MECHANICAL ENGINEERING

M. Tech. PROGRAMME
(Duration: TWO Years)

Course Credits Course Title

DESIGN ENGINEERING

CORE COURSES: 21 Credits
(Compulsory)

ME5101 3:0 Numerical Methods and Computational Techniques
ME5102 3:0 Stress Analysis
ME5103 3:0 Advanced Vibration and Acoustics
ME5104 3:0 Computer Aided Design
ME5105 3:0 Analysis and Synthesis of Mechanisms
ME5106 3:0 Tribology and Condition Monitoring
ME5107 3:0 Optimization Techniques in Design

ELECTIVES: 06 Credits from the following courses

ME5109 3:0 Finite Element and Boundary Element Method
ME5110 3:0 Robotics
ME5111 3:0 Advanced Machine Design
ME5112 3:0 Fracture Mechanics
ME5113 3:0 Machine Tool Design
ME5114 3:0 Interactive Computer Graphics

LAB. PRACTICE : 04 Credits

ME5119 0:2 Aug.- Dec. Term (I)
ME5120 0:2 Jan.-April Term. (II)

SEMINAR: 04 Credits

ME5122 0:2 Aug.- Dec. Term (I)
ME5123 0:2 Aug.- Dec. Term (III)

PROJECT: 32 Credits

ME5124 0:12 Aug.- Dec. Term(III) with Seminar
ME5125 0:20 Jan.-April Term (IV)

HEAT POWER ENGINEERING

CORE COURSES: 21 Credits
(Compulsory)

ME5201 3:0 Numerical Methods and Computational Techniques
ME5202 3:0 Advanced Thermodynamics
ME5203 3:0 Advanced Heat Transfer
ME5204 3:0 Advanced Fluid Mechanics
ME5205 3:0 Design of Heat Exchangers
ME5206 3:0 Energy Conservation and Management
ME5207 3:0 Modern Measurement Systems & Controls

ELECTIVES: 06 Credits from the following courses

ME5209 3:0 I.C. Engines
ME5210 3:0 Advanced Refrigeration
ME5211 3:0 Non Conventional Energy Sources
ME5212 3:0 Gas Turbines
ME5213 3:0 Air Conditioning System Design
ME5214 3:0 Environmental Pollution & Control

LAB. PRACTICE : 04 Credits

ME5219 0:2 Aug.- Dec. Term (I)
ME5220 0:2 Jan.-April Term. (II)

SEMINAR: 04 Credits

ME5222 0:2 Aug.- Dec. Term (I)
ME5223 0:2 Aug.- Dec. Term (III)

PROJECT: 32 Credits

ME5224 0:12 Aug.- Dec. Term(III) With Seminar
ME5225 0:20 Jan.-April Term (IV)

DESIGN ENGINEERING

ME 5101 (AUG.) 3:0
Numerical Methods and Computational Techniques

Solution of Transcendental and polynomial equations, Solution of Linear simultaneous equations, Gauss eliminations, Gauss Jordan, Gauss-Seidel iteration methods, power method to determine eigen value and eigen vector, partitioning of matrices, Least square technique for linear regression, polynomial regression, multiple linear regression, Interpolation, Newton's divided difference formula, Numerical integration and differentiation, Trapezoidal rule, Simpson's rules, Romberg Integration, Derivatives using forward difference, backward difference, divided difference, central difference formulae, Solution of ordinary differential equations, Predictor-Corrector method, Runge-Kutta methods, Milnes method, shooting method, Finite difference methods. Solution of higher order and simultaneous differential equations, Solution of partial differential equations, Finite difference methods for solution of parabolic, Hyperbolic and Elliptic equations, Finite element method, Introduction to FEM, linear and Lagrangian formulation, beam elements introduction to two dimensional problems.

Reference Books:

1. M. K. Jain/SRK Iyengar /R.K. Jain, "Numerical Methods for scientific and Engineering computations , **Wiley** Eastern Ltd., 1985.
2. Curtis F Gerald/ Patric O.,Wheatley, "Applied Numerical Analysis", Addison Wesley, 1989.
3. Terrence/Akai, "Applied Numerical Methods for Engineers", Wiley, 1994.
4. Dr. B. S. Grewal, "Numerical Methods in Engineering and science", Khanna Publishers, 1994.
5. A. Gourdin/M. Boumahart, "Applied Numerical Methods", PHI.
6. Segerlind, "Applied finite element Analysis", New York, Wiley, 1984.
7. Rogers and Adams, "Mathematical Elements in computer Graphics" McGraw-Hill, New York, 1976.
8. Hearn and baker, "Computer Graphics", Prentice Hall International, 1986.

ME 5102 (AUG.) 3:0
Stress Analysis

Theory of elasticity, Plane stress & Plane strain ,Two dimensional problems in Rectangular & Polar co-ordinate system, Analysis of stresses & strains in three dimension, Energy methods for analysis of stress, strain & deflection, The three theorem's: Theorem of virtual work, Theorem of least work , Castigliano's theorem. Rayleigh Ritz method, Galerkin's method. Theory of torsion, Torsion of prismatic bars of solid section and thin walled section. Anologies for torsion: Membrane Analogy, fluid flow analogy and Electrical analogy, Torsion of conical shaft, bar of variable diameter, Torsion of noncircular shaft, Bending of Prismatic bars & Unsymmetric Bending, Concept of shear centre in symmetrical and unsymmetrical bending, Plate Bending ,Bending of plate to cylindrical surface, Bending of circular plates of variable thickness, Pressurized Cylinders & Rotating Disks, Governing equations, stresses in thick walled cylinder under internal & external pressure , shrink fit compound cylinders, stresses in rotating flat solid disk ,flat disk with central hole ,disk with variable thickness, disk of uniform strength. Plastic action in thick walled cylinders & rotating disks, Contact stresses, Geometry of contact surface, Experimental stress Analysis, Dimensional

Analysis, Analysis techniques strain gauges: configuration, Instrumentation, Characteristics of strain gauge measurements. Theory of photo elasticity and techniques used in photo elastic Application. Plastic bending, The plastic flow process, shape factor, springback, plastic bending with strain hardening material, plastic bending of plastic, plastic hinges, plastic deflection.

Reference Books:

1. Cook and Young, "Advanced Mechanics of Materials", Prentice Hall, 2nd edition (August 28, 1998).
2. Richard G Budynar, "Advanced strength and Applied stress analysis", McGraw Hill.
3. Boresi/Schmidt/Sidebottom, "Advanced Mechanics of Materials", Willey.
4. Timoshenko and Goodier, "Theory of elasticity", McGraw Hill, 1970.
5. Timoshenko, "Advance Strength of Materials", vol 1 & 2, CBS.
6. Den Hartog, "Advance Strength of Materials" McGrawHill, 1952.

ME 5103 (AUG.) 3:0
Advanced Vibration and Acoustics

Transient Vibrations, Response of a single degree of freedom system to step and any arbitrary excitation, convolution (Duhamel's) integral, impulse response function, Multi degree of freedom systems, Free, damped and forced vibrations of two degree of freedom systems, Eigen values and Eigen vectors, normal modes and their properties, mode summation method, use of Lagrange's equations to derive the equations of motion, Continuous Systems, Vibrations of strings, bars, shafts and beams, discretised models of continuous systems and their solutions using Rayleigh – Ritz and Galerkin's methods, use of Lagrange's equation. Mode summation method, Vibration Control, Methods of vibration control, Non-linear vibrations, Systems with non-linear elastic properties, principle of superposition, Numerical and computer methods in vibrations: Rayleigh, Rayleigh-Ritz and Dunkerley's methods, matrix iteration method for eigen-value calculations, Holzer's method, introduction to finite element method for vibration analysis, Self excited vibrations, Introduction to Random Vibrations, Vibrations of strings and bars, Circular membranes and plates, Vibrations of a plane surface, Plane and Spherical acoustic waves, Transmission Phenomena, transmission from one fluid medium to another, normal incidence, reflection at the surface of a solid, standing wave patterns, transmission through three media, Resonators and filters, Absorption of sound waves in fluids : Phase log between pressure and condensation, viscous absorption of plane waves, heat conduction as a source of acoustic attenuation, Loudspeakers and Microphones, Ultrasonic and Sonar transducers, Speech, Hearing and Noise, The voice mechanism, acoustic power output of a speech, anatomy of the year, mechanism of hearing, thresholds of the ear, loudness, pitch and timbre, beats, aural harmonics and combination tones, masking by pure tones, masking by noise, binaural localization.

Reference Books:

1. J .P. Den Hartog, "Mechanical Vibrations", McGraw Hill Book Co. New York, 1958.
2. S. Timoshenko, "Vibration problems in Engineering", Wiley, 1974.
3. Francis S. Tse, Iran E. Movse, Rolland T.Hinkle, "Mechanical Virbations", CBS Publishers and Distributors, 1983.
4. W. Ker Wilson, "Practical Solution of Torsional Vibrations Problems", Chapman and Hall, 1969.
5. C. M. Harris, C.E. Crede "Shock and Vibration Hand Book", McGraw Hill Book Co., 1988.
6. D. J. Hater, "Matrix Computer methods of Vibration Analysis", Butterworths, 1973.

7. Thomson W.T., "Theory of Vibrations with applications", George Allen and Unwh Ltd. London, 1981.
8. Shriniwasan P., "Mechanical Vibration Analysis", Tata McGraw Hill, 1982.
9. Lawrence E. Kinsler and Austin R.Frey, "Fundamentals of acoustics", Wiley Eastern Ltd., 1987.
10. Michael Rettinger, "Acoustic Design and Noise Control", Vol. I & II. , Chemical Publishing Co., New York, 1977.
11. W.T. Thomson, "Theory of vibrations with applications", CBS Publishers, Delhi, 2003.
12. S.S. Rao, Addison, "Mechanical Vibrations", Wesley Publishing Co., 1990.
13. Leonard Meirovitch, "Fundamentals of vibrations", McGraw Hill International Edition.
14. Asok Kumar Mallik, "Principles of Vibration Control", Affiliated East-West Press.
15. A.H. Church, "Mechanical Vibrations", John Wiley and Sons, Inc, New York, 1994.

ME 5104 (AUG.) 3:0
Computer Aided Design

CAD Hardware and Software, Types of systems and system considerations, input and output devices, hardware integration and networking, hardware trends, Software modules, Computer Communications, Principle of networking, classification networks, network wring, methods, transmission media and interfaces, network operating systems, Computer Graphics Introduction, transformation of geometric models: translation, scaling, reflection, rotation, homogeneous representation, concatenated transformations; mappings of geometric models, translational mapping rotational mapping, general mapping, mappings as changes of coordinate system; inverse transformations and mapping; projections of geometric models, orthographic projections, Geometric Modeling, curve representation: Parametric representation of analytic curves, parametric representation of synthetic curves, curve manipulations. Surface representation, Fundamentals of solid modeling, boundary representation (B-rep), Constructive Solid Geometry (CSF), sweep representation, Analytic Solid Modeling (ASM), other representations; solid manipulations, solid modeling based applications: mass properties calculations, mechanical tolerancing, etc. Finite Element Modeling and Analysis, Finite Element Analysis, finite element modeling, mesh generation mesh requirements, semiautomatic methods, fully automatic methods, design and engineering applications, System Simulation, Need of simulation, areas of applications, when simulation is appropriate tool / not appropriate, concept of a system, components of a system, discrete and continuous systems, model of a system, types of models, types of simulation approaches

References Books

1. Ibrahbim Zeid, "CAD / CAM Theory and Practice".
2. Jim Browne, "Computer Aided Engineering and Design".
3. P. Radhakrishnan / V. Raju / S. Subramanyam, "CAD / CAM / CIM".
4. P.N. Rao, "CAD / CAM principles and applications", Tata Mcraw-Hill, 2002.
5. Rogers / Adams, "Mathematical Elements for Computer Graphics".
6. Rooney and Steadman, "Principles of Computer Aided Design", Aug. 1993.
7. Jerry Banks / John Carson / Barry Nelson / David Nicol, "Discrete-Event System Simulation".

ME 5105 (JAN.) 3:0
Analysis and Synthesis of Mechanisms

Basic Concepts; Definitions and assumptions; planar and spatial mechanisms; kinematic pairs; degree of freedom; equivalent mechanisms; Kinematic Analysis of Planar

Mechanisms. Review of graphical and analytical methods of velocity and acceleration analysis of kinematically simple mechanisms, velocity-acceleration, analysis of complex mechanisms by the normal acceleration and auxiliary-point methods, Curvature Theory: Fixed and moving centrodes, inflection circle, Euler-Savary equation, Bobillier constructions, cubic of stationary curvature, Ball's point, Applications in dwell mechanisms, Kinematic Synthesis of planar mechanisms, accuracy (precision) points, Chebesychev spacing, types of errors, Graphical synthesis for function generation and rigid body guidance with two, three and four accuracy points using pole method, centre and circle point curves, .Analytical synthesis of four-bar and slider-crank mechanisms, Freudenstein's equation, synthesis for four and five accuracy points, compatibility condition, synthesis of four-bar for prescribed angular velocities and accelerations using complex numbers, three accuracy point synthesis using complex numbers, Coupler Curves : Equation of coupler curve, Robert-Chebychev theorem, double points and symmetry, Kinematic Analysis of Spatial Mechanisms, Denavit-Hartenberg parameters, matrix method of analysis of spatial mechanisms

References Books. :

1. A. Ghosh and A.K. Mallik, "Theory of Machines and Mechanisms", Affiliated East-West Press, New Delhi, 1988.
2. R.S. Hartenberg and J. Denavit, "Kinematic Synthesis of Linkages", McGraw-Hill, New York, 1980.
3. A.G. Erdman and G.N. Sandor, "Mechanism Design – Analysis and Synthesis", (Vol. 1 and 2), Prentice Hall India, 1988.
4. A.S. Hall, "Kinematics and Linkage Design", Prentice Hall of India.
5. J.E. Shigley and J.J. Uicker, "Theory of Machines and Mechanisms", 2nd Edition, McGraw-Hill, 1995.
6. S.S. Rattan, "Theory of Machines", Tata McGraw Hill, 1993.

ME 5106 (JAN.) 3:0
Tribology and Condition Monitoring

Friction and wear, Friction control and wear prevention, boundary lubrication. Tribological properties of bearing materials and lubricants, theories of friction and wear, instabilities and stick-slip motion , Lubrication of bearings, Mechanics of fluid flow, Reynolds's equation and its limitations, idealized bearings, infinitely long plane pivoted and fixed show sliders, infinitely long and infinitely short (narrow) journal bearings, lightly loaded infinitely long journal bearing (Petroff's solution),Finite Bearings ,Hydrostatic, hydrodynamic and thrust oil bearings, heat in bearings, porous bearings, foil bearings. Hydrostatic squeeze film Circular and rectangular flat plates, variable and alternating loads, piston pin lubrications, application to journal bearings. Elasto-hydrodynamic lubrication – pressure viscosity term in Reynolds's equation, Hertz' theory, Ertel-Grubin equation, lubrication of spheres, gear teeth and rolling element bearings, Air lubricated bearings, Tilting pad bearings, magnetic recording discs with flyngheed, hydrostatic, hydrodynamic and thrust bearings with air lubrication, Tribological aspects of rolling motion: The Mechanics of tyre-road interactions, road grip and rolling resistance. Tribological aspects of wheel on rail contact. Tribological aspects of metal rolling, drawing and extrusion, Machinery noise control, Radiation of sound from vibrating structure, condition monitoring on expert system ,Acoustic emission for condition motoring in manufacturing, recent advances in reliability models to plant

maintenance, Development in sensor technology with application to Tribology , Implementation of condition monitoring in industries.

Reference Books:

1. A. Cameron, "Basic Lubrication Theory", Ellis Horwood Ltd, 1981.
2. A. Cameron, "The principles of lubrication", Longmans Green & Co. Ltd, 1966.
3. D.D. Fuller, "Theory and Practice of Lubrication for Engineers", John Wiley and Sons, 1984.
4. "Fundamentals of Friction and wear of Materials" American Society of Metals.
5. J.W. Powell, "The Design of Aerostatic Bearings".
6. Grassam and Powell, "Gas Bearings", Butter-worths, London, 1964..
7. Pinkush and Sterrolicht, "Theory of Hydrodynamic Lubrication".
8. T.A. Stolarski, "Tribology in Machine Design".

ME 5107 (JAN.) 3:0
Optimisation Techniques in Design

Introduction to optimization, classification of optimisation problems, classical optimisation techniques, Linear programming, simplex method and Duality in linear programming, sensitivity or post-optimality analysis, Karmarkar's methods, Non-Linear Programming: - One dimensional minimization, constrained optimisation, direct and indirect methods, Geometric programming, unconstrained and constrained minimization, complimentary geometric programming, application of geometric programming, Dynamic programming, multistage decision process, concept of sub optimisation and principle of optimality, continuous dynamic programming, Optimum design of tension bar, stepped bar, links connected to other elements by pins, beams, shafts, stepped shafts, shafts with keyways, members subjected to both bending and twisting, cams, spur gears, pressure vessels.

Reference Books:

1. S. S. Stricker, "Optimising performance of energy systems" Battelle Press, New York, 1985.
2. R.C. Johnson, "Optimum Design of Mechanical Elements", Willey, New York, 1980.
3. J. S. Arora, "Introduction to Optimum Design", McGraw Hill, New York, 1989.
4. L.C.W. Dixon, "Non-Linear Optimisation - Theory and Algorithms", Birkhauser, Boston, 1980.
5. R.J. Duffin, E.L. Peterson and C.Zener "Geometric Programming-Theory and Applications", Willey, New York, 1967.
6. G.B. Dantzig "Linear Programming and Extensions Princeton University Press", Princeton, N. J., 1963.
7. R. Bellman "Dynamic Programming-Princeton" University Press, Princeton, N.J. 1957.

ME 5109 (JAN.) 3:0
Finite Element and Boundary Element Methods

Introduction, steps in finite element method, descretisation, types of elements used, Shape of functions, Linear Elements, Local and Global coordinates, Noddle degrees of freedom, Finite element formulation, variational, weighted residual and virtual work methods, Field problems, irrotational flow, conduction heat transfer, electromagnetic and electrostatic fields, Quasi harmonic equation, Axisymmetric field problems, computer implementation, higher order elements, isoparametric version, Application to non-linear problems, solution to Nervier Strokes equations, phase change, radiation, temperature dependant materials, stress analysis in simple cases, axisymmetric solids, stress concentration factors, Boundary element approach, numerical implementation, analyzing

time domain, boundary element formulation, descretisation and matrix formulation, adaptive mesh refinement.

References Books :

1. Cook R.D. "Concepts and applications of finite element analysis" Wiley, New York, 1981.
2. Bathe K.J., Cliffs, N.J. "Finite element procedures in Engineering Analysis", Englewood. Prentice Hall, 1981.
3. Desai C.S. and J.F. Abel "Introduction to the finite element method." New York, Van Nostrand Reinhold, 1972.
4. Chandrupatla and Belegundu "Introduction to finite elements in Engineering", Prentice Hall of India Pvt. Ltd. New Delhi, 2001.
5. O. P. Gupta, "Finite and boundary element methods in Engineering", Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, 2000.

ME 5110 (JAN.) 3:0
Robotics

Introduction and Basic Concepts, Robotics and automation, Robot anatomy, structure of robots, resolution, accuracy, repeatability, point to point and continuous path robotic systems, Manipulator Kinematics Transformation matrices and their arithmetic, link and joint description, Denavit-Hartenberg parameters, frame assignment to links, direct kinematics, kinematic redundancy, kinematic calibration, inverse kinematics, solvability, algebraic and geometrical methods, Velocities and Static forces in manipulators Motion of the manipulator links, Jacobians, singularities, static forces, Jacobian in force domain, Manipulator Dynamics Iterative Newton-Euler dynamic formulation, structure of the manipulator dynamic equations, introduction to the Lagrangian formulation and generalized D'Alembert's equations of motion, Trajectory Generation Considerations in path description and generation, joint space schemes, paths with via points, Cartesian space schemes, geometrical problems with Cartesian paths, Manipulator Control : Introduction to closed loop control, second order linear systems and their control, control law partitioning, trajectory-following control, modeling and control of a single joint. Introduction to non-linear control, non-linear and time-varying systems, the control problem of manipulators, practical considerations, present industrial robot control systems, introduction to force control, brief introduction to robot actuators, need for sensors and vision system in the working and control of a robot, Robot Programming: Methods of robot programming, lead through programming, motion interpolation, branching capabilities, WAIT, SIGNAL and DELAY commands, subroutines, RAIL and VAL II programming languages, Introduction to Artificial Intelligence, Manipulator Mechanism Design Introduction, task requirements, kinematic configuration, quantitative measures of workspace attributes, redundant and closed chain structures, actuation schemes, stiffness and deflections, position and force sensing .

Reference Books:

1. John J. Craig, "Introduction to Robotics (Mechanics and Control)" , Addison-Wesley, 2nd Edition, 1989.
2. L. Sciavicco, B. Siciliano "Modelling and control of robot manipulators", The McGraw-Hill Co. Inc., 1996.
3. R.J. Schillin, "Fundamentals of Robotics: Analysis and Control", Prentice Hall.
4. K.S. Fu, R.C. Gonzales, C.S.G. Lee, "Robotics: Control, Sensing, Vision and Intelligence", McGraw Hill,1987.
5. Groover, "Industrial Robotics: Technology, Programming and Applications", McGraw Hill, 1986.

ME 5111 (JAN.) 3:0
Advanced Machine Design

Need Identification and problem definition, concept generation and evaluation, creativity methods, theory of inventive problem solving (TRIZ), Design and the production-consumption cycle, Morphology of design, problem analysis, synthesis of alternative solutions, evaluation and communication, application to design problems, Design against fatigue, design against creep, composite materials and structures, design for assembly, design for casting, forging and welding, Assessment of quality of manufactured products, process controls, quality assurance, probability and statistics applied to quality management, quality influencing design, cost evaluation, Risk, reliability and safety, robust design, Modeling and simulation, dimensional dynamics analysis, similitude and scale, models, Geometric modeling on the computer, Rapid prototyping,

Reference Books

1. George E Dieter, "Engineering Design", McGraw Hill Company, 2000.
2. Woodson T.T., "Introduction to Engineering Design", McGraw Hill Book Company, 1966.
3. John J.C. "Design Methods", Wiley Inter science, 1970.
4. Averill M. Law and W. David Kelton "Simulation, modelling and analysis", McGraw Hill Book Company, 1991.

ME 5112 (JAN.) 3:0
Fracture Mechanics

Structures of solids, dislocation theory, microscopic concepts in brittle fracture, ductile fracture and plasticity aspects of fracture, mathematical analysis of brittle and ductile fracture, Metallographic aspects of fracture, some physical aspects of fracture related to temperature and propagation of fatigue cracks. Creep fracture., Application of fracture mechanics to welded joints. Composite materials and non-metals. Fracture mechanics and engineering design, Energetics of fracture, energy release vate and stress intensity factor, mixed mode fracture, dynamic fracture, Structural safety and reliability, typical examples and case studies.

References Books. :

1. Brook D, "Elementary engineering fracture mechanics".
2. Liebowitz H., "Fracture" Volume I to VII.
3. A Nadai, W. S. Hemp, "Theory of flow and fracture of solids", McGraw Hill Book Company, 1950.

ME 5113 (JAN.) 3:0
Machine Tool Design

Fundamental Aspects of Machine Tool Design, General classification of machine tools. Types of surfaces, profiles and paths produced by machine tools, Estimation of the tool forces and power consumption in a lathe operation, milling, cylindrical grinding, drilling, broaching and shaping, Kinematics of Machine Tools, Types of driving systems. Basic considerations in the design of drives, Mechanical regulation of drives, Graphical representation of speed and structure diagram, Various types of structure diagrams, Selection of optimum ray diagram. Transmission in stepped regulation, Design of stepped drives, Gears and gear boxes, gear spindle drive, Stepless Regulation, Design of Machine Tool Beds, Tables and Columns, Constructional and design features of various types of

beds used in machine tools, Design of Machine Tool Guides, Design of Power Screws for Machine Tools, Design of Machine Tool Spindles, Rigidity of Machine Tools, Static and dynamic rigidity, contact rigidity, designing against vibrations and chatter in machine tools. Elimination of vibrations – damping, isolating vibrations, dynamic absorber with damping, viscous dampers, active dampers, Vibration analysis of machine tool structures by stiffness method and finite element method, Electrical and Hydraulic Drives for Machine Tools, Hydraulic power packs including positive displacement pump, linear and rotary actuators, types and operation of valves, NC and CNC Machine Tools, Design considerations. Basic concepts – construction, operations, tooling. Advanced and special developments related to CAD, CAM systems. NC programming.

Reference Books. :

1. S.K. Basu and D.K. Pal, "Design of Machine Tools", Fourth Edition, Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, 1990.
2. N.K. Mehta, "Machine Tool Design and Numerical Control" Second Edition, Tata McGraw Hill Publishing Co. Ltd., New Delhi.
3. F. Koenigsberger, "Design Principles of Metal Cutting and Machine Tools", Edition 1964, Pergamon Press Ltd., London.
4. G.C. Sen and A. Bhattacharya, "Principles of Machine Tools", Second Edition, New Central Book Agency (P) Ltd., Kolkata, 1988.

ME 5114 (JAN.) 3:0
Interactive Computer Graphics

Introduction to data structures and algorithms, model of interactive graphics systems, taxonomy of display systems, Data structures, data bases, list handling, picture structure, picture, Rendering of surfaces and solids, interpolation and approximation of curves and surfaces, Interaction handling, interactive input devices, device independence, attention handling, The Display processor, display file and picture file organization, Language concepts for interactive computer graphics, high level language implementation of display programming systems.

Reference Books:

1. Wolfgang K. Giloi, "Interactive Computer Graphics", Prentice Hall of India Pvt. Ltd., 1988.
2. Walter E Rodriguez, "Interactive Engineering Graphics", McGraw Hill Book Co., 1989.

LAB. PRACTICE: 04 Credits
ME5119 0:2 Aug.- Dec. Term (I)
ME5120 0:2 Jan.-April Term (II)

The term work shall consist of minimum eight exercises. Minimum two exercises from each subject based on preferably experimental measurements.

SEMINAR: 04 Credits
ME5122 0:2 Aug.- Dec. Term (I)
ME5123 0:2 Aug.- Dec. Term(III)

Seminar should be based on detailed study of any topic related to Design Engineering, preferably in the area in which the candidate would like to do the project work. The topic of the seminar shall be approved by the Guide and the Head of the Department on the basis of abstract submitted within the first month of the starting of the semester.

PROJECT: 32 Credits

ME5124 0:12 Aug.- Dec. Term with Seminar (III)

ME5125 0:20 Jan.-April Term (IV)

The Project Work will start in semester III and should preferably be live problem in industry or a micro issue having a bearing on performance of the industry and should involve scientific research, design, generation/collection and analysis of data, determining solution and must preferably bring out the individual contribution. The dissertation should be presented in standard format. The Oral examination shall be conducted with the help of approved external examiner.

HEAT POWER

ME 5201 (AUG.) 3:0
Numerical Methods and Computational Techniques

Solution of Transcendental and polynomial equations, Solution of Linear simultaneous equations, Gauss eliminations, Gauss-Seidel iteration methods, Least square technique for linear regression, polynomial regression, multiple linear regression, Interpolation, Newton's divided difference formula, Numerical integration and differentiation, Trapezoidal rule, Simpson's rules, Romberg Integration, Derivatives using forward difference, backward difference, divided difference, central difference formulae, Solution of ordinary differential equations, Predictor-Corrector method, Runge- Kutta methods, Milnes method, shooting method, Finite difference methods. Solution of higher order and simultaneous differential equations, Solution of partial differential equations, Finite difference methods for solution of parabolic, Hyperbolic and Elliptic equations, Finite element method, Introduction to FEM, linear and Lagrangian formulation, beam elements introduction to two dimensional problems.

Reference Books

1. M. K. Jain, SRK Iyengar, R. K .Jain, "Numerical Methods for scientific and engineering computations" Wiley, 1985.
2. Steven Chapra and Raymond P Canale, "Numerical Methods for Engineers", McGraw Hill, 2002.
3. Curtis F Gerald/ Patric O.,Wheatley, "Applied Numerical Analysis", Addison Wesley, 1999.
4. Terrence, Akai, "Applied Numerical Methods for Engineers", Wiley, 1993.
5. Dr. B. Sgrewal, "Numerical Methods in Engineering and science".
6. A. Gourdin, M.Boumahart, "Applied Numerical Methods", PHI.
7. Segerlind, "Applied finite element Analysis", New York, Wiley, 1984.
8. Rogers and Adams, "Mathematical Elements in computer Graphics".
9. Hearn and baker "Computer Graphics".

ME 5202 (AUG.) 3:0
Advanced Thermodynamics

First law, Second law, Tds equations, Maxwell relations, Clapeyron equation, pure substances, thermodynamic property relations, thermo-electricity, equations of state, Gas mixtures, Chemical Thermodynamics and Equilibrium, Statistical thermodynamics, statistical interpretations of first and second law, Third law of thermodynamics, Nerst heat theorem.

Reference Books:

1. Cengel, "Thermodynamics", Tata McGraw Hill Co., New Delhi, 1980.
2. Howell and Dedcius, "Fundamentals of Engineering Thermodynamics", McGraw Hill Inc., U.S.A.
3. Van Wylen & Sonntag, "Thermodynamics", John Wiley and Sons Inc., U.S.A.
4. Jones and Hawkings, "Engineering Thermodynamics", John Wiley and Sons Inc., U.S.A, 2004.
5. Holman, "Thermodynamics", McGraw Hill Inc., New York, 2002.
6. Faires V.M. and Simmag, "Thermodynamics", Macmillan Publishing Co. Inc., U.S.A.
7. Rao Y.V.C., "Postulational and Statistical Thermodynamics", Allied Publishers Inc, 1994.

ME 5203 (AUG.) 3:0
Advanced Heat Transfer

Conduction- one and two dimensional, Fins, conduction with heat source, unsteady state heat transfer, Natural and forced convection, integral equation, analysis and analogies, Transpiration cooling, ablasion heat transfer, boiling, condensation and two phase flow mass transfer, cooling, fluidized bed combustion, heat pipes, Radiation, shape factor, analogy, shields, radiation of gases & vapours.

Reference Books

1. J.P. Holman, "Heat Transfer", McGraw Hill Book Company, New York, 1990.
2. Incropera and Dewitt, "Fundamentals of Heat and Mass Transfer", John Wiley and Sons, New York, 2000.
3. Frank Kreith, "Principles of Heat Transfer", Harper and Row Publishers, New York, 1973.
4. Donald Q. Kern "Process Heat Transfer", Tata McGraw Hill Publishing Company Ltd., New Delhi, 1975.
5. Gupta and Prakash, "Engineering Heat Transfer", New Chand and Bros, Roorkee (U.P.) India, 1996.
6. R.C. Sachdeva "Fundamentals of Engineering Heat and Mass Transfer", Wiley Eastern Ltd., India, 1997.

ME 5204 (AUG.) 3:0
Advanced Fluid Mechanics

Fluid kinematics and dynamics, Reynolds's, Navier-Stokes and Momentum equations Laminar flow, unsteady flow, Boundary layer theory, Compressible Flow, Non-Newtonian fluid flow, Rheometry and material functions, non-Newtonian viscosity, generalized Newtonian models, Computational Fluid Dynamics techniques and applications.

Reference Books

1. Streeter V.L., Wylie E.B., Bedford K.W "Fluid Mechanics", McGraw Hill, 1998.
2. Fox R.W., McDonald A.T "Introduction to Fluid Mechanics", John Wiley and Sons Inc, 1985.
3. White F.M "Fluid Mechanics", McGraw Hill.
4. Shames I.H "Mechanics of Fluids", McGraw Hill, 2003.
5. Anderson John D.J "Computational Fluid Dynamics" The basics with Applications, McGraw Hill.
6. Bird R.B., Stewart W.F., Lightfoot E.N. "Transport Phenomena", John Wiley & Sons, 1960.

ME 5205 (JAN) 3:0
Design of Heat Exchangers

Heat Exchangers-Classification and Selection, LMTD, e-NTU methods, Fouling, Thermal-Hydraulic Fundamentals, Shell and Tube heat exchanger- Tinker's, Kern's and Bell Delaware's method, design methodology, Compact heat exchangers, Heat pipe, Rod-baffle heat exchanger. Mechanical Design of Heat Exchangers-design standards and codes, key terms in heat exchanger design, material selection, and thickness calculation for major components such as tube sheet, shell, tubes, flanges and nozzles, Introduction to simulation and optimization of heat exchangers, flow induced vibrations**.**

Reference Books

1. D.C. Kern, "Process Heat Transfer", McGraw Hill, 1950.

2. A .P. Frass and M.N. Ozisik, "Heat Exchanger Design", McGraw Hill, 1984.
3. Afgan N. and Schlinder E.V. "Heat Exchanger Design and Theory Source Book".
4. T. Kuppan, "Hand Book of Heat Exchanger Design".
5. "T.E.M.A. Standard", New York, 1999.
6. Kays and London, "Compact Heat Exchanger".
7. G. Walkers, "Industrial Heat Exchangers-A Basic Guide", McGraw Hill, 1982.

ME 5206 (JAN) 3:0
Energy Conservation and Management

The energy market, energy scenario, planning, utilization pattern and future strategy, Importance of energy management. Energy auditing- methodology and analysis, Energy economics, Energy conservation in industries, Cogeneration, Combined heating and power systems, relevant international standards and laws.

Reference Books

1. L.C. Witte, P.S. Schmidt, D.R.Brown, "Industrial Energy Management and Utilization", Hemispherical Publication, 1988.
2. Callaghan "Energy Conservation".
3. D.A. Reeg, "Industrial Energy Conservation", Pergamon Press, 1980.
4. T.L. Boyen, "Thermal Energy Recovery" Wiley, 1980.
5. L.J. Nagrath, "Systems Modeling and Analysis", Tata McGraw Hill, 1982.
6. W.C. Turner, "Energy Management Handbook ", Wiley, New York, 1982.
7. I.G.C. Dryden, "The Efficient Use of Energy ", Butterworth, London, 1982.
8. R. Loftnen, Van Nostrarid Reinhold C. "Energy Handbook", 1978.
9. TERI Publications.

ME 5207 (JAN) 3:0
Modern Measurement Systems & Controls

Functional elements of an instrument, Static and Dynamic Characteristics, Zero, First and Second Order Instruments, Step, Ramp, Impulse and Frequency response of instruments, Measuring Devices, standards and calibration of instruments, acquisition, manipulation, transmission, recording and processing of data, Computer aided experimentation, Control Systems, Types, block diagrams and performance analysis, signal flow graphs, Hydraulic, Pneumatic and electronic controllers, Transient and steady state response; time domain and Laplace transform representation of P, P + D & P + I control action; frequency response analysis and stability of control systems; applications, Programmable Logical Controllers-programming, applications.

Reference Books

1. Doebelin E.O "Measurement Systems: Application and Design", McGraw Hill Publishing Co, 1975.
2. Beckwith TG, N. Lewis Buck and Marangoni R.D., "Mechanical Measurements", Narosa Publishing House, New Delhi.
3. Johnson C.D. "Process Control and Instrumentation Technology", Prentice Hall of India (P), New Delhi, 1986.
4. Nakra B.C. "Theory and Applications of Automatic Controls", New Age International (P) Ltd., New Delhi.
5. Kuo B.C."Automatic Control Systems", Prentice Hall of India (P) Ltd., New Delhi, 1997.
6. Liptak B.G., "Instrument Engineers Handbook – Process Control", 1985.

ELECTIVE COURSES

ME 5209 (JAN) 3:0
I.C. Engines

Otto & Diesel cycle, air standard cycle, fuel-air cycles & actual cycles, I.C. Engine fundamentals, Fuels characteristics, additives, alternate fuels, Combustion phenomenon and combustion system in S.I & C.I. Engines, Fuel systems, Performance and Testing, Supercharging and Turbo charging, Engine Emissions and Control Systems.

Reference Books

1. L.C. Litchy, "Combustion Engines Processes", McGraw Hill, 1967.
2. E.F. Obert, "Internal Combustion Engines and Air Pollution", Intext Educational Publishers, 1973.
3. H.R. Ricardo, "The high speed I.C. Engine", Blackie, London", 1969.
4. A.S. Khatchilan, "Theory of C.I. Engine", Vol. 1 and 2, IIT, Bombay, 1966.
5. C.F. Taylor and E.S. Taylor, "Internal Combustion Engine", Stanton, 1961.
6. P.G. Burman and B. Luca, "Fuel Injection and Controls of I.C. Engines", Technical Press, 1962.
7. V. Ganeshan, "Internal Combustion Engines", Tata McGraw Hill, New Delhi, 1996.
8. C.R. Fergusson & A.R. Kirkpatrick, "Internal Combustion Engines", Delhi, 2001.
9. Haywood, "I.C. Engines", Mc Graw Hill.

ME 5210 (JAN) 3:0
Advanced Refrigeration

Vapour compression refrigeration, actual cycle, second law efficiency, multistage compression with inter-cooling, Multi-evaporator systems, Cascade systems, performance characteristics and capacity control of reciprocating and centrifugal compressors, screw compressor and scroll compressor, design, selection of evaporators, condensers, system balance, control systems, motor selection, refrigerants, alternative refrigerants, CFC/HCFC phase-out regulations, thermoelectric and nonconventional refrigeration systems, adiabatic de-magnetization, refrigeration applications, food preservation, transport, vapor absorption refrigeration, single effect and double effect systems, alternative working fluids, controls, aircraft refrigeration, Martinovsky cycle, Gas liquefaction systems - Linde-Hampson, Linde dual pressure, Claude cycle.

Reference Books

1. R.J.Dossat, "Principles of Refrigeration", Pearson Education Asia, 2001.
2. C.P.Arora, "Refrigeration and Air-conditioning", Tata McGraw-Hill, 2000.
3. Stoecker & Jones, "Refrigeration and Air-conditioning", McGraw Hill Book Company, New York, 1982.
4. Jordan & Priester, "Refrigeration and Air-conditioning".
5. A.R.Trott, "Refrigeration and Air-conditioning", Butterworths, 2000.
6. J.L.Threlkeld, "Thermal Environmental Engineering", Prentice Hall, 1970.
7. R.Barron, "Cryogenic systems", McGraw–Hill Company, New Yourk, 1985.
8. G.G.Hasseldon. "Cryogenic Fundamentals", Academic Press.
9. Bailey, "Advanced Cryogenics", Plenum Press, London, 1971.
10. W.F.Stoecker, "Industrial Refrigeration Handbook", McGraw-Hill, 1998.
11. John A.Corinchock, "Technician's Guide to Refrigeration systems", McGraw–Hill.
12. P.C.Koelet, "Industrial Refrigeration: Principles, Design and Applications", Macmillan, 1992.
13. ASHRAE HANDBOOKS (i) Fundamentals (ii) Refrigeration.
14. Graham Walker, "Miniature Refrigerators for Cryogenic Sensors and Cold Electronics", Clarendon Press, 1989.

ME 5211 (JAN) 3:0
Non Conventional Energy Sources

Conventional sources of energy, Nuclear, Alternative energy sources, Solar Radiation-estimation, prediction & measurement, Solar energy utilization, Performance of Solar flat plate collectors, concentrating collectors, thermal storage, Wind energy, Direct Energy conversion- PV, MHD, Fuel cells, thermionic, thermoelectric, Biomass, biogas, hydrogen, Geothermal.

Reference Books

1. J.A. Duffie and W.A. Beckman, "Solar Engineering of Thermal Processes", John Wiley, 1991.
2. D.Y. Goswami, F. Kreith and J.F. Kreider, "Principle of Solar Engineering", Taylor and Francis, 2000.
3. Sukhatme S.P., "Solar Energy", Tata McGraw Hill Publishing Co. Ltd., New Delhi, 1994.
4. Bansal and othes, "Non-Conventional Energy Sources".
5. J.F. Kreider, F. Kreith, "Solar Energy Handbook", McGraw Hill, 1981

ME 5212 (JAN) 3:0
Gas Turbines

Introduction, Cycles, Performance characteristics and improvement, Gas dynamics, Centrifugal, axial and mixed flow compressor, principles and characteristics, Turbine construction, Blade materials, manufacturing techniques, blade fixing, problems of high temperature operation, blade cooling, practical air cooled blades Combustion Systems, various fuels and fuel systems, Jet propulsion cycles and their analysis, parameters affecting performance, thrust augmentation, environmental considerations and applications.

Reference Books

1. H Cohen, GFC Rogers and HIH Saravanamuttoo, "Gas Turbine Theory", Pearson Education, 2000.
2. V. Ganesan, "Gas Turbines", Tata McGraw Hill, 2003.
3. S.M.Yahya "Turbines, Compressors and Fans", Tata McGraw Hill, 1992.
4. Vincent "The theory and design of Gas Turbine and Jet Engines", McGraw Hill, 1950.
5. W W Bathic, "Fundamentals of Gas Turbines", John Wiley and Sons.

ME 5213 (JAN) 3:0
Air Conditioning System Design

Air conditioning systems, various air-conditioning processes, enthalpy deviation curve, psychrometry , SHF, dehumidified air quantity, human comfort, indoor air quality, design conditions and load calculations, air distribution, pressure drop, duct design, fans &, blowers, performance & selection, noise control**.**

Reference Books

1. ASHRAE Handbook.
2. "Handbook of air-conditioning system design", Carrier Incorporation, McGraw Hill Book Co., U.S.A, 1965.
3. "Refrigeration and air-conditioning", ARI, Prentice Hall, New Delhi, 1993.
4. Norman C. Harris, "Modern Air Conditioning", New York, McGraw-Hill,1974.
5. Jones W.P., "Air Conditioning Engineering", Edward Arnold Publishers Ltd., London, 1984.
6. Hainer R.W., "Control Systems for Heating, Ventilation and Air-Conditioning", Van Nostrand Reinhold Co., New York, 1984.

7. Arora C.P., "Refrigeration & Air Conditioning", Tata Mc Graw Hill, 1985.
8. Manohar Prasad, "Refrigeration & Air Conditioning", New Age Publishers.
9. Stoecker, "Refrigeration & Air Conditioning", Mc Graw Hill, 1992.
10. Stoecker, "Design of Thermal Systems", Mc Graw Hill, 1992.

ME 5214 (JAN) 3:0

Environmental Pollution &Control

Air Pollution, effects, sampling and control, equipments and systems, control of gaseous contaminants, automotive emission and control, Industrial Air Pollution Water Pollution: pollutants and their effects, waste water treatment Pollution Control and Conservation The legal basis of environmental protection and provision, Noise -sources, measurement and control.

Reference Books

1. M.N. Rao, H.V. Rao, "Air Pollution", Tata McGraw Hill , New Delhi, 1993
2. C.S. Rao, "Environmental Pollution Control Engineering", New Age International Publishers (p) Ltd., 1996.
3. Howard S. Peavy, D.R. Rowe, "Environmental Engineering", McGraw Hill International.
4. DeNevers, "Air Pollution Control Engineering", McGraw Hill companies, 1994.
5. S.P. Mahajan, "Pollution Control in Process Industries", Tata McGraw Hill, 1985.
6. Metcalf and Eddy, "Waste Water Engineering", Tata McGraw Hill.

LAB. PRACTICE: 04 Credits

ME5219 0:2 Aug.- Dec. Term (I)

The term work shall consist of minimum two exercises from each subject.

ME5220 0:2 Jan.-April Term (II)

The term work shall consist of minimum two exercises from each subject.

SEMINAR: 04 Credits

ME5222 0:2 Aug.- Dec. Term (I)

Seminar should be based on deep study of any topic related to Heat Power Engineering as per the common instructions for all branches of M. Tech.

ME5223 0:2 Aug.- Dec. Term(III)

Project Seminar

Seminar should be based on the area in which the candidate has undertaken the dissertation work as per the common instructions for all branches of M. Tech.

PROJECT: 32 Credits

ME5224 0:12 Aug.- Dec. Term with Seminar (II)

ME5225 0:20 Jan.-April Term (IV)

The Project Work will start in semester III and should preferably be live problem in industry or a micro issue having a bearing on performance of the industry and should involve scientific research, design, generation/collection and analysis of data, determining solution and must preferably bring out the individual contribution. The dissertation should be presented in standard format. The Oral examination shall be conducted with the help of approved external examiner.