distance between Two skew lines-Equation of Sphere.

UNIT -III DIFFERENTIAL CALCULUS

Curvature in Cartesian co-ordinates – Centre and radius of curvature – Circle of curvature – Evolutes – Envelopes- Evolutes as Envelope of normals.

UNIT -IV FUNCTIONS OF SEVERAL VARIABLES

Partial derivatives – Euler's theorem for homogenous functions – Total derivatives – Differentiation of implicit functions – Jacobians –Maxima and Minima of functions of two or more Variables - Method of Lagrangian multipliers.

UNIT -V DIFFERENTIAL EQUATIONS

Equations of the First order and Higher Degree-Linear Differential equations of second and higher order with constant coefficients-Euler's Homogeneous Linear Differential equations.
Mathematica Software Demonstration.

TEXT BOOKS:

S. NO.	AUTHOR(S) NAME	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1	Veerarajan,T.	Engineering Mathematics for first year	Tata McGraw-Hill Publishing Company Limited, New Delhi.	2007
2	Sundaram, V. Lakhminarayan,K.A. and Balasubramanian,R.	Engineering Mathematics for first year..	Vikas Publishing Home , New Delhi	2006

REFERENCES:

S. NO.	AUTHOR(S) NAME	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1	Ramana. B.V	Higher Engineering Mathematics	Tata McGraw Hill Publishing Company, New Delhi.	2007
2	Grewal. B.S	Higher Engineering Mathematics ,40 th Edition	Khanna Publications, Delhi.	2007
3	Narayanan. S, Manicavachagam pillay.T.K and Ramaniah.G	Advanced Mathematics for Engineering Students.Volumes II and II	Viswanathan S.(Printers and Publishers) Pvt. Ltd. Chennai.	2002
4	Bajpai A.C., Mustoe L.R and Walker D.	Advanced Engineering Mathematics. 2 nd Edition	John Wiley & Sons, New Delhi.	1989

WEBSITES:

<ol style="list-style-type: none">1. www.intmath.com/plane-analytic-geometry/intro.php2. www.efunda.com3. www.mathcentre.ac.uk4. www.intmath.com/matrices-determinants5. www.wolfran.com

INTENDED OUTCOMES:

- To understand the statics of particles and rigid bodies
- To study the principles involved in friction and kinematics of particles

UNIT I STATICS OF PARTICLES

Forces – system of forces - concurrent forces in plane and space- resultant - problems involving the equilibrium of a particle-free body diagram-equilibrium of particle in space.

UNIT II STATICS OF RIGID BODIES IN TWO DIMENSIONS

Rigid bodies-moment of force about an axis-moment of a couple-equivalent system of coplanar forces-Rigid body in equilibrium-problems involving equilibrium of rigid body-types of supports-reactions of beams and frames.

UNIT III CENTROID, CENTRE OF GRAVITY AND MOMENT OF INERTIA

Centroids of areas, composite areas, determination of moment of inertia of plane figures, polar moment of inertia-radius of gyration – mass moment of inertia of simple solids.

UNIT IV KINEMATICS OF PARTICLES

Introduction-plane, rectilinear motion - time dependent motion-rectangular coordinates-projectile motion.

IMPULSE AND MOMENTUM: Concept of conservation of momentum- Impulse-Momentum principle-Impact-Direct central impact-oblique central impact.

UNIT V FRICTION

Laws of friction-coefficient of friction-problems involving dry friction- wedge and ladder friction.

KINETICS OF PARTICLES: Equations of motion-rectilinear motion-Newton's II law – D'Alembert's principle- Energy - potential energy-kinetic energy-conservation of energy-work done by a force - work energy method.

TEXT BOOKS:

S.NO	AUTHOR(S) NAME	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1	Beer F P and Johnston E.R	Vector Mechanics for Engineers-Statics and Dynamics	Tata Mc-Graw Hill Publishing Co. Ltd., New Delhi.	2009
2	Rajasekaran S and Sankarasubramanian G	Engineering Mechanics-Statics and Dynamics	Vikas Publishing House Pvt. Ltd., New Delhi.	2006

REFERENCES:

S.NO	AUTHOR(S) NAME	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1	Bansal R K	Engineering Mechanics	Laxmi Publications Pvt. Ltd., New Delhi.	2006
2	Young D H and Timashenko S	Engineering Mechanics	Tata McGraw-Hill, New Delhi.	2006
3	Jivan Khachane and Ruchi Shrivastava	Engineering Mechanics: Statics and Dynamics	ANE Books, New Delhi.	2006

WEBSITES:

1. http://nptel.iitm.ac.in/courses/Webcourse-contents/IIT%20Guwahati/engg_mechanics/index.htm
2. <http://nptel.iitm.ac.in/video.php?subjectId=112103108>
3. <http://web.mit.edu/emech/dontindex-build/index.html>
4. <http://www.indiabix.com/engineering-mechanics/questions-and-answers/>

INTENDED OUTCOMES:

- To understand the basic concepts of different types of electrical machines and their performance.
- To study the different methods of starting D.C motors and induction motors.
- To study the conventional and solid-state drives.

UNIT I INTRODUCTION

Basic Elements – Types of Electric Drives – factors influencing the choice of electrical drives – heating and cooling curves – Loading conditions and classes of duty – Selection of power rating for drive motors with regard to thermal overloading and Load variation factors

UNIT II DRIVE MOTOR CHARACTERISTICS

Mechanical characteristics – Speed-Torque characteristics of various types of load and drive motors – Braking of Electrical motors – DC motors: Shunt, series and compound - single phase and three phase induction motors.

UNIT III STARTING METHODS

Types of D.C Motor starters – Typical control circuits for shunt and series motors – Three phase squirrel cage and slip ring induction motors.

UNIT IV SPEED CONTROL OF D.C.DRIVES

Speed control of DC series and shunt motors – Armature and field control, Ward-Leonard control system - Using controlled rectifiers and DC choppers –applications.

UNIT V SPEED CONTROL OF A.C. DRIVES

Speed control of three phase induction motor – Voltage control, voltage / frequency control, slip power recovery scheme – Using inverters and AC voltage regulators – applications.

TEXT BOOKS:

S.NO	AUTHOR(S) NAME	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1	Vedam Subramaniam	Electric Drives (concepts and applications)	Tata McGraw-Hill, New Delhi.	2001
2	Nagrath I.J. and Kothari D.P,	Electrical Machines	Tata McGraw- Hill, New Delhi	2004

REFERENCES:

S.NO	AUTHOR(S) NAME	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1	Pillai.S.K,	A first course on Electric drives	Wiley Eastern Limited, New Delhi.	1998.
2	Singh M.D and Khanchandani K.B,	Power Electronics	Tata McGraw-Hill, New Delhi.	2003

INTENDED OUTCOMES:

To impart knowledge on

- Constructional details, principle of operation and characteristics of various electronic devices
- Digital Electronics Fundamentals
- Fundamentals of Communication systems

UNIT – I SEMICONDUCTORS AND RECTIFIERS

Classification of solids based on energy band theory-Intrinsic semiconductors-Extrinsic semiconductors-P type and N type-PN junction-Zener effect-Zener diode characteristics-Half wave and full wave rectifiers -Voltage regulation.

UNIT – II TRANSISTORS AND AMPLIFIERS

Bipolar junction transistor- CB, CE, CC configuration and characteristics-Biasing circuits-Class A, B and C amplifiers- Field effect transistor-Configuration and characteristic of FET amplifier-SCR, Diac, Triac, UJT-Characteristics and simple applications-Switching transistors-Concept of feedback-Negative feedback-Application in temperature and motor speed control.

UNIT – III DIGITAL ELECTRONICS

Binary number system - AND, OR, NOT, NAND, NOR circuits-Boolean algebra-Exclusive OR gate - Flip flops-Half and full adders-Registers-Counters-A/D and D/A conversion.

UNIT – IV 8085 MICROPROCESSOR

Block diagram of microcomputer-Architecture of 8085-Pin configuration-Instruction set-Addressing modes-Simple programs using arithmetic and logical operations.

UNIT – V INTERFACING AND APPLICATIONS OF MICROPROCESSOR

Basic interfacing concepts - Interfacing of Input and Output devices-Applications of microprocessor Temperature control, Stepper motor control, traffic light control.

TEXT BOOKS:

S.NO	Author(s) Name	Title of the book	publisher	Year of Publication
1	Millman and Halkias	Integrated Electronics	Tata McGraw-Hill publishers, New Delhi.	1995
2	Ramesh Goankar	Microprocessor Architecture Programming and Applications with 8085	Wiley Eastern Limited , Mumbai	1998

REFERENCES:

S.NO	Author(s) Name	Title of the book	publisher	Year of Publication
1	Malvino and Leach	Digital Principles and Applications	Tata McGraw-Hill, NewDelhi	1996
2	Mehta V.K	Principles of Electronics	S. Chand and Company Ltd.,New Delhi	1994
3	Douglas V.Hall	Microprocessor and Interfacing Programming and Hardware	Tata McGraw-Hill, New Delhi	1999
4	Salivahanan S., Suresh Kumar N., Vallavaraj A	Electronic Devices and Circuits I Edition	Tata McGraw-Hill, New Delhi	1999

INTENDED OUTCOMES:

- To have knowledge on computer hardwares and softwares.
- To understand the various data representation techniques.
- To make the students to get knowledge on software engineering methodologies
- To know the correct and efficient ways of solving problems.
- To learn to develop algorithm for simple problem solving.
- To learn to program in C.

UNIT - I COMPUTER BASICS

Evolution of computers- Generations of computers- Classification of computers-Applications of computers- Computer Organization and Architecture- Computer Memory and Storage- Input Output Media.

UNIT - II SOFTWARE, PROGRAMMING AND INTERNET

Algorithm- Flowchart- Pseudo code – Program control structures- Programming paradigms- Programming languages- Generations of Programming languages- Computer Software- Definition- Categories of Software - Terminologies- Internet- Evolution- Basic Internet terms- Getting connected to Internet-Applications

UNIT - III C FUNDAMENTALS

Introduction to C- Constants- Variables- Data types- Operators and Expressions-Managing Input and Output operations- Decision Making and Branching- Looping

UNIT - IV ARRAYS AND FUNCTIONS

Arrays- Character Arrays and Strings- User defined functions- Storage Classes

UNIT - V STRUCTURES AND FILES

Structures- Definition- Initialization- Array of Structures- Structures within structures- Structures and Functions- Unions- File Management in C

REFERENCES:

S.NO	Author(s) Name	Title of the book	publisher	Year of Publication
1	ITL Education Solutions Ltd	Introduction to Information Technology	Pearson Education. Delhi.	2008
2	Rajaraman, V	Fundamentals of Computers. IV Edition	Prentice Hall. New Delhi	2006
3	Byron Gottfried	Programming with C Second Edition	TMH, New Delhi.	2002

PRACTICE

INTRODUCTION: Graphic language, Classification of drawings, Principles of drawing: IS codes for Machine drawing, Lines, Scales, Sections, Dimensioning, Standard abbreviations.

ORTHOGRAPHIC PROJECTIONS: Principles of first and third angle projections, Orthographic projection of points, Projections of straight lines located in first quadrant only, determination of true length and true inclination

PROJECTION OF SOLIDS: Projection of simple solids – Drawing views when the axis of the solid is inclined to one reference plane. Isometric projection – Isometric views of simple solids, truncated prisms, pyramids, cylinders and cones. Perspective projection of solids.

MODELING: 3D modeling of various machine elements using various options like protrusion, cut, sweep, draft, loft, blend, rib. Assembly, creating assembly from parts, assembly constraint, Conversion of 3D solid model to 2D drawing - different views, sections, isometric view and dimensioning.

Note: Any one of the 3D MODELING softwares like Solid works, Pro/E, IDEAS, CATIA, UNIGRAPHICS, AutoCAD to be used.

TEXT BOOKS:

S.NO	Author(s) Name	Title of the book	publisher	Year of Publication
1	Natarajan K.V	Engineering Drawing and Graphics XVII Edition	Private Publisher, Chennai	2003
2	Venugopal K	Engineering Graphics	New Age International (P) Limited , New Delhi.	2002
3	Bhatt.N.D. and Panchal.V.M.,	Machine Drawing	Charotar Publishing House	2003
4	P.S.G. Design Data Book			

REFERENCES:

S.NO	Author(s) Name	Title of the book	publisher	Year of Publication
1	Bertoline and Wiebe	Fundamentals of Graphics Communication III edition	McGraw Hill, New Delhi	2002
2	Warren J. Luzadder and Jon. M.Duff	Fundamentals of Engineering Drawing XI Edition	Prentice Hall of India Pvt. Ltd.,New Delhi	2001
3	Gopalakrishna K.R	Engineering Drawing (Vol. I & II)	Subhas Publications ,Bangalore	1998

PUBLICATION OF BUREAU OF INDIAN STANDARDS:

- IS 10711 – 2001: Technical products Documentation – Size and lay out of drawing sheets.
- IS 9609 (Parts 0 & 1) – 2001: Technical products Documentation – Lettering
- IS 10714 (Part 20) – 2001 & SP 46 – 2003: Lines for technical drawings.
- IS 11669 – 1986 & SP 46 – 2003: Dimensioning of Technical Drawings.
- IS 15021 (Parts 1 to 4) – 2001: Technical drawings – Projection Methods.

SEMESTER II

12PBEME201 ENGINEERING MATHEMATICS II

2 1 0 3 100

INTENDED OUTCOMES:

- To impact analytical skills to the students in the areas of multiple integrals and applications of vector calculus.
- To understand the concepts and applications of laplace transforms.
- To study about analytic functions and complex integration.

UNIT-I MULTIPLE INTEGRALS

Double integration – Cartesian coordinates – Polar coordinates – Change of order of integration – Triple integration in Cartesian co-ordinates – Area as double integrals.

UNIT-II VECTOR CALCULUS

Gradient, Divergence and Curl – Directional derivative – Irrotational and Solenoidal vector fields – Vector integration – Problem solving using Green's theorem, Gauss divergence theorem and Stoke's theorems (Excluding proof)- Simple applications involving cubes and rectangular parallelepipeds.

UNIT-III ANALYTIC FUNCTIONS

Analytic functions - Necessary and Sufficient conditions for an analytic function (without proof) – Cauchy-Riemann equations – Harmonic - Properties of analytic functions – Constructions of an analytic function - Conformal mapping: $w = z+a$, az , $1/z$, Z^2 and bilinear transformation.

UNIT-IV COMPLEX INTEGRATION

Complex Integration - Problems solving using Cauchy's integral theorem and integral formula – Taylor and Laurent expansions - Residues – Cauchy's residue theorem - Applications of Residue theorem to evaluate real integrals.

UNIT-V LAPLACE TRANSFORMS

Transforms of elementary functions – Basic properties – Transforms of derivatives and integrals – Initial and final value theorems. Inverse Laplace transforms – Convolution theorem – Solution of Ordinary Differential Equations with constant coefficients using Laplace transforms – Transform of periodic functions

TEXT BOOKS:

S. NO.	AUTHOR(S) NAME	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1	Veerarajan, T.	Engineering Mathematics for first year	Tata McGraw-Hill Publishing Company Limited, New Delhi.	2007
2	Sundaram, V. Lakhminarayan, K.A. and Balasubramanian, R.	Engineering Mathematics for first year	Vikas Publishing Home , New Delhi	2006

REFERENCES:

S. NO.	AUTHOR(S) NAME	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1	Erwin Kreyszig	Advanced Engineering Mathematics.	John Wiley & Sons	1999
2	Glyn James	Advanced Modern Engineering Mathematics,	Pearson Education Ltd, New Delhi	2004
3	Bali, N. P. and Manish Goyal	Text book of Engineering Mathematics.	Laxmi Publications (p) Ltd., Chennai	2008
4	Venkataraman, M. K.	Engineering Mathematics.	The National Publishing Company, Chennai	2004
5	Narayanan. S, Manicavachagam pillay.T.K and Ramaniah.G	Advanced Mathematics for Engineering Students.	Viswanathan S.(Printers and Publishers) Pvt. Ltd. Chennai.	2002

WEBSITES:

<ol style="list-style-type: none">1. www.maths-dur.ac2. www.efunda.com3. www.mathcentre.ac.uk4. www.sosmath.com/diffeq/laplace/basic/basic.html

INTENDED OUTCOMES:

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

Review (Not for Exam):

Crystal structure – BCC, FCC and HCP structure – unit cell – crystallographic planes and directions, miller indices – crystal imperfections, point, line, planar and volume defects – Grain size, ASTM grain size number.

UNIT I CONSTITUTION OF ALLOYS AND PHASE DIAGRAMS

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

UNIT II HEAT TREATMENT

Definition – Full annealing, stress relief, recrystallisation and spheroidizing –normalising, hardening and tempering of steel. Isothermal transformation diagrams – cooling curves superimposed on IT diagram CCT - Hardenability, Jominy end quench test – Austempering, martempering – case hardening, carburising, nitriding, cyaniding, carbonitriding – Flame and Induction hardening.

UNIT III FERROUS AND NON FERROUS METALS

Effect of alloying additions on steel (**Mn, Si, Cr, Mo, V, Ti & W**) - stainless and tool steels – HSLA - maraging steels – Gray, White malleable, spheroidal - Graphite - alloy cast irons Copper and Copper alloys – Brass, Bronze and Cupronickel – Aluminum and Al-Cu – precipitation strengthening treatment – Bearing alloys.

UNIT IV NON-METALLIC MATERIALS

Polymers – types of polymer, commodity and engineering polymers – Properties and Applications of thermoplastics (PP,PVC,APS,PMMA) and thermosetting plastics(PF,UF,MF) –Engineering Ceramics –Introduction to Fibre reinforced plastics.

UNIT V MECHANICAL PROPERTIES AND TESTING

Mechanism of plastic deformation, slip and twinning – Types of fracture – Testing of materials under tension, compression and shear loads – Hardness tests (Brinell, Vickers and Rockwell), Impact test - Izod and Charpy, Fatigue and creep properties.S-N curves fatigue and creep testing.toughness tests.

NON DESTRUCTIVE TESTING: Non Destructive Testing basic principles and testing method for Radiographic testing, Ultrasonic testing, Magnetic particle inspection and Liquid penetrant inspections, Eddy current testing.

TEXT BOOK:

S.NO	AUTHOR(S) NAME	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1	Kenneth G.Budinski and Michael K.Budinski	Engineering Materials	Prentice-Hall of India Private Limited , New Delhi.	2010

REFERENCES:

S.NO	AUTHOR(S) NAME	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1	William D. Callister & David G. Rethwisch	Material Science and Engineering	John Wiley and Sons, Delhi	2010
2	Raghavan.V	Materials Science and Engineering	Prentice Hall of India Pvt., Ltd, New Delhi.	2006
3	Shackelford, J.F.,	Introduction to Materials Science for Engineers	Pearson Edition	2009

WEBSITES :

1. www.materials.unsw.edu.au
2. ocw.MIT.edu
3. www.istl.org
4. metalurgy-screw-tutorial.tobyavujo.com

INTENDED OUTCOMES:

- To gain knowledge of simple stresses, strains and deformation in components due to external loads.
- To assess stresses and deformations through mathematical models of beams, twisting bars or combinations of both.
- Effect of component dimensions and shape on stresses and deformations are to be understood.

UNIT I STRESS, STRAIN AND DEFORMATION OF SOLIDS

Rigid and Deformable bodies – Strength, Stiffness and Stability – Stresses; Tensile, Compressive and Shear – Deformation of simple and compound bars under axial load – Thermal stress – Elastic constants – Strain energy and unit strain energy – Strain energy in uniaxial loads.

UNIT II BEAMS - LOADS AND STRESSES

Types of beams: Supports and Loads – Shear force and Bending Moment in beams – Cantilever, Simply supported and Overhanging beams – Stresses in beams – Theory of simple bending – Stress variation along the length and in the beam section – Effect of shape of beam section on stress induced – Shear stresses in beams – Shear flow.

UNIT III TORSION

Analysis of torsion of circular bars – Shear stress distribution – Bars of solid and hollow circular section – Stepped shaft – Twist and torsion stiffness – Compound shafts – Fixed and simply supported shafts – Application to close-coiled helical springs – Maximum shear stress in spring section including Wahl Factor – Deflection of helical coil springs under axial loads – Design of helical coil springs – stresses in helical coil springs under torsion loads

UNIT IV BEAM DEFLECTION

Elastic curve of Neutral axis of the beam under normal loads – Evaluation of beam deflection and slope: Double Integration method, Macaulay Method, and Moment-area Method –Columns – End conditions – Equivalent length of a column – Euler equation – Slenderness ratio – Rankine's formula for columns

UNIT V ANALYSIS OF STRESSES IN TWO DIMENSIONS

Biaxial state of stresses – Thin cylindrical and spherical shells – Deformation in thin cylindrical and spherical shells – Biaxial stresses at a point – Stresses on inclined plane – Principal planes and stresses – Mohr's circle for biaxial stresses – Maximum shear stress - Strain energy in bending and torsion.

TEXT BOOKS:

S.NO	AUTHOR(S) NAME	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1	Punmia B.C and Jain A.K,	Strength of Materials and Theory of Structures - Vol.1	Laxmi Publications New Delhi	1992
2	Ramamrutham S and Narayan R	Strength of Materials	Dhanpat Rai and Sons., New Delhi.	2008

REFERENCES:

S.NO	AUTHOR(S) NAME	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1	Jindal U C	Textbook on Strength of Materials	Asian Books Pvt, Ltd, Chennai.	2007
2	Don H Morris, William F Riley and Leroy D Sturges	Mechanics of Materials	John Wiley and Sons Inc.	2001
3	Popov E P	Mechanics of Materials	Prentice Hall Inc., Englewood Cliffs, New Jersey.	1976
4	Bedi D S	Strength of Materials	S Chand and Co. Ltd., New Delhi.	1984

WEBSITES :

<ol style="list-style-type: none">1. www.engineersedge.com2. http://en.wikiversity.org3. www.globalsources.com4. www.dspace.cusat.ac.in
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INTENDED OUTCOMES:

- To introduce the students the concepts of some basic manufacturing processes and fabrication techniques, such as metal casting, metal joining, metal forming and plastics component manufacture.

UNIT - I FOUNDRY EQUIPMENTS AND MATERIALS

Patterns. Moulds-types of moulds, moulding sand characteristics and testing procedures. Core making, melting furnaces.

UNIT - II PRODUCTION OF CASTINGS

Processes-shell moulding, investment castings, centrifugal castings, die casting. Gating and risering. Fettling and cleaning of casting. Inspection and testing of castings. Casting defects and remedies.

UNIT - III GAS WELDING

Oxy-acetylene welding, types of flames, welding torches, welding techniques.

ARC WELDING AND RESISTANCE WELDING

Arc welding-carbon arc, shielded metal arc, submerged arc, TIG and MIG welding. Welding electrodes-function and characteristics of electrode coating. Resistance welding-spot, seam, projection and butt welding, heat flow in welded components. Other welding process, Laser beam welding, Electron beam welding. Friction welding, Friction stir welding and Ultra sonic welding.

UNIT - IV METAL FORMING PROCESSES

Cold and hot working, rolling, drawing, extrusion and forging, sheet metal cutting, bending. Drawing applications, defects. Types of presses.

UNIT - V SPECIAL FORMING METHODS

Explosive forming, electro magnetic forming, electro hydraulic forming, powder metallurgy process, composite mouldings.

INTRODUCTION TO SOFTWARE FOR MANUFACTURING APPLICATIONS

Metal forming and flow analysis software (for metallic /plastic components).

TEXT BOOKS:

S.NO	Author(s) Name	Title of the book	publisher	Year of Publication
1	Heine R W, Loper C.R., and Rosenthal P.C	Principles of Metal Casting	Tata McGraw Hill Publishing Co. Ltd., New Delhi	2005
2	Rao P N	Manufacturing Technology	Tata McGraw Hill Publishing Co. Ltd., New Delhi	1998
3	Khanna O P	Welding Technology	Dhanpat Rai and Sons, New Delhi	1994
4	Kalpakjian	Manufacturing Engineering and Technology III Edition	Addison-Wesley Publishing Company, Inc.,New Delhi	1995

REFERENCES:

S.NO	Author(s) Name	Title of the book	publisher	Year of Publication
1	SME	Tool and Manufacturing Engineers Handbook Vol., 2	McGraw Hill Book Co., New York	1984
2	Parmar R.S	Welding Processes and Technology	Khanna Publishers, Delhi	1992
3	Krishna K Chawla	Composite Materials-Science and Engineering	Springer Verlag, New York	1987
4	William K Dalton, Gregg Bruce R	Modern Materials and Manufacturing Processes	Pearson Education, Delhi	2007
5	Elanchezhian C, Vijaya Ramnath B	Manufacturing Technology – 1	Easwar Press, Chennai	2005
6	Peter Beeley	Foundry Technology Second Edition	Butterworth, Penang	2005
7	Baldev Raj and V Shankar	Welding Technology For Engineers	Narosa Book Distributors Pvt. Ltd., Chennai	2006

WEBSITES:

1. www.themetalcasting.com
2. www.industrialmetalcastings.com
3. www.purolator-lp.com
4. www.manufacturercompanies.com/manufacturers
5. www.amtonline.org

INTENDED OUTCOMES:

- To make the students to understand the principles of metrology and measurements.
- To expose the students to the methods of measurement and its application in manufacturing industries.
- To enable the students to use LASER technology in measurements.

UNIT I CONCEPT OF MEASUREMENT

General concept – generalised measurement system- units and standards-measuring instruments-sensitivity, readability, range of accuracy, precision-static and dynamic response-repeatability-systematic and random errors - correction, calibration, interchangeability.

UNIT II LINEAR AND ANGULAR MEASUREMENT

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

UNIT III FORM MEASUREMENT

Measurement of screw threads-Thread gauges, floating carriage micrometer-measurement of gears-tooth thickness-constant chord and base tangent method-Gleason gear testing machine – radius measurements-surface finish, straightness, flatness and roundness measurements.

UNIT IV LASER AND ADVANCES IN METROLOGY

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

UNIT V MEASUREMENT OF POWER, FLOW AND TEMPERATURE RELATED PROPERTIES

Force, torque, power:-mechanical, pneumatic, hydraulic and electrical type-Flow measurement: Venturi, orifice, rotameter, pitot tube –Temperature: bimetallic strip, pressure thermometers, thermocouples, electrical resistance thermister.

TEXT BOOKS:

S.NO	AUTHOR(S) NAME	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1	Jain R.K	Engineering Metrology	Khanna Publishers, Delhi.	2002
2	Alan S. Morris	The Essence of Measurement	Prentice Hall of India, New Delhi.	1997

REFERENCES:

S.NO	AUTHOR(S) NAME	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1	Gupta S.C	Engineering Metrology	Dhanpat rai Publications, New Delhi.	2005
2	Tayal A.K,	Instrumentation and Mechanical Measurements	Galgotia Publications, New Delhi.	2000
3	Beckwith T.G and N. Lewis Buck N	Mechanical Measurements	Addison Wesley, New york.	2006
4	Donald D Eckman	Industrial Instrumentation	ASTM Hand Book, Wiley Eastern, New Delhi.	1990

WEBSITES :

1. www.tms.org
2. www.arci.res.in/
3. www.fbh-berlin.com
4. www.lasermetrology.com/
5. www.lasermetrology.com/

PRACTICALS:

12PBEME211

STRENGTH OF MATERIALS AND METROLOGY LAB

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LIST OF EXPERIMENTS

PART – A:

1. Tensile test on metals-stress strain characteristics
2. Cupping test on metal sheets-load deformation characteristics, cupping load, cupping number.
3. Hardness test on metals-Brinell, Vicker and Rockwell Hardness tests.
4. Impact test on metals-Charpy, Izod impact tests.
5. Shear test on metals-direct shear strength, single shear, double shear.
6. Tests on helical springs-compression, tension springs-load deformation characteristics, stiffness, shear stress, modulus of rigidity, energy.
7. Torsion test on beams-torque and angle of twist characteristics, shear stress, modulus of rigidity, energy.
8. Microscopic examination of i) Hardened samples ii) Hardened and tempered samples.
9. Tempering – Improvement of Mechanical properties –Comparison for i) Unhardened specimen ii) Quenched specimen iii) Quenched and tempered specimen.
10. Study of low carbon steel and medium carbon steel.

PART – B:

1. Calibration of Vernier / Micrometer / Dial Gauge
2. Checking Dimensions of part using slip gauges
3. Measurements of Gear Tooth Dimensions – Addendum, Dedendum, and Pitch circle diameter and Tooth thickness.
4. Measurement of Taper Angle using sine bar / tool makers microscope
5. Measurement of straightness and flatness
6. Measurement of thread parameters
7. Checking the limits of dimensional tolerances using comparators (Mechanical / Pneumatic / Electrical)
8. Measurement of Temperature using Thermocouple / Pyrometer
9. Measurement of Displacement (Strain Gauge / LVDT / Wheatstone bridge)
10. Measurement of Force
11. Measurement of Vibration / Shock

SEMESTER III

12PBEME301

ENGINEERING MATHEMATICS III

2 1 0 3 100

INTENDED OUTCOMES:

- To develop the skills of the students in the areas of transforms and partial differential equations.
- To understand the applications of partial differential equations.

UNIT- I **FOURIER SERIES**

Dirichlet's conditions – General Fourier series – Odd and even functions – Half range sine series – Half range cosine series – Complex form of Fourier Series – Parseval's identify – Harmonic Analysis.

UNIT -II **FOURIER TRANSFORM**

Fourier integral theorem (without proof) – Fourier transform pair –Sine and Cosine transforms – Properties – Transforms of simple functions – Convolution theorem – Parseval's identity.

UNIT- III **PARTIAL DIFFERENTIAL EQUATIONS**

Formation of partial differential equations by elimination of arbitrary constants and arbitrary functions – Solution of standard types of first order partial differential equations – Lagrange's linear equation – Linear partial differential equations of second and higher order with constant coefficients.

UNIT- IV **APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS**

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

UNIT- V **Z -TRANSFORM AND DIFFERENCE EQUATIONS**

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

TEXT BOOK:

S. NO.	AUTHOR(S) NAME	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1	Kandasamy,P., Thilagavathy,K. and Gunavathy,K.	Engineering Mathematics Volume III.	S. Chand & Company Ltd., New Delhi.	1998

REFERENCES:

S. NO.	AUTHOR(S) NAME	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1	Andrews, L.A. and Shivamoggi B.K.	Integral Transforms for Engineers and Applied Mathematicians	Macmillen, New York	1988
2	Narayanan, S., Manicavachagom Pillay, T.K. and Ramaniah, G	Advanced Mathematics for Engineering Students. Volumes II and III,	Viswanathan S Printers and Publishers Pvt. Ltd. Chennai.	2002
3	Churchill, R.V. and Brown, J.W.	Fourier Series and Boundary Value Problems	McGraw-Hill Book Co., Singapore.	1987
4	Wylie C. Ray and Barrett Louis, C.	Advanced Engineering Mathematics	McGraw-Hill, Inc., New York	1995
5	Grewal, B.S.	Higher Engineering Mathematics	Khanna Publishers, Delhi.	2001

WEBSITES :

<ol style="list-style-type: none">1. www.sosmath.com2. http://mathworld.wolfram.com/FourierSeries.html3. http://www.math.umn.edu/~olver/pdn.html4. http://www.facstaff.bucknell.edu/mastascu/econtrolhtml/sampled/sampled.html
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INTENDED OUTCOMES:

- To understand the structure and the properties of the fluid.
- To analyse and appreciate the complexities involved in solving the fluid flow problems.
- To understand the energy exchange process in fluid mechanics handling incompressible fluids.

UNIT I FLUID PROPERTIES

Units & measurement - Fluid properties - Density, Specific gravity, Viscosity, Surface tension, capillarity - Pascal's Law - pressure measurements — manometers. Fluid statics - Total pressure and centre of pressure - buoyancy and floatation- metacentre and metacentric height (definition only)

UNIT II FLUID KINEMATICS AND FLUID DYNAMICS

Fluid Kinematics - Flow visualization - lines of flow - types of flow - velocity field and acceleration - continuity equation (one and three dimensional differential forms)- Equation of streamline - stream function - velocity potential function - circulation - flow net – fluid dynamics - equations of motion - Euler's equation along a streamline - Bernoulli's equation – applications - Venturimeter, Orifice meter, Pitot tube - dimensional analysis - Buckingham's π theorem- applications - similarity laws and models.

UNIT III INCOMPRESSIBLE FLUID FLOW

Viscous flow - Navier-Stoke's equation (Statement only) - Shear stress, pressure gradient relationship - laminar flow between parallel plates - Laminar flow through circular tubes (Hagen Poiseuille's) - Hydraulic and energy gradient - flow through pipes - Darcy -Weisback's equation - pipe roughness - friction factor- Moody's diagram-minor losses - flow through pipes in series and in parallel - power transmission - Boundary layer flows, boundary layer thickness, boundary layer separation - drag and lift coefficients.

UNIT IV HYDRAULIC TURBINES

Fluid machines: definition and classification - exchange of energy - Euler's equation for turbo machines - Construction of velocity vector diagrams - head and specific work - components of energy transfer - degree of reaction.

Hydro turbines: definition and classifications - Pelton turbine - Francis turbine - propeller turbine - Kaplan turbine - working principles - velocity triangles - work done - specific speed - efficiencies - performance curve for turbines.

UNIT V HYDRAULIC PUMPS

Classification - centrifugal pump-working principle-head, discharge, efficiencies and losses - performance curves - specific speed. Reciprocating pump-components and working-slip-indicator diagram - air vessel - Jet pump - Gear pump - Submersible pump.

TEXT BOOKS:

S.NO	AUTHOR(S) NAME	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1	Streeter V.L, and Wylie E.B	Fluid Mechanics	McGraw-Hill, New Delhi.	1998
2	Kumar K.L	Engineering Fluid Mechanics	S. Chand	2004

REFERENCES:

S.NO	AUTHOR(S) NAME	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1	Bansal, R.K.,	Fluid Mechanics and Hydraulics Machines	Laxmi publications (P) Ltd, New Delhi.	2005
2	White, F.M	Fluid Mechanics	Tata McGraw-Hill, New Delhi.	2008
3	Fox and McDonald	Fluid Mechanics	John Wiley	2006

WEBSITES:

<ol style="list-style-type: none">1. www.imeche.org2. openlibrary.org3. nptel.iitg.ernet.in4. www.tequipment.com

INTENDED OUTCOMES:

- To understand the layout of linkages in the assembly of a system/machine.
- To study the principles involved in assessing the displacement, velocity and acceleration at any point in a link of a mechanism
- To analyse the motion resulting from a specified set of linkages in a mechanism.

UNIT I BASICS OF MECHANISMS

Terminology and Definitions-Degree of Freedom - Mobility-Kutzbach criterion-Grashoff's law-Kinematic Inversions of 4-bar chain and slider crank chains-Mechanical Advantage-Transmission angle-Description of common Mechanisms-Single, double and offset slider mechanisms - Quick return mechanisms - Ratchets and escapements - Indexing Mechanisms - Rocking Mechanisms - Straight line generators-Design of Crank-rocker Mechanisms.

UNIT II KINEMATICS

Displacement, velocity and acceleration - analysis in simple mechanisms - Graphical Method velocity and acceleration polygons - Kinematic analysis by Complex Algebra methods-Vector Approach, Computer applications in the kinematic analysis of simple mechanisms- Instantaneous center – Coriolis Acceleration.

UNIT III KINEMATICS OF CAM

Classifications - Displacement diagrams-parabolic, Simple harmonic and Cycloidal motions - Layout of plate cam profiles - Derivatives of Follower motion - High speed cams - circular arc and tangent cams - Standard cam motion - Pressure angle and undercutting.

UNIT IV GEARS

Spur gear Terminology and definitions-Fundamental Law of toothed gearing and involute gearing-Inter changeable gears-gear tooth action – Terminology - Interference and undercutting-Non standard gear teeth- Helical, Bevel, Worm, Rack and Pinion gears (Basics only)-Gear trains-Parallel axis gear trains-Epicyclic gear trains-Differentials

UNIT V FRICTION

Surface contacts-Sliding and Rolling friction - Friction drives – Friction in screw threads - Friction clutches - Belt and rope drives, Friction aspects in Brakes – Friction in vehicle propulsion and braking.

TEXT BOOKS:

S.NO	Author(s) Name	Title of the book	publisher	Year of Publication
1	Rattan S.S	Theory of Machines	Tata McGraw-Hill Publishing Company Ltd., New Delhi.	1998
2	Shigley J.E and Uicker J J	Theory of Machines and Mechanisms	McGraw-Hill, Inc, New York.	1995

REFERENCES:

S.NO	Author(s) Name	Title of the book	publisher	Year of Publication
1	Thomas Bevan	Theory of Machines	CBS Publishers and Distributors, New Delhi.	1984
2	Ghosh A and Mallick A.K,	Theory of Mechanisms and Machines	Affiliated East-West Pvt. Ltd., New Delhi.	1988
3	Rao J.S and Dukkipati R.V	Mechanism and Machine Theory	Wiley-Eastern Ltd., New Delhi.	1992
4	John Hannah and Stephens R.C	Mechanics of Machines Viva Low-Prices Student Edition	Wiley-Eastern. Ltd., New Delhi .	1999

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.

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 : Part 2: 1988 Bevel Gear Systems Part – 2 Spiral Bevel Gears

INTENDED OUTCOMES:

- To provide in-depth study of thermodynamic principles, thermodynamics of state, basic thermodynamic relations, Principle of Psychrometry & Properties of pure substances
- To enlighten the basic concepts of vapour power cycles.

UNIT I BASIC CONCEPTS AND FIRST LAW

Basic concepts - classical and statistical approaches, scope and limitation - Thermodynamic systems - closed, open, isolated and adiabatic- property, state, process, quasi-static process, cycle, point and path function, work, energy- Zeroth law of thermodynamics – concept of temperature and heat - concept of ideal and real gases - First law of thermodynamics – application to closed and open systems, PMM1, internal energy, specific heat capacities, enthalpy, steady flow energy equation - engineering applications

UNIT II SECOND LAW AND ENTROPY

Physical description of the second law - Kelvin-Planck and Clausius statements - equivalence. Reversible processes and cycles. Carnot cycle – corollaries - Absolute temperature scale. Entropy – Entropy of fluids and gases - directional law of nature, Clausius inequality – Third law of thermodynamics

UNIT III THERMODYNAMIC AVAILABILITY

Basics – Energy in non-flow processes: Expressions for the energy of a closed system- Equivalence between mechanical energy forms and energy – Flow of energy associated with heat flow – Energy consumption and entropy generation. Energy in steady flow processes : Expressions for energy in steady flow processes – Energy dissipation and entropy generation.

UNIT IV PROPERTIES OF PURE SUBSTANCE AND IDEAL & REAL GASES

Pure substance, phase, phase change process, property diagrams, PVT surface-Gas mixtures- properties of ideal and real gases, equation of state, Avagadro's law, Vander Waal's equation of states, compressibility and its chart. Dalton's law of partial pressure, exact differentials-T-D, relations, Maxwell relations, Clausius Clapeyron equations, Joule Thomson Coefficient.

UNIT V PSYCHROMETRY

Psychrometry and psychrometric charts, property calculations of air vapour mixtures- Psychrometric process- sensible and latent heat exchange processes-Adiabatic mixing, evaporative cooling -problems.

(Use of standard Steam table, Mollier diagram and Psychometric chart are permitted in the examination)

TEXT BOOKS:

S.NO	AUTHOR(S) NAME	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1	Nag.P.K	Engineering Thermodynamics	Tata McGraw-Hill, New Delhi.	2008

REFERENCES:

S.NO	AUTHOR(S) NAME	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1	Kothandaraman C.P. and Domkundwar S	Engineering Thermodynamics	Dhanpatrai & sons, New Delhi	2004
2	Holman.J.P	Thermodynamics	McGraw-Hill, NewDelhi.	1988
3	Yunus Cengel,Michael Bones	Thermodynamics-An Engineering Approach	Tata McGraw-Hill, New Delhi.	2008

WEBSITES :

<ol style="list-style-type: none">1. ocw.MIT.edu2. www.qrg.northwestern.edu3. www.itiomar.it4. me.cramster.com

PRACTICALS:

12PBEME311 ELECTRICAL & ELECTRONICS ENGINEERING LAB 0 0 3 1 100

LIST OF EXPERIMENTS

1. Load test on DC Shunt & DC Series motor
2. O.C.C & Load characteristics of DC Shunt and DC Series generator
3. O.C & S.C Test on a single phase transformer
4. Regulation of an alternator by EMF & MMF methods.
5. Load test and speed control of three phase squirrel cage Induction motor (voltage / frequency)
6. Study of DC & AC Starters
7. Study of Logic Gates (Basic Gates)
8. Half Adder and Full Adder
9. Shift Registers and Counters
10. Operational Amplifier (Adder, Subtractor, Differentiator, Integrator, Inverting and Non - Inverting)

12PBEME312 FLUID MECHANICS AND MACHINERY LAB 0 0 3 1 100

LIST OF EXPERIMENTS

1. Determination of the Coefficient of discharge of given Orifice meter.
2. Determination of the Coefficient of discharge of given Venturi meter.
3. Calculation of the rate of flow using Rota meter.
4. Determination of friction factor for a given set of pipes.
5. Conducting experiments and drawing the characteristic curves of centrifugal pump
6. Conducting experiments and drawing the characteristic curves of submergible pump
7. Conducting experiments and drawing the characteristic curves of reciprocating pump.
8. Conducting experiments and drawing the characteristic curves of Gear pump.
9. Conducting experiments and drawing the characteristic curves of Pelton wheel.
10. Conducting experiments and drawing the characteristics curves of Francis turbine.

SEMESTER IV

12PBEME401

DESIGN OF MACHINE ELEMENTS

2 1 0 2 100

INTENDED OUTCOMES:

- 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

Introduction to the design process - factor influencing machine design, selection of materials based on mechanical properties – Direct, Bending and torsional stress equations – Impact and shock loading – calculation of principle stresses for various load combinations, eccentric loading – Design of curved beams – crane hook and ‘C’ frame - Factor of safety - theories of failure – stress concentration – design for variable loading – Soderberg, Goodman and Gerber relations.

UNIT II DESIGN OF SHAFTS AND COUPLINGS

Design of solid and hollow shafts based on strength, rigidity and critical speed – Design of keys and key ways - Design of rigid and flexible couplings – Introduction to gear and shock absorbing couplings - design of knuckle joints.

UNIT III DESIGN OF FASTNERS AND WELDED JOINTS

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

UNIT IV DESIGN OF SPRINGS AND LEVERS

Design of helical, leaf, disc and torsional springs under constant loads and varying loads – Concentric torsion springs - Belleville springs – Design of Levers.

UNIT V DESIGN OF BEARINGS AND FLYWHEELS

Design of bearings – sliding contact and rolling contact types – Cubic mean load – Design of journal bearings – McKees equation – Lubrication in journal bearings – calculation of bearing dimensions – Design of flywheels involving stresses in rim and arm.

(Use of standard data books is permitted in the examination)

TEXT BOOKS:

S.NO	AUTHOR(S) NAME	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1	Juvinall R.C and Marshek K.M	Fundamentals of Machine Component Design Third Edition	John Wiley & Sons, New Delhi.	2002
2	Bhandari V.B,	Design of Machine Elements	Tata McGraw-Hill Book Co, New Delhi.	2003

REFERENCES:

S.NO	AUTHOR(S) NAME	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1	Norton R.L	Design of Machinery	Tata McGraw-Hill Book Co., New Delhi.	2004
2	Orthwein W	Machine Component Design	Jaico Publishing Co., New Delhi.	2003
3	Ugural A.C,	Mechanical Design – An Integral Approach	McGraw-Hill Book Co., New York.	2004
4	Spotts M.F, Shoup T.E,	Design and Machine Elements	Pearson Education, New Delhi.	2004

WEBSITES :

1. www.roymech.co.uk
2. www.ncbi.nlm.nih.gov
3. www.engineersedge.com
4. www.bearings.machinedesign.com
5. www.efunda.com

INTENDED OUTCOMES:

- To integrate the concepts, laws and methodologies from the first course in thermodynamics into the analysis of cyclic process.
- To apply the thermodynamic concepts into various thermal applications like Steam turbines, Compressors and Refrigeration and Air conditioning Systems.

UNIT I GAS POWER CYCLES

Stirling, Ericsson, Otto, Diesel, Dual, Lenoir, Atkinson, Brayton cycles - Calculation of mean effective pressure and air standard efficiency - actual and theoretical PV diagrams of four stroke and two stroke engines.

UNIT II INTERNAL COMBUSTION ENGINES

Classification of I.C engines, four stroke and two stroke cycle engines - combustion phenomenon and characteristics - combustion chamber design in SI and CI engine - detonation, knocking, delay period - timing diagrams – super-charging - ignition system and fuel injection system. Engine tests - performance, heat balance, retardation - Morse test.

UNIT III NOZZLES, TURBINES & STEAM POWER CYCLES

Steam nozzles- flow through steam nozzles, effect of friction, critical pressure ratio, super saturated flow - Steam turbines- impulse and reaction turbine, compounding, velocity diagram, condition for maximum efficiency - multi stage turbines, conditional lines, cycles with reheating and regenerating heating - reheat factor, degree of reaction, governing of turbines - Steam power cycle-properties of steam, Rankine Cycle - Determination of Dryness fraction of steam.

UNIT IV AIR COMPRESSORS

Classifications of compressors - Reciprocating air compressor - performance characteristics, effect of clearance volume, free air delivery and displacement, intercooler, after cooler - Rotary compressor - vane type, centrifugal and axial, flow performance characteristics - Screw compressor - performance characteristics

UNIT V REFRIGERATION AND AIR CONDITIONING

Fundamentals of refrigeration – COP - Vapour compression refrigeration system - cycle, p-h chart, Vapour absorption system- comparison, properties of refrigerants. Fundamentals of air conditioning system, cycle, controls, air handling and distribution, simple cooling and heat load estimation

(Use of standard thermodynamic table, Mollier diagram, Psychometric chart and Refrigeration property table is permitted in the examination)

TEXT BOOKS:

S.NO	AUTHOR(S) NAME	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1	Rajput R.K	Thermal Engineering Sixth edition	Laxmi Publications, New Delhi.	2010
2	Arora C.P	Refrigeration and Air conditioning	Tata McGraw-Hill, New Delhi.	2002

REFERENCES:

S.NO	AUTHOR(S) NAME	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1	Kothandaraman C.P, Domkundwar and Domkundwar A.V	A course in Thermal Engineering Fifth Edition	Dhanpat Rai & Sons, Delhi.	2002
2	Ganesan V	Internal Combustion Engines	Tata McGraw-Hill, New Delhi.	2008
3	Cengel	Thermodynamics An Engineering Approach	Third Edition, Tata McGraw Hill, New Delhi.	2008

WEBSITES :

1. www.kruse-ltc.com
2. www.grc.nasa.gov
3. www.poweronsite.org
4. www.machinerylubrication.com
5. www.tpub.com
6. www.engineeringtoolbox.com
7. www.scribd.com/

INTENDED OUTCOMES:

- To understand the force-motion relationship in components subjected to External Forces
- To analyse the force-motion characteristics of standard mechanisms
- To study the undesirable effects of unbalances resulting from prescribed motions in mechanism.
- To visualise the effect of Dynamics of Undesirable Vibrations
- To understand the principles in mechanisms used for governing of machines.

UNIT I FORCE ANALYSIS

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

UNIT II BALANCING

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

UNIT III FREE VIBRATION

Basic features of vibratory systems - idealized models - Basic elements and lumping of parameters - Degrees of freedom - Single degree of freedom - Free vibration - Equations of motion - natural frequency - Types of Damping - Damped vibration critical speeds of simple shaft - Torsional systems; Natural frequency of two and three rotor systems.

UNIT IV FORCED VIBRATION

Response to periodic forcing - Harmonic Forcing - Forcing caused by unbalance - Support motion – Force transmissibility and amplitude transmissibility - Vibration isolation.

UNIT V MECHANISMS FOR CONTROL

Governors - Types - Centrifugal governors - Gravity controlled and spring controlled centrifugal governors –Characteristics - Effect of friction - Controlling Force - other Governor mechanisms. Gyroscopes - Gyroscopic forces and Torques - Gyroscopic stabilization - Gyroscopic effects in Automobiles, ships and airplanes

TEXT BOOKS:

S.NO	Author(s) Name	Title of the book	publisher	Year of Publication
1	Rattan S.S	Theory of Machines	Tata McGraw-Hill Publishing Company Ltd., New Delhi.	1994
2	Shigley J.E. and Uicker J.J	Theory of Machines and Mechanisms	McGraw-Hill, New York.	1995

REFERENCES:

S.NO	Author(s) Name	Title of the book	publisher	Year of Publication
1	Rao J.S. and Dukkipati R.V	Mechanism and Machine Theory	Wiley- Eastern Limited, New Delhi.	1992
2	John Hannah and Stephens R.C	Mechanics of Machines	Viva low-Priced Student Edition, chennai.	1999
3	Thomas Bevan	Theory of Machines	CBS Publishers and Distributors, New Delhi.	1984

WEBSITES :

1. http://freevideolectures.com/Course/2364/Dynamics-of-Machines
2. http://en.wikipedia.org/wiki/Balancing_of_rotating_masses
3. http://www.efunda.com/formulae/vibrations/sdof_free_damped.cfm
4. http://www.roymech.co.uk/Useful_Tables/Vibrations/Free_Vibrations.html

INTENDED OUTCOMES :

- To give a comprehensive insight into natural resources, ecosystem and biodiversity.
- To educate the ways and means to protect the environment from various types of pollution.
- To impart some fundamental knowledge on human welfare measures.

UNIT - I PLANET EARTH

Atmosphere – Planet Earth – Biosphere – Hydrosphere – Lithosphere – Ecosystem and Bio diversity – endemic and endangered species – habitat – wet lands –deforestation – hotspot – composition of atmosphere – Troposphere – stratosphere mesosphere – thermosphere – ozone and ozone depletion – Air pollution – pollution sources, effects and control – green house effect and global warming – climate change – Case Studies in current scenario.

UNIT - II HYDROLOGIC CYCLE

Water – hydrologic cycle – ground water – water shed – water use and quality – point and non-point sources of pollution – oceans and fisheries – salinity – temperature – density – pressure – light – bioluminescence – tsunamis – glaciers – water pollution – dissolved oxygen – surface water treatment – waste water treatment – acid rain – thermal pollution, noise pollution and control - case studies in current scenario.

UNIT - III LAND

Land – weathering and erosion - types of weathering – types of soil – soil erosion – land slides – deserts – types – desertification – land degradation – features of desert – geochemical cycling – solid and hazardous waste, chemical waste, radio active waste – non hazardous waste - case Studies in current scenario.

UNIT – IV ENERGY

Future policy and alternatives – fossil fuels – nuclear energy – solar energy – wind energy – hydroelectric energy – geothermal energy – tidal energy – sustainability – green power – nano technology – international policy - case studies in current scenario.

UNIT - V ENVIRONMENT PROTECTION

Biogeographical classification of India – Biodiversity in India – India as mega diversity nation – hotspots of biodiversity in India – threats to biodiversity – conservation of biodiversity – environment protection act – issues and possible solution – population growth - population explosion – environment and human health - case Studies in current scenario.

TEXT BOOKS:

S.NO	Author(s) Name	Title of the book	publisher	Year of Publication
1	Gilbert M.Masters	Introduction to Environmental Engineering and Science Second Edition	Pearson Education Pvt., Ltd.,New Delhi.	2004
2	Miller T.G. Jr	Environmental Science	Wadsworth Publishing Co online , Belmont , NA..	-
3	Townsend C., Harper J and Michael Begon	Essentials of Ecology	Blackwell Science.	-
4	Trivedi R.K. And Goel P.K,	Introduction to Air Pollution	Techno-Science Publications.	-

REFERENCE:

S.NO	Author(s) Name	Title of the book	publisher	Year of Publication
1	Linda D. Williams	Environmental Science Demystified	Tata McGraHill Publishing Company Limited, New Delhi.	2005
2	Tyler Miller G.JR	Environmental Science	Thomson & Thomson Publishers, Newyork.	2004
3	William P Cunningham	Principles of Environmental Science	Tata McGraHill, New Delhi.	2007
4	Bharucha Erach	The Biodiversity of INDIA	Mapin Publishing Private Limited, Ahamedabad, India.	-
5	Trivedi R.K,	Hand Book of Environmental Laws, Rules, Guidelines, Compliances and Standards”, Volume I & II	Enviromedia.	-

WEBSITES:

1. www.clemson.edu/ces/ees
2. www.ees.lanl.gov/ees11/geophysics/other/mars/marsworkshop.html
3. www.newagepublishers.com/samplechapter/001281.pdf
4. www.unesco.org/ext/field/beijing/scienceb.htm, www.infinitepower.org/education.htm

INTENDED OUTCOMES:

- To know the advantages and applications of Fluid Power Engineering and Power Transmission System.
- To learn the Applications of Fluid Power System in automation of Machine Tools and others Equipments.

UNIT I FLUID POWER SYSTEMS AND FUNDAMENTALS

Introduction to fluid power, Advantages of fluid power, Application of fluid power system. Types of fluid power systems, Properties of hydraulic fluids – General types of fluids – Fluid power symbols. Basics of Hydraulics-Applications of Pascals Law- Laminar and Turbulent flow – Reynold's number – Darcy's equation – Losses in pipe, valves and fittings.

UNIT II HYDRAULIC SYSTEM & COMPONENTS

Sources of Hydraulic Power: Pumping theory – Pump classification – Gear pump, Vane Pump, piston pump, construction and working of pumps – pump performance – Variable displacement pumps. Fluid Power Actuators: Linear hydraulic actuators – Types of hydraulic cylinders – Single acting, Double acting special cylinders like tandem, Rodless, Telescopic, Cushioning mechanism, Construction of double acting cylinder, Rotary actuators – Fluid motors, Gear, Vane and Piston motors.

UNIT III DESIGN OF HYDRAULIC CIRCUITS

Construction of Control Components : Direction control valve – 3/2 way valve – 4/2 way valve – Shuttle valve – check valve – pressure control valve – pressure reducing valve, sequence valve, Flow control valve – Fixed and adjustable, electrical control solenoid valves, Relays, ladder diagram. Accumulators and Intensifiers: Types of accumulators – Accumulators circuits, sizing of accumulators, intensifier – Applications of Intensifier – Intensifier circuit.

UNIT IV PNEUMATIC SYSTEMS AND COMPONENTS

Pneumatic Components: Properties of air – Compressors – Filter, Regulator and Lubricator Unit – Air control valves, Quick exhaust valves, pneumatic actuators. Fluid Power Circuit Design, Speed control circuits, synchronizing circuit, Pneumo hydraulic circuit, Sequential circuit design for simple applications using cascade method.

UNIT V DESIGN OF PNEUMATIC CIRCUITS

Servo systems – Hydro Mechanical servo systems, Electro hydraulic servo systems and proportional valves. Fluidics – Introduction to fluidic devices, simple circuits, Introduction to Electro Hydraulic Pneumatic logic circuits, ladder diagrams, PLC applications in fluid power control. Fluid power circuits; failure and troubleshooting.

TEXT BOOKS:

S.NO	Author(s) Name	Title of the book	Publisher	Year of Publication
1	Anthony Esposito	Fluid Power with Applications	Pearson Education, New Delhi.	2000
2	Majumdar S.R,	Oil Hydraulics	Tata McGraw-Hill, New Delhi.	2000

REFERENCES:

S.NO	Author(s) Name	Title of the book	Publisher	Year of Publication
1	Majumdar S.R,	Pneumatic systems – Principles and maintenance	Tata McGraw Hill, New Delhi.	1995
2	Anthony Lal	Oil hydraulics in the service of industry	Allied publishers, New Delhi.	1982
3	Michael J, Princes and AshbyJ.G	Power Hydraulics	Prentice Hall of India, New Delhi.	1989
4	Dudelyt, Pease A and John T. Pippenger	Basic Fluid Power	Prentice Hall of India, New Delhi.	1987

WEBSITES :

1.	http://www.g-w.com/PDF/SampChap/60525_0816_Ch02.pdf
2.	http://www.engineeringtoolbox.com/classification-pumps-d_55.html
3.	http://www.omega.com/auto/pdf/SimpValvesguide.pdf
4.	http://www.arca53.dsl.pipex.com/index_files/propair.htm
5.	http://www.control-systems-principles.co.uk/whitepapers/servo-control-systems1.pdf

PRACTICALS:

12PBEME311 MANUFACTURING TECHNOLOGY LABORATORY 0031100

LIST OF EXERCISES:

1. Exercises in shaper
2. Exercises in Surface grinding and cylindrical grinding process
3. Exercises in Tool grinding – single point and multi point tools
4. Exercises in milling
5. Exercises in slotting
6. Drilling/Tapping/Reaming
7. Exercises in Capstan and Turret Lathe

INTENDED OUTCOMES:

- | |
|---|
| <ul style="list-style-type: none"> • To understand various sensors and transducers • To understand the various components of automation system • To understand the concept of monitoring/controlling • To understand the various applications of mechatronics |
|---|

UNIT I MECHATRONICS SENSORS AND TRANSDUCERS

Introduction to Mechatronics - Systems – Measurement Systems – Control Systems – Traditional design - Microprocessor based Controllers. Introduction to sensors - Performance Terminology – Displacement - Position and Proximity – Velocity and Motion - Fluid Pressure - Temperature Sensors – Light Sensors - Selection of Sensors – Signal processing – Servo systems.

UNIT II ACTION SYSTEM AND SYSTEM MODELS

Introduction - Electrical Actuation Systems - Mechanical Switches - Solid State Switches - Solenoids – D.C Motors - A.C Motors - Stepper Motors. Introduction - Building block of Mechanical, Electrical, Fluid and Thermal Systems, Rotational - Transnational Systems, Electromechanical Systems - Hydraulic - Mechanical Systems.

UNIT III MICROPROCESSORS IN MECHATRONICS

Introduction - Architecture - pin configuration Instruction set – Programming of Microprocessors using 8085 instructions – Interfacing. Input and output devices - interfacing D/A converters and A/D converters – Application – Temperature control – Stepper motor.

UNIT IV CONTROLLERS

Introduction - Continuous and discrete process Controllers - Control Mode - Two - Step mode - Proportional Mode - Derivative Mode - Integral Mode - PID Controllers - Digital Controllers - Adaptive Control - Digital Logic Control - Micro Processors Control. Introduction to PLC - Basic Structure – Input / Output Processing – Programming – Mnemonics – Timers, Internal relays and counters - Data Handling – Analog Input / Output – Selection of a PLC.

UNIT V DESIGN OF MECHATRONICS SYSTEMS

Stages in designing Mechatronics Systems - Traditional and Mechatronic Design - Possible Design Solutions - Case Studies of Mechatronics Systems, Pick and place robot - automatic Car Park Systems - Engine Management Systems.

TEXT BOOK:

S.NO	AUTHOR(S) NAME	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1	Bolton W	Mechatronics	Pearson Education, Delhi.	2003

REFERENCES:

S.NO	AUTHOR(S) NAME	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1	Michael B. Hiland and David G. Alciatore	Introduction to Mechatronics and Measurement Systems	McGraw-Hill International Editions, New York.	2007
2	Bradley D, Dawson A.D, Buru N.C and Loader A.J	Mechatronics	Chapman and Hall, Pearson Education Asia, New Delhi.	2000
3	Ghosh P.K and Sridhar P.R	Introduction to Microprocessors for Engineers and Scientist	Prentice Hall of India, New Delhi.	2004

WEB SITE:

1. www.cs.indiana.edu

INTENDED OUTCOMES:

- To gain knowledge on the principles and procedure for the design of power transmission components.
- To understand the standard procedure available for design of transmission systems.
- To learn to use standard data and catalogues

UNIT I DESIGN OF TRANSMISSION SYSTEMS FOR FLEXIBLE ELEMENTS

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

UNIT II SPUR GEARS AND PARALLEL AXIS HELICAL GEARS

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

UNIT III BEVEL, WORM AND CROSS HELICAL GEARS

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 DESIGN OF GEAR BOXES

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.

UNIT V DESIGN OF CAM, CLUTCHES AND BRAKES

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-internal and external shoe brakes.

TEXT BOOKS:

S.NO	AUTHOR(S) NAME	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1	Juvinall R. C, Marshak K.M	Fundamentals of Machine component Design	Third Edition, John Wiley & Sons., London	2002
2	Bhandari, V.B,	Design of Machine Elements	Tata McGraw-Hill Publishing Company Ltd, New York.	2008

REFERENCES:

S.NO	AUTHOR(S) NAME	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1	Maitra G.M., Prasad L.V	Hand book of Mechanical Design	Tata McGraw-Hill, New Delhi.	2009
2	Shigley J.E and Mischke C.R,	Mechanical Engineering Design	McGraw-Hill International Editions, New Delhi.	2003
3	Prabhu. T.J	Design of Transmission Elements	Mani Offset, Chennai.	2000

WEBSITES :

1. <http://en.wikipedia.org/wiki/Gear>
2. <http://www.physicsforums.com/showthread.php?t=292163>
3. <http://www.seminarprojects.com/Thread-design-and-fabrication-of-gearbox-full-report>
4. <http://www.cs.cmu.edu/~rapidproto/mechanisms/chpt6.html>

INTENDED OUTCOMES:

- To gain knowledge on integrating computers at various levels of planning and manufacturing.
- To understand the flexible manufacturing system and to handle the product data and various software used for manufacturing

UNIT – I INTRODUCTION

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

UNIT – II GROUP TECHNOLOGY, COMPUTER AIDED PROCESS PLANNING AND CNC MACHINES

Group technology- - part families - Classification and coding - Approaches to computer aided process planning -variant approach and generative approaches – CNC Machines – Types of control system – NC Part Programming – Computer aided part programming – APT Language – Machining centers – Turning centers – CAD/CAM Integration – Part programming method selection.

UNIT – III SHOP FLOOR CONTROL AND INTRODUCTION OF FMS

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

UNIT – IV CIM IMPLEMENTATION AND DATA COMMUNICATION

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

UNIT – V OPEN SYSTEM AND DATABASE FOR CIM

Open systems-open system inter connection - manufacturing automations protocol and technical office protocol (MAP /TOP).

Development of databases -database terminology- architecture of database systems-data modeling and data associations -relational data bases - database operators - advantages of data base and relational database.

TEXT BOOK:

S.NO	AUTHOR(S) NAME	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1	Mikell.P.Groover	Automation, Production Systems and computer integrated manufacturing	Pearson Education, Delhi.	2001

REFERENCES:

S.NO	AUTHOR(S) NAME	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1	Yorem koren	Computer Integrated Manufacturing system	McGraw-Hill, New York.	2005
2	Kant Vajpayee S	Principles of computer integrated manufacturing	Prentice Hall India, New Delhi.	2003
3	Radhakrishnan P, Subramanyan S and Raju V	CAD/CAM/CIM”, 2 nd Edition	New Age International (P) Ltd, New Delhi.	2000

WEBSITES:

1.	http://en.wikipedia.org/wiki/Computer-integrated_manufacturing
2.	http://www.technologystudent.com/rmprp07/intman1.html
3.	http://www.computerintegratedmanufacturing.com/

INTENDED OUTCOMES:

- To understand the application of various experimental heat transfer correlations in engineering applications.
- To learn the thermal analysis and sizing of heat exchangers.
- To understand the basic concepts of mass transfer.

UNIT I CONDUCTION

Basic Concepts – Mechanism of Heat Transfer – Conduction, Convection and Radiation – General Differential equation of Heat Conduction – Fourier Law of Conduction – Cartesian and Cylindrical Coordinates – One Dimensional Steady State Heat Conduction – Conduction through Plane Wall, Cylinders and Spherical systems – Composite Systems – Conduction with Internal Heat Generation – Extended Surfaces – Unsteady Heat Conduction – Lumped Analysis – Use of Heislers Chart.

UNIT II CONVECTION

Basic Concepts – Convective Heat Transfer Coefficients – Boundary Layer Concept – Types of Convection – Forced Convection – Dimensional Analysis – External Flow – Flow over Plates, Cylinders and Spheres – Internal Flow – Laminar and Turbulent Flow – Combined Laminar and Turbulent – Flow over Bank of tubes – Free Convection – Dimensional Analysis – Flow over Vertical Plate, Horizontal Plate, Inclined Plate, Cylinders and Spheres.

UNIT III PHASE CHANGE HEAT TRANSFER AND HEAT EXCHANGERS

Nusselts theory of condensation-pool boiling, flow boiling, correlations in boiling and condensation. Types of Heat Exchangers – LMTD Method of heat Exchanger Analysis – Effectiveness – NTU method of Heat Exchanger Analysis – Overall Heat Transfer Coefficient – Fouling Factors.

UNIT IV RADIATION

Basic Concepts, Laws of Radiation – Stefan Boltzman Law, Kirchoff Law –Black Body Radiation – Grey body radiation Shape Factor Algebra – Electrical Analogy – Radiation Shields –Introduction to Gas Radiation.

UNIT V MASS TRANSFER

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

TEXT BOOKS:

S.NO	AUTHOR(S) NAME	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1	Sachdeva R.C	Fundamentals of Engineering Heat and Mass Transfer	New Age International, New Delhi.	2009

REFERENCES:

S.NO	AUTHOR(S) NAME	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1	Frank P. Incropera and David P. DeWitt	Fundamentals of Heat and Mass Transfer	John Wiley and Sons, New Delhi.	2011
2	Ozisik M.N	Heat Transfer	McGraw-Hill Book Co, New Delhi.	1994
3	Kothandaraman C.P	Fundamentals of Heat and Mass Transfer	New Age International, New Delhi	2008

WEBSITES :

<ol style="list-style-type: none">1. http://nptel.iitm.ac.in/courses/Webcourse-contents/IISc-BANG/Heat%20and%20Mass%20Transfer/New_index1.html2. http://www.learnerstv.com/Free-Engineering-Video-lectures-ltv084-Page1.htm3. http://en.wikipedia.org/wiki/Heat_transfer
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PRACTICALS:

12PBEME511

THERMAL ENGINEERING LABORATORY

0 0 3 1 100

LIST OF EXPERIMENTS

I.C ENGINES AND FUELS

1. Valve timing and port timing diagrams.
2. Performance test on 4 stroke diesel engine.
3. Heat balance test on 4 stroke diesel engine.
4. Morse test on Multi-cylinder petrol engine.
5. Determination of flash point and fire point.

HEAT TRANSFER

1. Thermal conductivity measurement by guarded plate method
2. Determination of Stefan-Boltzman constant.
3. Determination of emissivity of a grey surface

REFRIGERATION AND AIR CONDITIONING

1. Determination of COP of a refrigeration system
2. Experiments on air-conditioning system
3. Performance test on single/two stage reciprocating air compressor.

LIST OF EXPERIMENTS**PART – A:**

1. Kinematics of 4 bar mechanisms – Slider crank and Crank Rocker Mechanism - Determination of velocity and acceleration.
2. Kinematics of Universal Joints – Determination of velocity and acceleration
3. Kinematics of Gear Trains – Simple, Compound, Epi-cyclic and Differential: Determination of velocity ratio and Torque
4. Governors - Determination of sensitivity, effort, etc. for Watt, Porter, Proell, and spring controlled Governors
5. Cam – Determination of jump speed and profile of the cam.
6. Motorized Gyroscope-Verification of laws -Determination of gyroscopic couple.
7. Whirling of shaft-Determination of critical speed of shaft with concentrated loads.
8. Balancing of rotating and reciprocating masses.
9. Determination of moment of inertia by oscillation method for connecting rod and flywheel.
10. Vibrating system - Spring mass system - Determination of damping co-efficient of single degree of freedom system
11. Determination of torsional frequencies for compound pendulum and flywheel system with lumped moment of inertia.
12. Transverse vibration –free- Beam. Determination of natural frequency and deflection of beam.

PART – B:

1. Design and testing of fluid power circuits to control
(i) velocity (ii) direction and (iii) force of single and double acting actuators
2. Design of circuits with logic sequence using Electro pneumatic trainer kits.
3. Simulation of basic Hydraulic, Pneumatic and Electric circuits using software
4. Circuits with multiple cylinder sequences in Electro pneumatic using PLC.
5. Servo controller interfacing for open loop
6. PID controller interfacing
7. Stepper motor interfacing with 8051 Micro controller
(i) Full step resolution (ii) Half step resolution
8. Modeling and analysis of basic electrical, hydraulic and pneumatic systems using LAB VIEW
9. Computerized data logging system with control for process variables like pressure, flow and temperature

INTENDED OUTCOMES:

- To know the concepts of Linear programming technique
- To study the applications and use of Assignment, Transportation
- To know the techniques of PERT, CPM and Inventory control

UNIT – I INTRODUCTION TO OPERATIONS RESEARCH

Operations research and decision-making - types of mathematical models and constructing the model - Role of computers in operations research -Linear Programming Techniques: Formulation of linear programming problem, applications and limitations, graphical method, simplex method - The Big –M method - the two–phase method, dual problems.

UNIT – II TRANSPORTATION PROBLEMS

Least cost method, North west corner rule, Vogel’s approximation method, modified distribution method, optimization models, unbalance and degeneracy in transportation model.

UNIT – III ASSIGNMENT MODELS AND SCHEDULING

Difference between transportation problem and assignment problem, Hungarian algorithm, unbalanced assignment problems maximization case in assignment problems, traveling salesman problem. Scheduling - processing n jobs through two machines, processing n jobs through three machines, processing two jobs through ‘m’ machines, processing n jobs through m machines.

UNIT – IV INVENTORY CONTROL AND QUEUING THEORY

Variables in inventory problems, inventory models with penalty, shortage and quantity discount, safety stock, inventory models with probability, lead time, demand, multi item deterministic model.

Queuing Models: Queues – Notation of queues, performance measures, The M/M/1 queue, The M/M/m queue, batch arrival queuing system, queues with breakdowns.

UNIT – V PROJECT MANAGEMENT, GAME THEORY, REPLACEMENT MODELS

Basic terminologies, constructing a project network, network computations in CPM and PERT, cost crashing - Game Theory: Theory of games, competitive games, rules for game theory, mixed strategies, two person zero sum game, n person zero sum game - Replacement Models: Replacement of Items due to deterioration with and without time value of Money, Group replacement policy, Staff replacement

TEXT BOOKS:

S.NO	AUTHOR(S) NAME	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1	Elwood S Buffa	Modern Production / Operations Management	Wiley Eastern, New Delhi.	2007
2	Kanti Swarup, Gupta P.K and Manmohan	Operations Research	Sultan Chand and Sons, New Delhi.	2008

REFERENCES:

S.NO	AUTHOR(S) NAME	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1	Viswanathan N and Narahari Y	Performance Modeling of Automated Manufacturing Systems	Prentice Hall Inc, Newyork.	2000
2	Dharani Venkatakrishnan S	Operations Research	Keerthi Publication House, Coimbatore.	2000
3	Prem kumar Gupta and Hira D.S	Operation Research	S Chand and Company Limited, New Delhi.	2004

WEBSITES :

1. <http://www.scienceofbetter.org/what/index.htm>
2. <http://www.informs.org/Pubs/OR>
3. http://www.me.utexas.edu/~jensen/ORMM/models/unit/network/subunits/special_cases/transpo rtation.html
4. <http://www.projectmanagement.com/>

OBJECTIVE:

- To introduce the basic concepts, parts of robots and types of robots
- To make the students familiar with the various drive systems for robot, sensors and their applications in robots, programming of robots
- To discuss about the various applications of robots, justification, implementation and safety of robot.

UNIT I FUNDAMENTALS OF ROBOT

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

Pneumatic Drives – Hydraulic Drives – Mechanical Drives – Electrical Drives – D.C. Servo Motors, Stepper Motor, 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

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 (Triangulation Principle, Structured, Lighting Approach, Time of Flight Range Finders, Laser Range Meters), Proximity Sensors (Inductive, Hall Effect, Capacitive, Ultrasonic and Optical Proximity Sensors), 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 Servicing and Navigation.

UNIT IV ROBOT KINEMATICS AND ROBOT PROGRAMMING

Forward Kinematics, Inverse Kinematics and Differences; Forward Kinematics and Reverse Kinematics of Manipulators with Two, Three Degrees of Freedom (In 2 Dimensional), Four Degrees of Freedom (In 3 Dimensional) – Deviations and Problems.

Teach Pendant Programming, Lead through programming, Robot programming Languages – VAL Programming – Motion Commands, Sensor Commands, End effector commands, and Simple programs

UNIT V IMPLEMENTATION AND ROBOT ECONOMICS

RGV, AGV; Implementation of Robots in Industries – Various Steps; Safety Considerations for Robot Operations; Economic Analysis of Robots – Pay back Method, EUAC Method, Rate of Return Method.

TEXT BOOK:

S.NO	AUTHOR(S) NAME	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1	Groover M.P.	Industrial Robotics – Technology Programming and Applications	McGraw-Hill, New Delhi	2001

REFERENCES:

S.NO	AUTHOR(S) NAME	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1	Fu.K.S., Gonzalz.R.C. and Lee C.S.G	Robotics Control, Sensing, Vision and Intelligence	McGraw-Hill Book Co., New Delhi.	1988
2	Yoram Koren	Robotics for Engineers	McGraw-Hill Book Co., New Delhi.	1992
3	Janakiraman. P.A	Robotics and Image Processing	Tata McGraw-Hill, New Delhi.	1995

WEBSITES :

1. www.learnaboutrobots.com/industrial.htm

INTENDED OUTCOMES:

- To learn about the basics of economics and cost analysis related to engineering so as to take economically sound decisions.
- To make the students to understand capital market, breakeven point analysis and depreciation.

UNIT – I ECONOMICS

Nature and scope, Revenue and demand analysis – law of demand, law of supply, production analysis – production costs, long run and short run costs, Indian Banking systems – functions of central bank, commercial banks, inflation and deflation – consequences and control measures, foreign exchange, balance of payment, national income

UNIT – II MANAGEMENT PRINCIPLES

Evolution, principles, functions – planning, organizing, staffing, directing and controlling

UNIT – III ORGANIZATIONAL BEHAVIOUR

Individual behavior – Personality, perception, attitude, values, learning, and group behavior – stages of group formation, group dynamics, organizational culture, change and its management

UNIT – IV LEGISLATION MANAGEMENT

Factories act – provision relating to health, safety and welfare, workmen’s compensation act, trade union act – objectives, principles of trade union, history of trade unionism, provisions of the act

UNIT – V MARKETING AND FINANCIAL MANAGEMENT

Pricing policies, channels of distribution, sales management, advertisement management, sources of management, financial planning, financial institutions

TEXT BOOK:

S.NO	AUTHOR(S) NAME	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1	Dwivedi D.N	Managerial Economics	Vikas Publishing, New Delhi	2001
2	Bhusan, Y.K	Fundamentals of Business organization and management	S.Chand and Sons, New Delhi.	2001
3	Robbins.S.P	Organizational behaviour	PHI Ltd., New Delhi	2005
4	Khan, M.Y and Jain P.K	Financial Management	TMH Publishing Company Ltd., New Delhi.	2000

REFERENCES:

S.NO	AUTHOR(S) NAME	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1	Harol Koontz and Henz Wehrich	Essentials of Management	Reprint., McGraw Hill Publishing, Singapore.	2003
2	Sundaram and K.P.M. Money	Banking and International Trade	S.Chand & Sons, New Delhi.	2002
3	Fred Luthans	Organizational Behaviour	TMH, Singapore	2000
4	Prasana Chandra	Financial Management Theory and Praticce	TMH, New Delhi	2001

INTENDED OUTCOMES:

- To Understand and apply the principles of science, technology, engineering, and math to solve industry-related problems.
- Contribute to the profitable growth of industrial economic sectors by using IE analytical tools, effective computational approaches, and systems thinking methodologies.

UNIT – I INTRODUCTION TO PLANT LOCATION

Facilities requirement, need for layout study - types of layout. Plant location analysis - factors, costs, location decisions - simple problems in single facility location models, network location problems.

UNIT – II LAYOUT DESIGN

Design cycle - SLP procedure manpower, machinery requirements - computer algorithms - ALDEP, CORELAP, CRAFT

UNIT – III QUANTITATIVE METHODS AND MATERIALS HANDLING

Group technology - Production Flow analysis (PFA), ROC (Rank Order Clustering) - Line balancing. Principles, unit load concept, material handling system design, handling equipment types, selection and specification, containers and packaging.

UNIT – IV OPERATIONS ANALYSIS AND WORK MEASUREMENT

Productivity and living standards, Productivity measurement, work design and Productivity. Total time for a job or operation, total work content and ineffective time, methods and motions, graphic tools. Stop watch time study, Standard data, methods time measurement (MTM), Development of Production Standards, learning effect.

UNIT – V HUMAN FACTORS IN WORK SYSTEM DESIGN

Human factors Engineering/Ergonomics, human performance in physical work, anthropometry, design of work station, design of displays and controls.

TEXT BOOK:

S.NO	AUTHOR(S) NAME	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1	Richard Francis .L. and John .A.White	Facilities Layout and Location an analytical approach	Prentice Hall Inc	1992
2.	Benjamin .W. Neibel	Motion and time study	Richard .D .Irwin Inc	2002
3.	Stephen Konz	Work design	Publishing Horizon Inc	1997

REFERENCES:

S.NO	AUTHOR(S) NAME	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1	Tompkins .J.A. and J.A. White	Facilities planning	John Wiley	2003
2	James Apple,M.Plant	Material Handling	John Wiley	1977
3	Barnes,R.M	Motion and Time study	John Wiley	1980
4	Bridger R.S	Introduction to Ergonomics	McGraw Hill	1995

WEBSITES:

1. <http://www.websukat.com/PAOM-plant-layout.htm>
2. http://www.du.ac.in/fileadmin/DU/Academics/course_material/EP_07.pdf
3. <http://www.scribd.com/doc/60109160/8/Rank-Order-Clustering-Method>
4. <http://www.zalzala.info/IKMA/LinkedDocuments/GAManufacturing/sld006.htm>
5. <http://www.wrebv.nl/l6.pdf>

PRACTICALS:

12PBEME611 COMPUTER AIDED ANALYSIS AND MANUFACTURING LABORATORY

0 0 3 1 100

B. Analysis (Simple Treatment only)

1. Stress analysis of a plate with a circular hole.
2. Stress analysis of rectangular L bracket
3. Stress analysis of beams (Cantilever, Simply supported, Fixed ends)
4. Mode frequency analysis of beams (Cantilever, Simply supported, Fixed ends)
5. Harmonic analysis of a 2D component
6. Thermal stress analysis of a 2D component
7. Conductive heat transfer analysis of a 2D component

COMPUTER AIDED MANUFACTURING (CAM)

1. **MANUAL PART PROGRAMMING (Using G and M Codes) in CNC lathe**
 - 1.1 Part programming for Linear and Circular interpolation, Chamfering and Grooving
 - 1.2 Part programming using standard canned cycles for Turning, Facing, Taper turning and Thread cutting
2. **MANUAL PART PROGRAMMING (using G and M codes) in CNC milling**
 - 2.1 Part programming for Linear and Circular interpolation and Contour motions.
Part programming involving canned cycles for Drilling, Peck drilling, and Boring.

SIMULATION AND NC CODE GENERATION

NC code generation using CAD / CAM softwares - Post processing for standard CNC Controls like FANUC, Hiedenhain etc.

SEMESTER VII

12PBEME701

TOTAL QUALITY MANAGEMENT

3 0 0 3 100

INTENDED OUTCOMES:

- To understand the statistical approach for quality control.
- To create an awareness about the ISO and QS certification process and its need for the industries

UNIT I ESSENTIALS OF TQM

Definition of Quality, Dimensions of Quality, Quality Planning, Quality costs - Analysis Techniques for Quality Costs, Basic concepts of Total Quality Management, Historical Review, Principles of TQM, Leadership – Concepts, Role of Senior Management, Quality Council, Quality Statements, Strategic Planning, Deming Philosophy, Barriers to TQM Implementation.

UNIT II TQM PRINCIPLES

Customer satisfaction – Customer Perception of Quality, Customer Complaints, Service Quality, Customer Retention, Employee Involvement – Motivation, Empowerment, Teams, Recognition and Reward, Performance Appraisal, Benefits, Continuous Process Improvement – Juran Trilogy, PDSA Cycle, 5S, Kaizen, Supplier Partnership – Partnering, sourcing, Supplier Selection, Supplier Rating, Relationship Development, Performance Measures – Basic Concepts, Strategy, Performance Measure.

UNIT III TQM TOOLS

The seven tools of quality, Statistical Fundamentals – Measures of central Tendency and Dispersion, Population and Sample, Normal Curve, Control Charts for variables and attributes, Process capability, Concept of six sigma, New seven Management tools.

UNIT IV TQM TECHNIQUES

Benchmarking – Reasons to Benchmark, Benchmarking Process, Quality Function Deployment (QFD) – House of Quality, QFD Process, Benefits, Taguchi Quality Loss Function, Total Productive Maintenance (TPM) – Concept, Improvement Needs, FMEA – Stages of FMEA.

UNIT V QUALITY SYSTEMS

Need for ISO 9000 and Other Quality Systems, ISO 9000:2000 Quality System – Elements, Implementation of Quality System, Documentation, Quality Auditing, TS 16949, ISO 14000 – Concept, Requirements and Benefits.

TEXT BOOK:

S.NO	AUTHOR(S) NAME	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1	Dale H.Besterfiled	Total Quality Management	Pearson Education, Inc.	2003

LIST OF ELECTIVES FOR Part Time B.E. MECHANICAL ENGINEERING

12PBEMEE01 UNCONVENTIONAL MACHINING PROCESSES 3 0 0 3 100

INTENDED OUTCOMES:

- To understand the basic concepts of nontraditional machining techniques
- To know the factors influencing the processes and their applications

UNIT I INTRODUCTION

Unconventional machining Processes – Need – classification – Brief overview of all techniques.

UNIT II MECHANICAL ENERGY BASED PROCESSES

Abrasive Jet Machining – Water Jet Machining – Ultrasonic Machining. (AJM, WJM and USM). Working Principles – equipment used – Process parameters – MRR-Variation in techniques used – Applications.

UNIT III ELECTRICAL ENERGY BASED PROCESSES

Electric Discharge Machining (EDM) - working Principles-equipments-Process Parameters-MRR-electrode / Tool – Power Circuits-Tool Wear – Dielectric – Flushing – Wire cut EDM – Applications.

UNIT IV CHEMICAL AND ELECTRO-CHEMICAL ENERGY BASED PROCESSES

Chemical machining and Electr-Chemical machining (CHM and ECM)-Etchants-maskant-techniques of applying maskants-Process Parameters – MRR-Applications.
Principles of ECM-equipments-MRR-Electrical circuit-Process Parameters-ECG and ECH Applications.

UNIT V THERMAL ENERGY BASED PROCESSES

Laser Beam machining (LBM), plasma Arc machining (PAM) and Electron Beam Machining (EBM). Principles-Equipment-Types-Beam control techniques – Applications.

TEXT BOOK:

S.NO	Author(s) Name	Title of the book	Publisher	Year of Publication
1	Vijay.K. Jain,	Advanced Machining Processes	Allied Publishers Pvt. Ltd., New Delhi, ISBN 81-7764-294-4.	2002

REFERENCES:

S.NO	Author(s) Name	Title of the book	Publisher	Year of Publication
1	Benedict. G.F	Nontraditional Manufacturing Processes	Marcel Dekker Inc., New York.	1987
2	Pandey P.C. and Shah H.S	Modern Machining Processes	Tata McGraw-Hill, New Delhi.	
3	Mc Geough	Advanced Methods of Machining	Chapman and Hall, London.	1998
4	Paul De Garmo, Black T and Ronald.A.Kohser,	Material and Processes in Manufacturing”, 8 th Edition	Prentice Hall of India Pvt. Ltd., New Delhi. ISBN – 81-203-1243-0.	2001

WEBSITES:

1. http://www.newagepublishers.com/samplechapter/001566.pdf
2. http://nptel.iitm.ac.in/courses/Webcourse-contents/IIT%20Kharagpur/Manuf%20Proc%20II/pdf/LM-36.pdf
3. http://www.enotes.com/topic/Electron_beam_machining
4. http://webtools.delmarlearning.com/sample_chapters/Ch08_rev_CP.pdf
5. http://www.archivesmse.org/vol28_8/28810.pdf

INTENDED OUTCOMES:

- 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

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

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

UNIT III PRODUCT PRICING AND MARKETING RESEARCH

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

UNIT IV MARKETING PLANNING AND STRATEGY FORMULATION

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

UNIT V ADVERTISING, SALES PROMOTION AND DISTRIBUTION

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

TEXT BOOKS:

S.NO	Author(s) Name	Title of the book	Publisher	Year of Publication
1	Ramasamy and Nama kumari	Marketing Environment: Planning, implementation and control the Indian context	-----	1990
2	Govindarajan. M	Industrial marketing management	Vikas Publishing Pvt. Ltd, New Delhi.	2003

REFERENCES:

S.NO	Author(s) Name	Title of the book	Publisher	Year of Publication
1	Philip Kotler	Marketing Management	Pearson Education, New Delhi.	2001
2	Green Paul E and Donald Tull	Research for marketing decisions	Prentice Hall of India, New Delhi.	1975
3	Donald S. Tull and Hawkins	Marketing Reasearch	Prentice Hall of Inida, New Delhi.	1997
4	Philip Kotler and Gary Armstrong	Principles of Marketing	Prentice Hall of India, New Delhi.	2000
5	Steven J.Skinner	Marketing	All India Publishers and Distributes Ltd., New Delhi.	1998

WEBSITES :

<ol style="list-style-type: none">1. http://www.netmba.com/marketing/process/2. http://www.themarketingprocessco.com/marketing/3. http://www.helium.com/4. http://www.quickmba.com/marketing/market-segmentation/5. http://www.marketstreetresearch.com/capabilities/
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INTENDED OUTCOMES:

- To integrate the thermodynamic concepts into the analysis of refrigeration cycles.
- To give awareness to students on parameter to be considered for designing Refrigeration & Air Conditioning.
- To enable the student to design air conditioning system for building.

UNIT I REFRIGERATION CYCLE

Review of thermodynamic principles of refrigeration. Concept of Aircraft refrigeration system. Vapour compression refrigeration cycle - use of P-H charts - multistage and multiple evaporator systems - cascade system - COP comparison. Vapor absorption refrigeration system. Ammonia water and Lithium Bromide water systems. Steam jet refrigeration system

UNIT II REFRIGERANTS, SYSTEM COMPONENTS AND BALANCING

Compressors - reciprocating & rotary (elementary treatment.) - Condensers - evaporators - cooling towers. Refrigerants - properties - selection of refrigerants, Alternate Refrigerants, Refrigeration plant controls - testing and charging of refrigeration units. Balancing of system components. Applications to refrigeration systems - ice plant - food storage plants - milk -chilling plants – refrigerated cargo ships.

UNIT III PSYCHROMETRY

Psychrometric processes- use of psychrometric charts - - Grand and Room Sensible Heat Factors - bypass factor - requirements of comfort air conditioning - comfort charts - factors governing optimum effective temperature, recommended design conditions and ventilation standards

UNIT IV COOLING LOAD CALCULATIONS

Types of load - design of space cooling load - heat transmission through building. Solar radiation - infiltration - internal heat sources (sensible and latent) - outside air and fresh air load - estimation of total load - Domestic, commercial and industrial systems - central air conditioning systems.

UNIT V AIRCONDITIONING

Air conditioning equipments – air cleaning and air filters - humidifiers - dehumidifiers - air washers - condenser – cooling tower and spray ponds - elementary treatment of duct design - air distribution system. Thermal insulation of air conditioning systems. - Applications: car, industry, stores, and public buildings

TEXT BOOKS:

S.NO	Author(s) Name	Title of the book	Publisher	Year of Publication
1	Manohar Prasad	Refrigeration and Air Conditioning	Wiley Eastern Ltd, New Delhi.	1983
2	Arora. C.P.	Refrigeration and Air Conditioning	Tata McGraw-Hill, New Delhi.	1988

REFERENCES:

S.NO	Author(s) Name	Title of the book	Publisher	Year of Publication
1	Roy.J Dossat	Principles of Refrigeration	Pearson Education, New Delhi.	1997
2	Jordon and Prister	Refrigeration and Air Conditioning	Prentice Hall of India PVT Ltd., New Delhi.	1985
3	Stoecker N.F and Jones	Refrigeration and Air Conditioning	Tata McGraw Hill, New Delhi.	1981

WEBSITES :

1.	http://nptel.iitg.ernet.in/Mech_Engg/IIT%20Kharagpur/Refrigeration%20and%20Air%20Conditioning.htm
2.	http://www.ashrae.org/
3.	http://en.wikipedia.org/wiki/Thermal_comfort

INTENDED OUTCOMES:

- 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

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

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

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

UNIT IV CONTROL TECHNIQUES

Vibration isolation, tuned absorbers, untuned 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

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

TEXT BOOKS:

S.NO	Author(s) Name	Title of the book	Publisher	Year of Publication
1	Singiresu S.Rao	Mechanical Vibrations	Pearson Education, ISBN –81-297-0179-0	2004
2	Kewal Pujara	Vibrations and Noise for Engineers	Dhanpat Rai & Sons, New Delhi.	1992

REFERENCES:

S.NO	Author(s) Name	Title of the book	Publisher	Year of Publication
1	Bernard Challen and Rodica Baranescu	Diesel Engine Reference Book - Second edition	SAE International - ISBN 0-7680-0403-9.	1999
2	Julian Happian-Smith,	An Introduction to Modern Vehicle Design	Butterworth-Heinemann, New Delhi, ISBN 0750-5044-3.	2004
3	John Fenton	Handbook of Automotive body Construction and Design Analysis	Professional Engineering Publishing, ISBN 1-86058-073.	1998

WEBSITES :

<ol style="list-style-type: none">1. http://www.sae.org2. http://cedb.asce.org/cgi/wwwdisplay.cgi?04055203. http://www.viacoustics.com/systems.html4. www.diracdelta.co.uk/science/source/a/e/aerodynamic%20noise/source.html5. http://www.vibrationiso.com/

INTENDED OUTCOMES:

- To enable the students to understand the principle of working and the components of different non-conventional sources of energy and their utilization.
- To get an exposure on the power plants working with non conventional energy

UNIT I ENERGY AND ENVIRONMENT

Primary energy sources - world energy resources-Indian energy scenario-energy cycle of the earth – environmental aspects of energy utilisation, CO₂ emissions and Global warming–renewable energy resources and their importance. Potential impacts of harnessing the different renewable energy resources.

UNIT II SOLAR ENERGY

Principles of solar energy collection -solar radiation - measurements - instruments - data and estimation- types of collectors - characteristics and design principles of different type of collectors - performance of collectors - testing of collectors. Solar thermal applications - water heaters and air heaters - performance and applications - simple calculations - solar cooling - solar drying - solar ponds - solar tower concept - solar furnace.

UNIT III WIND, TIDAL AND GEO THERMAL ENERGY

Energy from the wind - general theory of windmills - types of windmills - design aspects of horizontal axis windmills - applications. Energy from tides and waves – working principles of tidal plants and ocean thermal energy conversion plants - power from geothermal energy - principle of working of geothermal power plants.

UNIT IV BIO ENERGY

Energy from bio mass & bio gas plants -various types - design principles of biogas plants - applications. Energy from wastes - waste burning power plants - utilization of industrial and municipal wastes - energy from the agricultural wastes.

UNIT V OTHER RENEWABLE ENERGY SOURCES

Direct energy conversion (Description, principle of working and basic design aspects only) – Magneto hydrodynamic systems (MHD) - thermoelectric generators – thermionic generators - fuel cells - solar cells - types, Emf generated, power output, losses and efficiency and applications. Hydrogen conversion and storage systems

TEXT BOOKS:

S.NO	Author(s) Name	Title of the book	Publisher	Year of Publication
1	Rai G.D	Non conventional Energy sources	Khanna Publishers, New Delhi.	1999
2	Duffie and Beckmann	Solar Energy Thermal Processes	John Wiley, London.	1974

REFERENCES:

S.NO	Author(s) Name	Title of the book	Publisher	Year of Publication
1	Sukhatme S.P	Solar Energy	2 nd edition, Tata McGraw Hill, New Delhi.	2003
2	Sulton	Direct Energy Conversion	McGraw-Hill, New Delhi.	1966
3	Garg. H. P and Prakash J	Solar Energy - Fundamentals and applications	Tata McGrawHill, New Delhi.	1997
4	Ashok V Desai	Non-conventional Energy	Wiley Eastern Ltd, New Delhi.	1990

WEBSITES :

<ol style="list-style-type: none">1. http://www.apricus.com/html/solar_typesofsolar.htm2. http://www.solarserver.de/wissen/sonnenkollektoren-e.html3. http://earthsci.org/mineral/energy/wind/wind.html4. http://www.biomassgasification.com/

INTENDED OUTCOMES:

- To introduce the concept of SQC
- To understand process control and acceptance sampling procedure and their application.
- To learn the concept of reliability

UNIT I INTRODUCTION AND PROCESS CONTROL FOR VARIABLES

Introduction, definition of quality, basic concept of quality, definition of SQC, benefits and limitation of SQC, Quality assurance, Quality cost-Variation in process- factors – process capability – process capability studies and simple problems – Theory of control chart- uses of control chart – Control chart for variables – X chart, R chart and σ chart.

UNIT II PROCESS CONTROL FOR ATTRIBUTES

Control chart for attributes –control chart for proportion or fraction defectives – p chart and np chart – control chart for defects – C and U charts, State of control and process out of control identification in charts.

UNIT III ACCEPTANCE SAMPLING

Lot by lot sampling – types – probability of acceptance in single, double, multiple sampling techniques – O.C. curves – producer's Risk and consumer's Risk. AQL, LTPD, AOQL concepts-standard sampling plans for AQL and LTPD- uses of standard sampling plans.

UNIT IV LIFE TESTING - RELIABILITY

Life testing – INTENDED OUTCOMES: – failure data analysis, Mean failure rate, mean time to failure, mean time between failure, hazard rate, system reliability, series, parallel and mixed configuration – simple problems. Maintainability and availability – simple problems. Acceptance sampling based on reliability test – O.C Curves.

UNIT V QUALITY AND RELIABILITY

Reliability improvements – techniques- use of Pareto analysis – design for reliability – redundancy unit and standby redundancy – Optimization in reliability – Product design – Product analysis – Product development – Product life cycles.

Note: Use of approved statistical table permitted in the examination.

TEXT BOOKS:

S.NO	Author(s) Name	Title of the book	Publisher	Year of Publication
1	Grant, Eugene .L	Statistical Quality Control	McGraw-Hill, New Delhi.	1996
2	Srinath L.S	Reliability Engineering	Affiliated East west press New Delhi	1991

REFERENCES:

S.NO	Author(s) Name	Title of the book	Publisher	Year of Publication
1	Manohar Mahajan	Statistical Quality Control	Dhanpat Rai & Sons, New Delhi.	2001
2	Gupta R.C	Statistical Quality control	Khanna Publishers, New Delhi.	1997
3	Besterfield D.H.	Quality Control	Prentice Hall, New Delhi.	1993
4	Sharma S.C	Inspection Quality Control and Reliability	Khanna Publishers, NewDelhi.	1998
5	Danny Samson	Manufacturing & Operations Strategy	Prentice Hall, New Delhi.	1991
6	Connor P.D.T.O	Practical Reliability Engineering	John Wiley, New Delhi.	1993

WEBSITES :

1.	http://www.statsoft.com/textbook/stquacon.html
2.	http://www.isixsigma.com/library/content/c010806a.asp
3.	http://www.statgraphics.com/control_charts.htm
4.	http://www.sqconline.com/sampling-plans.html
5.	http://reliability.sandia.gov/Maintenance/Data_Failure_Analysis/data_failure_analysis.html
6.	http://www.designinindia.net/everywhere/disciplines/product-design/index.html

INTENDED OUTCOMES:

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

UNIT I WORK STUDY AND ERGONOMICS

Method study – Definition –Objectives-Motion economy- Principles – Tools and Techniques- Applications – Work measurements- purpose – use – procedure – tools and techniques- Standard time –Ergonomics – principles – applications.

UNIT II PROCESS PLANNING

Definition – objectives – Scope – approaches to process planning- Process planning activities – Finished part requirements- operating sequences- machine selection – material selection parameters- Set of documents for process planning- Developing manufacturing logic and knowledge- production time calculation – selection of cost optimal processes.

UNIT III INTRODUCTION TO COST ESTIMATION

Objectives of cost estimation- costing – cost accounting- classification of cost- Elements of cost.

UNIT IV COST ESTIMATION

Types of estimates – methods of estimates – data requirements and sources- collection of cost-allowances in estimation.

UNIT V PRODUCTION COST ESTIMATION

Estimation of material cost, labour cost and over heads, allocation of overheads – Estimation for different types of jobs.

TEXT BOOK:

S.NO	Author(s) Name	Title of the book	Publisher	Year of Publication
1	Sinha.B.P Q	Mechanical Estimating and Costing	Tata McGraw-Hill, Publishing Co., New Delhi.	1995

REFERENCES:

S.NO	Author(s) Name	Title of the book	Publisher	Year of Publication
1	Phillip.F Ostwalal and Jairo Munez	Manufacturing Processes and systems”, 9 th Edition	John Wiley, London.	1998
2	Russell.R.S and TailorB.W	Operations Management	4 th Edition, PHI, New Delhi	2003

WEBSITES :

1. webstyleguide.com/process/plan.html
2. www.npd-solutions.com/capp.html

INTENDED OUTCOMES:

- To understand the basic concepts of mass transfer conservation methods.
- To understand the application of Energy Audit methods.

UNIT I ENERGY SCENARIO

Present status, rate of growth, energy utilization (sector wise), concept of energy conservation, energy economics.

COMBUSTION: Fuel analysis, combustion calculations, air requirements, theoretical and excess air requirements, excess air control, flue gas analysis and measurement, types of draught, draught calculations, chimney size calculations. F.D and I.D fan draught requirements and power requirements, furnace pressure requirements.

UNIT II INDUSTRIAL BOILERS

Types and characteristics of industrial boilers, heat balance in boilers, efficiency trials in boilers, energy conservation opportunities in boilers operation and maintenance, water treatment requirements, soot blowing requirements, super heaters and superheat controls, waste heat recovery systems.

STEAM: Distribution requirements of steam and streamlines, efficient utilization of steam, steam trapping and air venting, flash steam recovery, condensate recovery, thermal insulation for systems including HVAC, steam balance calculations.

UNIT III INDUSTRIAL FURNACES

Furnace types and characteristics, heat balance in furnaces, furnace efficiency calculations, energy conservation opportunities in furnaces, refractories types and properties, waste heat recovery system, insulating refractories, ceramic fibers, heat loss reduction calculations, wall and stored heat loss reduction.

UNIT IV DRYING

Principle of drying and types of driers, mass and heat balance in driers, energy conservation opportunities in drying operations.

EVOPORATION: Principle of evaporation and types of evaporations, mass and heat balance, single and multiple effect evaporation, capacity and steam economy calculations, vapour recompression system.

UNIT V ENERGY AUDIT AND APPLICATIONS

Types, methodology, questionnaire development, specific energy consumption (unitwise/section wise), identification of energy conservation measures/ technologies, economic and cost benefit analysis, case studies.

REFERENCES:

S.NO	Author(s) Name	Title of the book	Publisher	Year of Publication
1	Trinks M.H, W.Mawhinney	Industrial Furnaces	John Wiley Publications, London.	2004
2	Prabir Basu, Cen Kefa, Louis Jestin	Boilers and Burners Design and Theory	Springer Publications, New Delhi.	1999
3	Lyle O	Efficient use of Steam”, Heritage, Oyvkusgersm. 1954,” Efficient use of Fuel”,	Her Majesty’s Stationary Office, UK.	1963

WEBSITES :

1. www.energyconservation.co.in
2. www.energymanagertraining.com
3. www.nrel.gov
4. www.aerfindia.org
5. www.gvepinternational.org

INTENDED OUTCOMES:

- To understand the principles, functions and design practices of Jigs, Fixtures and dies for press working
- To understand the Principles of jigs and fixtures design, locating principles, locating elements and clamping Devices.

UNIT I PURPOSE TYPES AND FUNCTIONS OF JIGS AND FIXTURES

Tool design objectives - Production devices - Inspection devices - Materials used in Jigs and Fixtures – Types of Jigs - Types of Fixtures-Mechanical actuation-pneumatic and hydraulic actuation-Analysis of clamping force-Tolerance and error analysis.

UNIT II JIGS

Drill bushes –different types of jigs-plate latch, channel, box, post, angle plate, angular post, turnover, pot jigs-Automatic drill jigs-Rack and pinion operated. Air operated Jigs components. Design and development of Jigs for given components.

UNIT III FIXTURES

General principles of boring, lathe, milling and broaching fixtures- Grinding, planning and shaping fixtures, assembly, Inspection and welding fixtures- Modular fixtures. Design and development of fixtures for given component.

UNIT IV PRESS WORKING TERMINOLOGIES AND ELEMENTS OF DIES AND STRIP LAY OUT

Press working terminology-Presses and press accessories-Computation of capacities and tonnage requirements. Elements of progressive combination and compound dies:Die block-die shoe. Bolster plate-punch plate-punch holder-guide pins and bushes – strippers – knockouts-stops –pilots-Selection of standard die sets strip lay out-strip lay out calculations

UNIT V DESIGN AND DEVELOPMENT OF DIES

Design and development of progressive and compound dies for Blanking and piercing operations. Bending dies – development of bending dies-forming and drawing dies-Development of drawing dies. Design considerations in forging, extrusion, casting and plastic dies.

TEXT BOOKS:

S.NO	Author(s) Name	Title of the book	Publisher	Year of Publication
1	Edward G Hoffman	Jigs & Fixture Design	Thomson – Delmar Learning, Singapore.	2004
2	Donaldson C	Tool Design	Tata McGraw-Hill, New Delhi	1986

REFERENCES:

S.NO	Author(s) Name	Title of the book	Publisher	Year of Publication
1	Kempster	Jigs & Fixtures Design	The English Language Book Society, Tata McGraw-Hill Publishing, New Delhi.	1978
2	Joshi P.H	Jigs & Fixtures Second Edition	Tata McGraw-Hill Publishing Company Limited, New Delhi.	2004
3	Hiram E Grant	Jigs and Fixture	Tata McGraw-Hill, New Delhi.	2003
4	-	Fundamentals of Tool Design	CEEE Edition, ASTME.	1983
5	-	Design Data Handbook	PSG College of Technology, Coimbatore	-

WEBSITES :

<ol style="list-style-type: none">1. www.wisetool.com2. www.invert-a-bolt.com3. www.diemech.com4. www.schaeferertools.com5. www.steelsmith.com

INTENDED OUTCOMES:

- To provide an overview of the integrated design process with a practical bias.
- To understand and develop a design process leading to a realizable product with an appreciation of the economics, environmental concerns, manufacturability and product life cycle management.

UNIT I PRODUCT DESIGN PROCESS

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

UNIT II CONCEPT GENERATION, SELECTION AND TESTING

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

UNIT III CONCEPT GENERATION-INNOVATION THROUGH TRIZ TOOL

TRIZ – Theory to Resolve Inventive Problem Solving – Historical development – Essence of TRIZ; 36 Contradiction parameters – Contradiction matrix – 40 Inventive principles – 76 Standard solutions – **ARIZ** – Algorithm to solve inventive problem – Case studies

UNIT IV PRODUCT ARCHITECTURE, INDUSTRIAL DESIGN, DESIGN FOR MANUFACTURE AND PROTOTYPING

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

UNIT V ROBUST DESIGN AND PRODUCT DEVELOPMENT ECONOMICS AND INTELLECTUAL PROPERTY RIGHTS

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

TEXT BOOK:

S.NO	Author(s) Name	Title of the book	Publisher	Year of Publication
1	Ulrich KT. and Eppinger S.D	Product Design and Development	McGraw-Hill Book Company, International Edition ISBN 007 123 273 7, New Delhi.	2003

REFERENCES:

S.NO	Author(s) Name	Title of the book	Publisher	Year of Publication
1	Dieter G.E	Engineering Design	McGraw-Hill Book Company, International Edition, ISBN 007 116 204 6 (Unit – I), Singapore.	2000
2	Ullman D.G	The Mechanical Design Process Third Edition	McGraw-Hill Book Co, ISBN 007 1122818, Singapore.	2003
3	Otto K.N and Wood K.L	Product Design-Techniques in Reverse Engineering and New product Development	First Indian Reprint, Pearson Education, ISBN812970271 1, Delhi.	2004
4	Yousef Haik	Engineering Design Process	Vikas Publishing House, Uttar Pradesh, India.	1999

WEBSITES :

<ol style="list-style-type: none">1. http://www.engineersedge2. http://www.technologystudent.com3. http://www.onesmartclick.com4. http://www.nptel.iitg.ernet.in5. http://www.nptel.iitm.ac.in
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INTENDED OUTCOMES:

- To gain some fundamental knowledge about nuclear physics, nuclear reactor, nuclear fuels, reactors and safe disposal of nuclear wastes.

UNIT I NUCLEAR PHYSICS

Nuclear model of an atom-Equivalence of mass and energy-binding- radio activity-half life-neutron interactions-cross sections.

UNIT II NUCLEAR REACTIONS AND REACTION MATERIALS

Mechanism of nuclear fission and fusion- radio activity- chain reactions-critical mass and composition-nuclear fuel cycles and its characteristics-uranium production and purification-Zirconium, thorium, beryllium.

UNIT III REPROCESSING

Reprocessing: nuclear fuel cycles-spent fuel characteristics-role of solvent extraction in reprocessing-solvent extraction equipment.

UNIT IV NUCLEAR REACTOR

Nuclear reactors: types of fast breeding reactors-design and construction of fast breeding reactors-heat transfer techniques in nuclear reactors- reactor shielding. Fusion reactors.

UNIT V SAFETY AND DISPOSAL

Safety and disposal: Nuclear plant safety-safety systems-changes and consequences of accident-criteria for safety-nuclear waste-types of waste and its disposal-radiation hazards and their prevention-weapons proliferation.

TEXT BOOK:

S.NO	Author(s) Name	Title of the book	Publisher	Year of Publication
1	Thomas J.Cannoly	Fundamentals of nuclear Engineering	John Wiley and Sons, New York.	1978

REFERENCES:

S.NO	Author(s) Name	Title of the book	Publisher	Year of Publication
1	J.G Collier J.G and Hewitt G.F	Introduction to Nuclear power	HemispherePublishing, New York.	1987
2	Wakil M.M.El	Power Plant Technology	McGraw-Hill International, NewDelhi.	1984

WEBSITES :

1. www.nuclearcanada.ca.
2. <http://hyperphysics.phy-astr.gsu.edu/hbase/nucene/fasbre.html>
3. http://library.thinkquest.org/3471/nuclear_waste_body.html
4. http://www.classzone.com/books/earth_science/terc/content/investigations/es0501/es0501page03.cfm

INTENDED OUTCOMES:

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

UNIT I GOVERNING EQUATIONS AND BOUNDARY CONDITIONS

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 - Turbulence -Kinetic -Energy Equations – mathematical behavior of PDEs on CFD: Elliptic, Parabolic and Hyperbolic equations.

UNIT II DISCRETIZATION AND SOLUTION METHODOLOGIES

Methods of Deriving the Discretization Equations - Taylor Series formulation – Finite difference method – Control volume Formulation – Spectral method.

Solution methodologies: Direct and iterative methods, Thomas algorithm, Relaxation method, Alternating Direction Implicit method.

UNIT III HEAT CONDUCTION

Finite difference and finite volume formulation of steady/transient one-dimensional conduction equation, Source term linearization, Incorporating boundary conditions, Finite volume formulations for two and three dimensional conduction problems

UNIT IV CONVECTION AND DIFFUSION

Finite volume formulation of steady one-dimensional convection and Diffusion problems, Central, upwind, hybrid and power-law schemes - Discretization equations for two dimensional convection and diffusion.

UNIT V CALCULATION OF FLOW FIELD

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. Turbulence models: mixing length model, two equation (k- ϵ) models.

TEXT BOOKS:

S.NO	Author(s) Name	Title of the book	Publisher	Year of Publication
1	Versteeg H.K, and Malalasekera.W	An Introduction to Computational Fluid Dynamics	The Finite Volume Method, Longman, Prentice Hall, New Delhi.	1998
2	Ghoshdastidar P.S	Computer Simulation of flow and heat transfer	Tata McGraw-Hill Publishing Company Ltd., New Delhi.	1998

REFERENCES:

S.NO	Author(s) Name	Title of the book	Publisher	Year of Publication
1	Patankar S.V	Numerical Heat Transfer and Fluid Flow	Ane- Books2004 Indian Edition, McGraw-Hill, New Delhi.	1980
2	Muralidhar K and Sundarajan T	Computational Fluid Flow and Heat Transfer	Narosa Publishing House, New Delhi.	1995
3	BoseT.K	Narosa publishing House, New Delhi.	Numerical Fluid Dynamics	1997
4	Muralidhar K, and Biswas	Advanced Engineering Fluid Mechanics	Narosa Publishing House, New Delhi.	1996

WEBSITES :

<ol style="list-style-type: none">1. http://www.ams.org/mcom//.pdf2. http://www.cham.co.uk/website/new/cfdintro.htm3. http://www.mechartes.com/4. http://www.technologystudent.com5. http://web.njit.edu/topics/Prog_Lang_Docs/html/FLUENT/fluent/fluent5/ug/html/node594.htm
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INTENDED OUTCOMES:

- To gain the fundamental knowledge about the design variations of thermal turbo machines.
- To perform the design of the thermal turbo machines.

UNIT I INTRODUCTION TO TURBO MACHINES

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

UNIT II CENTRIFUGAL FANS AND BLOWERS

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

UNIT III AXIAL FANS AND PROPELLERS

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

UNIT IV AXIAL FLOW TURBINES

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

UNIT V RADIAL FLOW TURBINES AND WIND TURBINES

Constructional details — Stage velocity triangles – H-S diagram – Stage efficiencies and losses – Performance characteristics.

Wind turbines: definition and classifications – Constructional details –Horizontal axis wind turbine- Power developed – Axial thrust – Efficiency.

TEXT BOOKS:

S.NO	Author(s) Name	Title of the book	Publisher	Year of Publication
1	Yahya S.H	Turbines, Compressors and Fans	Tata McGraw-Hill Publishing Company, New Delhi.	1996
2	Dixon S.L	Fluid Mechanics, Thermodynamics of Turbomachines Second Edition	Pergamon press, Oxford, U.K.	1990

REFERENCES:

S.NO	Author(s) Name	Title of the book	Publisher	Year of Publication
1	Kadambi V and Manohar Prasad	An Introduction to energy conversion Vol. III	Wiley Eastern India Ltd, New Delhi.	1977
2	Shepherd D.H	Principles of Turbomachinery	the Macmillan Company, New York.	1969

WEBSITES :

1.	http://en.wikipedia.org/wiki/Turbomachinery
2.	http://ekwestrel.com/diffuser-versus-volute/diffuser-versus-volute
3.	http://mit.edu/16.unified/www/FALL/thermodynamics/notes/node93.html
4.	http://www.codecogs.com/reference/engineering/fluid_mechanics/turbines/axial_flow_turbines.php

INTENDED OUTCOMES:

- To introduce the students, the different types of composite materials, their properties and applications.

UNIT I INTRODUCTION TO COMPOSITES

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

UNIT II POLYMER MATRIX COMPOSITES

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

UNIT III METAL MATRIX COMPOSITES

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

UNIT IV CERAMIC MATRIX COMPOSITES

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

UNIT V ADVANCES IN COMPOSITES

Carbon /carbon composites – Advantages of carbon matrix – limitations of carbon matrix Carbon fibre – chemical vapour deposition of carbon on carbon fibre perform. Sol gel technique. Composites for aerospace applications.

TEXT BOOKS:

S.NO	Author(s) Name	Title of the book	Publisher	Year of Publication
1	Mathews F.L and Rawlings R.D	Composite materials Engineering and Science”, 1 st edition	Chapman and Hall, London, England	1994
2	Chawla K.K	Composite materials	Springer – Verlag, , New York.	1987

REFERENCES:

S.NO	Author(s) Name	Title of the book	Publisher	Year of Publication
1	Clyne T.W and Withers P.J	Introduction to Metal Matrix Composites	Cambridge University Press, UK.	1993
2	Strong A.B	Fundamentals of Composite Manufacturing	SME	1989
3	Sharma S.C	Composite materials	Narosa Publications, New Delhi.	2000

WEBSITES :

<ol style="list-style-type: none">1. http://www.metu.edu.tr/~ckaynak/METE%20470.htm2. http://www.springerlink.com/content/978-1-4020-8771-43. http://www.virginia.edu/bohr/mse209/chapter17.htm4. http://www.virginia.edu/bohr/mse209/chapter10.htm5. http://www.mse.mtu.edu/~drjohn/my4150/6. http://www.msm.cam.ac.uk/Teaching/PtIAB/C16/index.html

INTENDED OUTCOMES:

- To understand the various components and functions of production planning and control such as work study, product planning, process planning, production scheduling, Inventory Control.
- To know the recent trends like manufacturing requirement Planning (MRP II) and Enterprise Resource Planning (ERP).

UNIT I INTRODUCTION

Objectives: and benefits of planning and control-Functions of production control-Types of production-job- batch and continuous-Product development and design-Marketing aspect - Functional aspects-Operational aspect-Durability and dependability aspect-aesthetic aspect. Profit consideration-Standardization, Simplification & specialization-Break even analysis-Economics of a new design.

UNIT II WORK STUDY

Method study, basic procedure-Selection-Recording of process - Critical analysis, Development - Implementation - Micro motion and memo motion study - work measurement - Techniques of work measurement - Time study - Production study - Work sampling - Synthesis from standard data - Predetermined motion time standards.

UNIT III PRODUCT PLANNING AND PROCESS PLANNING

Product planning-Extending the original product information-Value analysis-Problems in lack of product planning-Process planning and routing-Pre requisite information needed for process planning-Steps in process planning-Quantity determination in batch production-Machine capacity, balancing-Analysis of process capabilities in a multi product system.

UNIT IV PRODUCTION SCHEDULING

Production Control Systems-Loading and scheduling-Master Scheduling-Scheduling rules-Gantt charts-Perpetual loading-Basic scheduling problems - Line of balance - Flow production scheduling-Batch production scheduling-Product sequencing - Production Control systems-Periodic batch control-Material requirement planning kanban –Dispatching-Progress reporting and expediting-Manufacturing lead time-Techniques for aligning completion times and due dates.

UNIT V INVENTORY CONTROL AND RECENT TRENDS IN PPC

Inventory control-Purpose of holding stock-Effect of demand on inventories-Ordering procedures.

Two bin system -Ordering cycle system-Determination of Economic order quantity and economic lot size-ABC analysis-Recorder procedure-Introduction to computer integrated production planning systems-elements of Just In Time Systems-Fundamentals of MRP II and ERP.

TEXT BOOK:

S.NO	Author(s) Name	Title of the book	Publisher	Year of Publication
1	Martand Telsang	Industrial Engineering and Production Management", First edition	S.Chand and Company, New Delhi.	2000

REFERENCES:

S.NO	Author(s) Name	Title of the book	Publisher	Year of Publication
1	Samson Eilon	Elements of production planning and control	Universal Book Corporation, Mumbai.	1984
2	Elwood S.Buffa, and Rakesh K.Sarin	Modern Production Operations Management”, 8 th Edition	John Wiley and Sons, New Delhi.	2000
3	Jain C.K and Aggarwal L.N	Production Planning Control and Industrial Management	Khanna Publishers, New Delhi.	1990
4	Nair N.G	Production and Operations Management	Tata McGraw-Hill, New Delhi.	1996
5	Chary S.N	Theory and Problems in Production & Operations Management	Tata McGraw Hill, New Delhi.	1995

WEBSITES :

<ol style="list-style-type: none">1. http:// envfor.nic.in/divisions/iwsu/iwsu.html2. http://src.edu/work-study3. http://thequalityportal.com/articles/value.htm4. http://wendt.library.wisc.edu/miles/milesbook.html5. http://en.wikipedia.org/wiki/Kanban6. http://en.wikipedia.org/wiki/Inventory_control_system7. http://waspbarcode.com/inventory_control8. http://lib.washington.edu/business/guides/jit.

INTENDED OUTCOMES:

- To analysis the stresses and deformations through advanced mathematical models.
- To estimate the design strength of various industrial equipments.

UNIT I ANALYSIS OF PLATES

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

UNIT II THICK CYLINDERS AND SPHERES

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

UNIT III ROTATING DISCS

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

UNIT IV BEAMS ON ELASTIC FOUNDATION

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

UNIT V CURVED BEAMS AND CONTACT STRESSES

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

TEXT BOOKS:

S.NO	Author(s) Name	Title of the book	Publisher	Year of Publication
1	Boresi A.P, Schmidt R.J	Advanced Mechanics of Materials", Sixth edition	John Wiley and Sons, London.	2003
2	Dally J.W and Riley W.F	Experimental Stress Analysis	John Wiley and Sons, London.	2003

REFERENCES:

S.NO	Author(s) Name	Title of the book	Publisher	Year of Publication
1	Burr A.H , CheathAm J.B	Mechanical Analysis and Design”, Second edition	Prentice Hall of India, New Delhi.	2001
2	Den-Hartog J.P	Strength of Materials	John Wiley and Sons, London.	-

WEBSITES :

<ol style="list-style-type: none">1. http://www.rwc.uc.edu/koehler/biophys/2f.html2. http://wiki.answers.com/Q/What_is_torsion3. www.engin.umich.edu/students/ELRC/me211/beamdef.html4. http://www.mech.uwa.edu.au/DANotes/cylinders/thin/thin.html5. http://en.wikipedia.org/wiki/shear_stress

INTENDED OUTCOMES:

- To enable the student to understand the several aspects of the design process and to apply them in practice.
- Also to train the student in the concept of product costing and other manufacturing economics in optimization of product design

UNIT I PRODUCT DESIGN AND DEVELOPMENT

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

UNIT II ECONOMICS OF DESIGN

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

UNIT III PRODUCT MODELING

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

UNIT IV PRODUCT COSTING

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

UNIT V RECENT ADVANCES AND CONCEPTS IN PRODUCT DESIGN

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

TEXT BOOKS:

S.NO	Author(s) Name	Title of the book	Publisher	Year of Publication
1	Sameul Eilon	Elements of Production Planning and Control	McMillan and Company., New York.	1962
2	Jones S.W	Product Dosing and Process Selection	Butterworth Publications,	1973
3	Karl T. Ulrich and Stephen Eppinger D	Product Design and Development	McGraw Hill,Newyork	1994

REFERENCES:

S.NO	Author(s) Name	Title of the book	Publisher	Year of Publication
1	Harry Nystrom	Creativity and Innovation	John Wiley & Sons, London.	1979
2	George E Dieter	Engineering Design – Materials and process approach	Tata McGraw-Hill, New Delhi.	1991
3	Donald E Carter	Concurrent Engineering	Addison Wesley, London.	1992

WEBSITES :

<ol style="list-style-type: none">1. http://marketingteacher.com/lesson-store/lesson-plc.html2. http://www.ielm.ust.hk/dfaculty/ajay/courses/ieem513/Layout/lecLayout.html3. http://www.soton.ac.uk/~jps7/Lecture%20notes/Lecture%209%20Concurrent%20Engineering.pdf4. http://www.research.kobe-u.ac.jp/eng-mech-design/taura/img/taura_pub/POET.pdf5. http://classes.bus.oregonstate.edu/fall-07/ba321/Caplan/Cost%20Accounting%20-%20Chapter%2014%20-%202007.htm
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INTENDED OUTCOMES:

- | |
|---|
| <ul style="list-style-type: none"> To implement the various maintenance policies repair methods for machine elements |
|---|

UNIT I PRINCIPLES AND PRACTICES OF MAINTENANCE PLANNING

Basic Principles of maintenance planning – Objectives: and principles of planned maintenance activity – Importance and benefits of sound Maintenance systems – Reliability and machine availability – MTBF, MTTR and MWT – Factors of availability – Maintenance organization – Maintenance economics.

UNIT II MAINTENANCE POLICIES – PREVENTIVE MAINTENANCE

Maintenance categories – Comparative merits of each category – Preventive maintenance, maintenance schedules, repair cycle - Principles and methods of lubrication – TPM.

UNIT III CONDITION MONITORING

Condition Monitoring – Cost comparison with and without CM – On-load testing and off-load testing – Methods and instruments for CM – Temperature sensitive tapes – Pistol thermometers – wear-debris analysis

UNIT IV REPAIR METHODS FOR BASIC MACHINE ELEMENTS

Repair methods for beds, slideways, spindles, gears, lead screws and bearings – Failure analysis – Failures and their development – Logical fault location methods – Sequential fault location.

UNIT V REPAIR METHODS FOR MATERIAL HANDLING EQUIPMENT

Repair methods for Material handling equipment - Equipment records –Job order systems - Use of computers in maintenance.

TEXT BOOKS:

S.NO	Author(s) Name	Title of the book	Publisher	Year of Publication
1	Srivastava S.K	Industrial Maintenance Management	S.Chand and Co.,New Delhi	1981
2	Bhattacharya S.N	Installation, Servicing and Maintenance	S.Chand and Co., New Delhi.	1995

REFERENCES:

S.NO	Author(s) Name	Title of the book	Publisher	Year of Publication
1	White E.N	Maintenance Planning	I Documentation, Gower Press, London.	1979
2	Garg M.R	Industrial Maintenance	S.Chand & Co., New Delhi.	1986
3	Higgins L.R	Maintenance Engineering Hand book”, 5th Edition	McGraw Hill, New Delhi	1988
4	Armstrong	Condition Monitoring	BSIRSA ,Frankfurt.	1988
5	Davies	Handbook of Condition Monitoring	Chapman &Hall , London.	1996

WEB SITES:

1. <http://www.maintenanceonline.org/maintenanceonline/>
2. http://www.weibull.com/SystemRelWeb/preventive_maintenance.htm
3. <http://www.reliabilityweb.com/fa/pdm.htm>
4. <http://www.maintenanceresources.com/productsshowcase/productlisting/mechanicalpage.htm>
5. <http://www.globalsecurity.org/military/systems/ground/mhe.htm>

INTENDED OUTCOMES:

- To implement the various design process for various material.
- To determine the failure analysis tools

UNIT I MATERIALS AND DESIGN PROCESS

Factors affecting the behavior of materials in components, effect of component geometry and shape factors, design for static strength, stiffness, designing with high strength and low toughness materials, designing for hostile environments, material processing and design, processes and their influence on design, process attributes, systematic process selection, screening, process selection diagrams, ranking, process cost.

UNIT II FRACTURE MECHANICS

Ductile fracture, brittle fracture, Cleavage-fractography, ductile-brittle transition-Fracture mechanics approach to design-energy criterion, stress intensity approach, time dependent crack growth and damage

LINEAR ELASTIC FRACTURE MECHANICS: Griffith theory, Energy release rate, instability and R-curve, stress analysis of cracks-stress intensity factor, K-threshold, crack growth instability analysis, crack tip stress analysis.

UNIT III ELASTIC PLASTIC FRACTURE MECHANICS

Crack tip opening displacement (CTOD), J integral, relationship between J and CTOD, DYNAMIC AND TIME-DEPENDENT FRACTURE: Dynamic fracture, rapid loading of a stationary crack, rapid crack propagation, dynamic contour integral, Creep crack growth-C Integral, Visco elastic fracture mechanics, viscoelastic J integral

UNIT IV DETERMINATION OF FRACTURE TOUGHNESS VALUES

Experimental determination of plane strain fracture toughness, K- R curve testing, J measurement, CTOD testing, effect of temperature, strain rate on fracture toughness.

UNIT V FAILURE ANALYSIS TOOLS

Reliability concept and hazard function, life prediction, life extension, application of poisson, exponential and Weibull distribution for reliability, bath tub curve, parallel and series system, MTBF,MTTR, FMEA definition-Design FMEA, Process FMEA , analysis causes of failure, modes, ranks of failure modes, fault tree analysis, industrial case studies/projects on FMEA.

TEXT BOOKS:

S.NO	Author(s) Name	Title of the book	Publisher	Year of Publication
1	John M Barsoom and Stanley T Rolte	Fracture and Fatigue Control in Structures	Prentice Hall, New Delhi.	1987
2	ASM Metals Handbook,	Failure Analysis and Prevention”, Tenth Edition, Vol.10	ASM Metals Park, Ohio, USA.	1995
3	Michael F Ashby	Material Selection in Mechanical Design	Butterworth-Heinemann, New Delhi.	1999

REFERENCES:

S.NO	Author(s) Name	Title of the book	Publisher	Year of Publication
1	Shigley and Mische	Mechanical Engineering Design	McGraw Hill,Ssingapore.	1992
2	Mahmoud M Farag	Material Selection for Engineering Design	Prentice Hall, New Delhi.	1997
3	Faculty of Mechanical Engineering, PSG College of Technology	“Design Data Book	DPV Printers.	1993

WEB SITES:

1. www.weibull.com

INTENDED OUTCOMES:

- To study the various factors influencing the manufacturability of components and the use of tolerances in manufacturing.

UNIT I DFM APPROACH, SELECTION AND SUBSTITUTION OF MATERIALS IN INDUSTRY

DFM approach, DFM guidelines, standardisation, group technology, value engineering, comparison of materials on cost basis, design for assembly, DFA index, Poka - Yoke principle; 6σ concept; design creativity.

Tolerance Analysis: Process capability, process capability metrics, C_p , C_{pk} , cost aspects, feature tolerances, geometric tolerances, surface finish, review of relationship between attainable tolerance grades and different machining process, cumulative effect of tolerances, sure fit law, normal law and truncated normal law.

UNIT II SELECTIVE ASSEMBLY

Interchangeable and selective assembly, deciding the number of groups, Model-I: group tolerances of mating parts equal; Model-II: total and group tolerances of shaft, control of axial play-introducing secondary machining operations, laminated shims, examples.

Datum Systems: Degrees of freedom, grouped datum systems-different types, two and three mutually perpendicular grouped datum planes, grouped datum system with spigot and recess, pin and hole, grouped datum system with spigot and recess pair and tongue-slot pair, computation of translational and rotational accuracy, geometric analysis and applications.

UNIT III TRUE POSITION TOLERANCING THEORY

Comparison between co-ordinate and convention method of feature location, tolerancing and true position tolerancing, virtual size concept, floating and fixed fasteners, projected tolerance zone, assembly with gasket, zero true position tolerance, functional gauges, paper layout gauging, compound assembly, examples.

UNIT IV FORM DESIGN OF CASTINGS AND WELDMENTS

Redesign of castings based on parting line considerations, minimising core requirements, redesigning cast members using weldments, use of welding symbols – design considerations for plastic component manufacturing.

Tolerance Charting Technique: Operation sequence for typical shaft type of components, preparation of process drawings for different operations, tolerance worksheets and centrality analysis, examples, design features to facilitate machining, datum features - functional and manufacturing, component design-machining considerations, redesign for manufacture, examples.

UNIT V LEAN MANUFACTURING

Need for lean concepts, different types of waste, metrics of manufacturing, an overview of value stream mapping- present state map, future state map, evaluation of benefits – Process FMEA, Design FMEA

TEXT BOOKS:

S.NO	Author(s) Name	Title of the book	Publisher	Year of Publication
1	Harry Peck	Designing for Manufacture	Pitman Publications, London.	1983
2	Matousek R	Engineering Design a Systematic Approach	Blackie and Son Ltd., London.	1974

REFERENCES:

S.NO	Author(s) Name	Title of the book	Publisher	Year of Publication
1	Spotts M F	Dimensioning and Tolerance for Quantity Production	Prentice Hall Inc., New Jersey, USA.	1983
2	Oliver R Wade	Tolerance Control in Design and Manufacturing	Industrial press Inc., New York.	1967
3	James G Bralla	Hand Book of Product Design for Manufacturing	McGraw Hill Publications, New Delhi.	1983
4	Trucks H E	Design for Economic Production Second Edition	Society of Manufacturing Engineers , Michigan	1987
5	Poka-Yoke	Improving Product Quality by Preventing Defects	Productivity Press	1992
6	Creveling C M	Tolerance Design - A Hand Book for Developing Optimal Specifications	Addison Wesley Longman Inc., USA.	1997

WEB SITES:

1. www.dfma.com
2. www.design4manufacturability.com

INTENDED OUTCOMES:

- | |
|---|
| <ul style="list-style-type: none"> To impart the different types of composite materials, their properties and applications |
|---|

UNIT I INTRODUCTION

Modern materials in design, types, metals, polymers, ceramics, composites. Polymers-Classification, properties of thermo plastics, properties of thermo setting plastics, applications, merits and demerits. Classification of composites, Honey comb composites, advantages, applications. Matrix and their role, principal types of fibre and matrix materials.

UNIT II PROCESS AND CHARACTERISTICS OF COMPOSITES

Manufacture of polymer matrix composites-Lay up and curing, open and closed mould processes, bag moulding, filament winding, pultrusion, pulforming, thermoforming, advantages and limitations of different processes. Manufacture of metal matrix and ceramic matrix composites. Advantages, limitations and characteristics of ceramic and metal matrix composites.

UNIT III CONCEPTS OF SOLID MECHANICS

Stress and strain, Strain Energy, Plane stress and plane strain, Generalized Hook's Law for different types of materials, material symmetry, Engineering constants, coordinate transformation, thermal effects and moisture effects,

UNIT IV MICRO MECHANICAL BEHAVIOUR OF A LAMINA

Volume and mass fractions, density and void content, evaluation of elastic moduli, ultimate strengths of a unidirectional lamina, coefficients of thermal and moisture expansion.

UNIT V MACRO MECHANICAL BEHAVIOUR OF A LAMINA

Hook's Law for a two dimensional unidirectional lamina and angular lamina, evaluation of elastic moduli for unidirectional and angle lamina, engineering constants of unidirectional and angle lamina, strength failure theories.

Macro Mechanical Behaviour Of A Laminate: Laminate code, stress - strain behaviour in a laminate, Resultant forces and moments in a laminate, interlaminar stresses in laminates.

TEXT BOOKS:

S.NO	Author(s) Name	Title of the book	Publisher	Year of Publication
1	Autar K Kaw	Mechanics of Composite Materials	CRC Press, New York	1997
2	Agarwal B.D. and Broutman L.J	Analysis and Performance of Fibre Composites	John Wiley and Sons Inc, London.	1990
3	Matthews F.L. and Rawlings R.D	Composite Materials	Engineering and Science.	
4	Srinivasan A.V and Michael McFarland	Smart Structures	Cambridge University Press, UK.	2001
5	Kalyanmoy Deb	Optimization for engineering design	Prentice-Hall,India (Pvt) Ltd., New Delhi	2000

REFERENCES:

S.NO	Author(s) Name	Title of the book	Publisher	Year of Publication
1	Ronald F Gibson	Principles of Composite Material Mechanics	McGraw Hill Book Co., Newyork.	1994
2	Robert M Jones	Mechanics of Composite Materials	McGraw Hill Book Co.,Newyork.	1970
3	Terry Richardson	Composites - A Design Guide	Industrial Press Inc, New York.	1987
4	Sanjay K Mazumdar	Composites Manufacturing	CRC Press, New York.	2003

WEB SITES:

1. www.springer.com
2. www.ossamashaar.4t.com

INTENDED OUTCOMES:

- | |
|---|
| <ul style="list-style-type: none"> To gain knowledge in production, gear material selection. |
|---|

UNIT I INTRODUCTION TO GEARS

Types of gears-classification, application of gears, gearboxes, drawings for gears, gear production method an overview, types of blanks and blank preparation. Production Of Cylindrical Gears: Procedure of cutting gears and obtainable quality in hobbing and gear shaping, cutter selection and work holding methods, setting calculations. Rack type gear shaping machine description and application. Internal gear cutting methods, CNC gear hobbing and gear shaping machines.

UNIT II PRODUCTION OF CONICAL GEARS

Production of straight bevel gears by bevel gear generator, duplex rotary cutter method, Gleason Reva cycle method, spiral and hybrid bevel gear generation. Description of machine, cutter and machine setting.

UNIT III GEAR MATERIAL SELECTION AND HARDENING METHODS

Properties of gear materials-non-metallic, non-ferrous and plastic gears, selection of material for power transmission, high speed application. Selection of material for worm and wheel. Hardening by through hardening, case hardening, induction hardening, flame hardening, nitriding and tuftriding, hardening defects.

UNIT IV GEAR FINISHING METHODS

Gear finishing advantages, finishing of gears by grinding, shaving, lapping and honing methods, cold rolling of gears - description of process, machine, cutters and process parameters setting.

Gear Inspection: Type of gear errors-gear quality standards and allowable limits-tooth thickness, base tangent length measurement, pitch error, radial run out, involute profile error measurements methods and analysis, composite error measurement, computerized gear inspection, gear failure reasons and remedies.

UNIT V MODERN GEAR PRODUCTION METHODS

Gear production by stamping, die casting, powder metal process, injection and compression moulding of plastic gears, cold and hot rolling. Mass production methods, shear speed shaping, gear broaching, Gleason G-TRAC – gear generation methods. Economical and Quality Production Of Gears: Gear production systems – batch production, gear production cells, lean and agile production practices, automobile gear and gear boxes, heavy engineering gear production, gear for instruments and appliances, process and cutter selection for quantity, cost and quality criteria.

TEXT BOOKS:

S.NO	Author(s) Name	Title of the book	Publisher	Year of Publication
1	Watson	Modern Gear Production	Persman Press, Oxford.	1984
2	HMT,	Production Technology	Tata McGraw Hill Co., New Delhi	1992

REFERENCES:

S.NO	Author(s) Name	Title of the book	Publisher	Year of Publication
1	SAE	Gear Design Manufacturing Inspection Manual	-----	1990
2	Weck .M,	Hand Book of Machine Tools Technology and Sun Gear Technology	magazine – Back Volumes.	1984

WEBSITES :

1. www.geartechnology.com
2. www.gearsolutions.com

INTENDED OUTCOMES:

- The basics of precision engineering
- The various techniques of precision engineering like Nano technology etc.
- The accuracy, influence of static stiffness, vibration accuracy etc.

UNIT I ACCURACY

Concept of accuracy – accuracy of numeric control systems, acceptance test for machine tools.

Factors Affecting Accuracy: Static stiffness and its influence on machining accuracy, inaccuracies due to thermal effects, influence of forced vibrations on accuracy, dimensional wear of cutting tools and its influence on accuracy.

UNIT II MICRO FINISHING PROCESS

Surface roughness, bearing area curves, surface texture measurement, methods of improving accuracy and surface finish, finish boring, finish grinding, precision cylindrical grinding, micro machining, precision micro drilling.

UNIT III UNCONVENTIONAL MACHINING

Precision, cut in wire, EDM machining, electro mechanical grinding, electron beam machining, laser beam machining.

UNIT IV MICRO ELECTRO MECHANICAL SYSTEMS

Introduction to silicon processing, wafer cleaning, diffusion and ion implantation, oxidation, photolithography, photo resist, resist strip, electron beam and X-ray lithography, thin film deposition, evaporation, sputtering, molecular beam epitaxy, chemical vapour deposition, electro plating.

UNIT V BULK MICRO MACHINING AND NANO TECHNOLOGY

Wet etching, isotropic etching, anisotropic etching, dry etching, physical etching, reactive ion etching, Nano Technology, nano-grating system, nano-lithography, fabrication of CCDs, nano processing of materials for super high density ICs, nano-mechanical parts.

TEXT BOOKS:

S.NO	Author(s) Name	Title of the book	Publisher	Year of Publication
1	Murthy. R L,	Precision Engineering in Manufacturing	New Age International Publishers, New Delhi.	1996
2	Mark J Madou	Fundamentals of Micro Fabrication	CRC Press , Florida.	2002
3	Nano Tanigudi	Nanotechnology	Oxford University Press, New York.	2003

REFERENCES:

S.NO	Author(s) Name	Title of the book	Publisher	Year of Publication
1	Davidson	Handbook of Precision Engineering, Vol. 1	McMillan, Chennai	1972
2	Jaeger.R.C	Introduction to Micro Electronics Fabrication	Addison Wesley, England.	1988
3	Chang C.V and Sze S.M	VLSI Technology	Tata McGraw Hill, New Delhi	2003
4	Bhart Bhusshan	Handbook of Nano Technology	Springer, Germany	2004

WEBSITES :

1. www.scientific.net
2. www.nist.gov.

INTENDED OUTCOMES:

- To understand the principles involved in gas dynamics related with energy and momentum
- To learn the underlying theories of rocket and jet propulsion

UNIT I BASIC CONCEPTS AND ISENTROPIC FLOWS

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

UNIT II FLOW THROUGH DUCTS

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

UNIT III NORMAL AND OBLIQUE SHOCKS

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

UNIT IV JET PROPULSION

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

UNIT V SPACE PROPULSION

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

TEXT BOOK:

S.NO	Author(s) Name	Title of the book	Publisher	Year of Publication
1	Yahya S.M	Fundamentals of Compressible Flow	New Age International (P) Limited, New Delhi.	1996

REFERENCES:

S.NO	Author(s) Name	Title of the book	Publisher	Year of Publication
1	Hill P. and Peterson C	Mechanics and Thermodynamics of Propulsion	Addison Wesley Publishing Company, London.	1992
2	Zucrow N.J	Aircraft and Missile Propulsion, Vol. I and II	John Wiley, London	1975
3	Zucrow N.J	Principles of Jet Propulsion and Gas Turbines	John Wiley, New York	1970
4	Cohen H, Rogers G.E.C and Saravanamuttoo,	Gas Turbine Theory	Longman Group Ltd.,Noida	-
5	Sutton G.P	Rocket Propulsion Elements	John Wiley, New York	1986
6	Shapiro A.H	Dynamics and Thermodynamics of Compressible Fluid Flow	John Wiley, New York	1953
7	Ganesan V	Gas Turbines	Tata McGraw Hill Publishing Co., New Delhi	1999

WEBSITES :

1. http://www.adl.gatech.edu/classes/ae3021/ae3021_f06_6.pdf
2. http://www.grc.nasa.gov/WWW/k-12/airplane/isndrv.html
3. http://panoramix.ift.uni.wroc.pl/~maq/papers/PM_Correct_Matyka.pdf
4. http://soliton.ae.gatech.edu/people/jseitzma/classes/ae3450/StudyProblems.pdf
5. http://www.sil.si.edu/smithsoniancontributions/AnnalsofFlight/pdf_lo/SAOF-0001.4.pdf

INTENDED OUTCOMES:

- To know the various tools and methodologies of lean manufacturing.
- To know the cost of wastes in manufacturing systems.
- To study the requirements of customer satisfaction in terms of quality.

UNIT I INTRODUCTION

Objectives of lean manufacturing-key principles and implications of lean manufacturing- Traditional Vs lean manufacturing – Lean benefits - Case studies

UNIT II LEAN MANUFACTURING CONCEPTS

Value creation and waste elimination- Major kinds of waste- pull production-different models of pull production-continuous flow-continuous improvement / Kaizen- Worker involvement.

UNIT III MANUFACTURING FLOW ELEMENT

Product/quantity analysis - process mapping - routing analysis - takt time calculations, line balancing and one-piece flow - Various types of layouts – Process - Product and cellular layouts - Manufacturing cell design criteria.

UNIT IV PROCESS CONTROL ELEMENT

Single minute exchange of dies (SMED) - total productive maintenance (TPM) - Poka-yoke - 5S - visual controls - graphic work instructions - Lean Sixsigma Concepts and tools - Sixsigma measurements - Case studies.

UNIT V VALUE STREAM MAPPING

The as-is diagram-the current state and future state map-application to the factory simulation scenario - overall equipment effectiveness(OEE)- measurements and case studies.

Just in Time manufacturing: Introduction - elements of JIT - Kanban system - Kanban sizing - Case studies

IMPLEMENTING LEAN: Road map-senior management Involvement - best practices.

(RECONCILING LEAN WITH OTHER SYSTEMS: Toyota production system-lean six sigma-lean and ERP-lean with ISO9001: 2000)

TEXT BOOKS:

S.NO	Author(s) Name	Title of the book	Publisher	Year of Publication
1	Askin R.G. and Goldberg J.B	Design and Analysis of Lean Production Systems	John Wiley and Sons Inc.,New Jercey.	2003
2	Micheal Wader	Lean Tools: A Pocket guide to Implementing Lean Practices	Productivity and Quality Publishing Pvt Ltd., New Delhi	2002

REFERENCES:

S.NO	Author(s) Name	Title of the book	Publisher	Year of Publication
1	Joseph A.D Feo , William W Bearnard,	Juran Institute's Six Sigma Break Through and Beyond	Tata McGraw-Hill Edition, New Delhi	2004
2	Richard B Chase, Robert Jacobs F and Nicholas J Aquilano	Operations Management for Competitive Advantage Tenth Edition	McGraw- Hill, Newyork	2003
3	Poka – Yoke	Improving Product Quality by Preventing Defects	Productivity Press, Chennai	1992
4	Alan Robinson	Continuous Improvement in Operations	Productivity Press, Portland, Oregon	1991

WEBSITES :

1. www.leanmanufacturingconcepts.com
2. www.learnleanblog.com

INTENDED OUTCOMES:

- To understand the role of logistics and the phases of supply chain
- To understand the models and activities of SC

UNIT I INTRODUCTION TO SUPPLY CHAIN MANAGEMENT

Definition, global optimization, Objectives of SCM. Logistics networks- data collection, model and data elevation, solution techniques.

UNIT II INVENTORY MANAGEMENT

Introduction, single warehouse, Inventory examples, economic lot size model, effect of demand uncertainty. Risk pooling, centralized and decentralized system, managing inventory in the supply chain, forecasting.

UNIT III VALUE OF INFORMATION

Bullwhip effect, information and supply chain technology. Supply chain integration- push, pull and push-pull system. Demand driven strategies, impact of internet on SCM, distribution strategies.

UNIT IV STRATEGIC ALLIANCES

Framework for strategic alliance, third party logistics, retailer, supplies partnership, distributor-integration, procurement and out servicing strategies.

UNIT V INTERNATIONAL ISSUES IN SCM

Introduction, risks and advantages- design for logistics, supplies integration into to new product development, mass customization. Issues in customer value.

Information Technology For Scm: Goals, standardization, infrastructure, DSS for supply chain management.

TEXT BOOKS:

S.NO	Author(s) Name	Title of the book	Publisher	Year of Publication
1	Simchi – Levi Davi, Kaminsky Philip and Simchi-Levi Edith	Designing and Managing the Supply Chain	Tata M.Graw- Hill Publishing Company Ltd, New Delhi	2003
2	Sunil Chopra and Peter Meindl	Supply Chain Management – Strategy, Planning and Operation”, 3 rd Edition	Prentice Hall, New Delhi	2006

REFERENCES:

S.NO	Author(s) Name	Title of the book	Publisher	Year of Publication
1	Ayers J.B	Hand book of Supply Chain Management	The St. Lencie press, New Delhi.	2001
2	Raghuram G and Rangaraj N	Logistics and Supply Chain Management: Cases and Concepts	Macmillan, New Delhi	2000
3	Scharj P.B, Lasen T.S	Managing the global supply chain	Viva Books, New Delhi	2000
4	Thomas E Vollman, Clay Whybark D	Manufacturing Planning and Control for Supply Chain Management”, Fifth Edition	Tata Mcgraw-Hill, New Delhi	2005

WEBSITES :

<ol style="list-style-type: none">1. http://www.supplychainmanagement.in/2. www.supplychainseminars.com3. http://www.training-management.info/4. http://www.erpfans.com/erpfans/erpdefinition/erp002.html5. http://www.ascet.com/documents.asp?grID=197&d_ID=981

INTENDED OUTCOMES:

- To make the students to understand the concepts of multi cylinder engines.
- To understand the working of various components, mechanisms suspension and braking systems.

UNIT – I AUTOMOBILE ARCHITECTURE AND PERFORMANCE

Automotive components, subsystems and their positions- Chassis, frame and body, front, rear and four wheel drives, Operation and performance, Traction force and traction resistance, Power required for automobile-Rolling, air and gradient resistance.

ENGINE ARCHITECTURE AND PERFORMANCE

Types of engine, multi valve engine, in-line engine, vee-engine, Petrol engine-direct, single point and multipoint injection, diesel engine-common rail diesel injection, supercharging and turbo charging, alternate fuels-ethanol and ethanol blend, compressed natural gas, fuel cells, hybrid vehicles.

UNIT – II TRANSMISSION SYSTEMS

Clutch : Types-coil spring and diaphragm type clutch, single and multi plate clutch, centrifugal clutch,
Gear box : Types-constant mesh, sliding mesh and synchromesh gear box, layout of gear box, gear selector and shifting mechanism, overdrive, automatic transmission, Propeller shaft, universal joint, slip joint, differential and real axle arrangement, hydraulic coupling.

UNIT – III WHEEL TYRES AND BRAKING SYSTEM

Types of wheels, construction, wired wheels, Tyres- construction, Radial, bias & belted bias, slip angle, Tread patterns, Tyre retreading cold & hot, Tubeless tyres.
Forces on vehicles, tyre grip, load transfer, braking distribution between axles, stopping distance, Types of brakes, Mechanical, Hydraulic, Air brakes, Disc & Drum brakes, Engine brakes anti lock braking system.

UNIT – IV SUSPENSION SYSTEM AND STEERING SYSTEM

Types-front and rear suspension, conventional and independent type suspension, leaf springs, coil springs, dampers, torsion bars, stabilizer bars, arms, air suspension systems.
Types of steering systems, Ackermann principle, Davis steering gear, steering gear boxes, steering linkages, power steering, wheel geometry-caster, camber toe-in, toe out etc., wheel Alignment and balancing.

UNIT – V AUTOMOTIVE ELECTRONICS: Introduction – ignition systems- Electronic fuel control – electronic control of braking and traction – engine management systems- automotive microprocessors uses – lighting and security systems.

TEXT BOOKS:

S.NO	AUTHOR(S) NAME	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1	Gupta R.B	Automobile Engineering	Satya Prakashan, Laxmi Publications, chennai .	2004
2	Kirpal Singh	Automobile Engineering Vol-I & II	Standard publishers, Delhi.	1997

REFERENCES:

S.NO	AUTHOR(S) NAME	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1	Julian Happian Smith	An introduction to modern vehicle design	Butterworth Heinemann, New Delhi.	2002
2	Crouse W H,	Automotive transmissions and power trains	Mc-Graw Hill Book Co., NewDelhi.	1976
3	Heniz Heisler	Vehicle and Engine Technology	Society of Automotive Engineers	1999
4	William T.M.	Automotive electronic systems	Heinemann Ltd., London	1978

WEBSITES :

1. http://en.wikipedia.org/wiki/Automotive_engineering
2. <http://www.animatedengines.com/>
3. <http://www.automotive-online.com/transmission-system/>
4. <http://www.rqriley.com/suspensn.htm>
5. [http://en.wikipedia.org/wiki/Transmission_\(mechanics\)](http://en.wikipedia.org/wiki/Transmission_(mechanics))

UNIT – I OVERVIEW OF CAD SYSTEMS:

Conventional and computer aided design processes-advantages and disadvantages. Subsystems of CAD-CAD hardware and software, analytical and graphics packages, CAD workstations. Networking of CAD systems

UNIT – II INTERACTIVE COMPUTER GRAPHICS AND GRAPHICS TRANSFORMATIONS:

Generative, cognitive and image processing graphics. Static and dynamic data graphics. Transport of graphics data. Graphic standards. Generation of graphic primitives - display transformation in Two- and Three – Dimensional graphics concepts, Graphical input technique, Geometric transformations, Visual Realism, Computer animation, customizing graphics software.

UNIT – III GEOMETRIC MODELING:

Wireframe, surface, NURBS and solid modeling-applications and advantages. Creating primitive solids, sweeping solids, Boolean operations. Extracting entities from a solid. Filletting of edges of solids. Boundary representation (B-rep) Constructive Solid Geometry(CSG) and Analytical Solid Modeling(ASM)

UNIT – IV PARAMETRIC DESIGN AND OBJECT REPRESENTATION:

Types of co-ordinate systems. Parametric design - definition and advantages. Parametric representation of analytic and synthetic curves. Parametric representation of surfaces and solids - manipulations.

PRODUCT DESIGN AND DEVELOPMENT:

Automated 2D drafting - basics, Mechanical assembly - bill of materials generation. Mass property calculations.

UNIT – V OPTIMIZATION TECHNIQUES:

Optimization-need, objective functions and constraints. Mathematical modeling and analysis.

CASE STUDY:

Design and optimisation procedure of shafts, flywheel, gears and journal bearing using computer packages.

TEXT BOOKS:

S.NO	Author(s) Name	Title of the book	publisher	Year of Publication
1	Radhakrishnan P and Kothandaraman C.P	Computer Graphics and Design	Dhanpat Rai and Sons, New Delhi	2002
2	Radhakrishnan P and Subramanyan S	CAD/CAM/CIM	New Age International (P) Ltd., New Delhi.	2002

REFERENCES:

S.NO	Author(s) Name	Title of the book	publisher	Year of Publication
1	Ibrahim Zeid	CAD/CAM Theory and Practice	McGraw- Hill Inc., New Delhi	2003
2	Vera B Anand	Computer Graphics and Geometric Modeling for Engineers	John Wiley and Sons Inc., New Delhi	2000
3	Barry Hawhes	The CAD/CAM Process	Pitman Publishing, London	1998
4	William M Newman and Robert Sproul	Principles of Interactive Computer Graphics	McGraw Hill Inc., New Delhi	1994
5	Sadhu Singh	Computer-Aided Design and Manufacturing	Khanna Publishers, New Delhi	2003
6	-	User's Manuals for ANSYS, ADAMS and Pro/Engineer software	-	1998
7	Rao S S	Optimisation Techniques	Wiley Eastern, New Delhi	2003

INTENDED OUTCOMES:

- | |
|---|
| <ul style="list-style-type: none"> • To understand the components and operations of steam power plants and hydel power plants • To understand the components and operations of Nuclear power plant and Gas turbine plants |
|---|

UNIT I INTRODUCTION TO POWER PLANTS & BOILERS

Layout of Steam, Hydel, Diesel, MHD, Nuclear and Gas Turbine Power Plants - Combined Power Cycles – Comparison and Selection, Load Duration Curves. Steam Boilers and Cycles – High Pressure and Super Critical Boilers – Fluidised Bed Boilers

UNIT II STEAM POWER PLANT

Fuel and Ash Handling, Combustion Equipment for burning coal, Mechanical Stokers, Pulveriser, Electrostatic Precipitator, Draught – different types, Surface Condenser Types, Cooling Towers

UNIT III NUCLEAR AND HYDEL POWER PLANTS

Nuclear Energy – Fission, Fusion Reaction, Types of Reactors, pressurized water reactor, Boiling Water Reactor, Waste Disposal and safety. Hydel Power Plant – Essential Elements, Selection of Turbines, Governing of Turbines- Micro Hydel developments.

UNIT IV DIESEL AND GAS TURBINE POWER PLANT

Types of Diesel Plants, Components, Selection of Engine Type, Applications Gas Turbine Power Plant – Fuels - Gas Turbine Material – Open and Closed Cycles – Reheating – Regeneration and Intercooling – Combined Cycle.

UNIT V OTHER POWER PLANTS AND ECONOMICS OF POWER PLANTS

Geo thermal – OTEC – Tidel - Pumped storage - Solar thermal central receiver system. Cost of Electric Energy – Fixed and operating Costs – Energy Rates – Types of Tariffs – Economics of load sharing, comparison of economics of various power plants.

TEXT BOOKS:

S.NO	Author(s) Name	Title of the book	publisher	Year of Publication
1	Wakil M.M	Power Plant Technology	McGraw-Hill. New Delhi.	1984
2	Arora S.C and Domkundwar S	A course in Power Plant Engineering	atrai Publishers, New Delhi.	-
3	Nag P.K	Power plant Engineering	Tata McGraw-Hill, New Delhi.	1998

REFERENCES:

S.NO	Author(s) Name	Title of the book	publisher	Year of Publication
1	Nagpal G.R	Power Plant Engineering	Khanna Publishers, New Delhi.	1998
2	Ramalingam K.K	Power Plant Engineering	Scitech Publications.	2002
3	Rai G.D	Introduction to Power Plant Technology	Khanna Publishers, New Delhi.	1995
4	Rajput R.K	Power Plant Engineering	Laxmi Publications, Chennai.	1995
5	Frank D.Graham	Power Plant Engineers Guide	D.B. Taraporevala Sons & Co, NewDelhi.	1993
6	Morse Frederick T	Power Plant Engineering	Prentice Hall of India, New Delhi.	1998

WEBSITES:

1. www.igcar.gov.in
2. ga.water.usgs.gov
3. www.mapsofindia.com
4. www.solarpaces.org