MECHANICAL ENGINEERING

M. Tech. PROGRAMME
(Duration: TWO Years)

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DESIGN ENGINEERING

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

Reference Books:

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. Analogies 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:
5. Timoshenko, “Advance Strength of Materials”, vol 1 & 2, CBS.

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:

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 wiring, 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. Ibrahim Zeid, “CAD / CAM Theory and Practice”.

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, Chebyshev 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. :

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 flywheel, 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 metal rolling, drawing and extrusion, Machinery noise control, Radiation of sound from vibrating structure, condition monitoring on expert system, Acoustic emission for condition monitoring 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:
5. J.W. Powell, “The Design of Aerostatic Bearings”.

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:

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, discretisation and matrix formulation, adaptive mesh refinement.

References Books:

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 : 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:
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

ME 5112 (JAN.) 3:0
Fracture Mechanics

References Books. :
1. Brook D, “Elementary engineering fracture mechanics”.
2. Liebowitz H., “Fracture” Volume I to VII.

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

Reference Books:


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:


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
5. Dr. B. Sgrewal, “Numerical Methods in Engineering and science”.

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:
**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, ablation 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**

**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**

**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**
3. Afgan N. and Schlinder E.V. “Heat Exchanger Design and Theory Source Book”.

**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**
2. Callaghan “Energy Conservation”.
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**

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

Reference Books

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

Reference Books
4. Bansal and others, “Non-Conventional Energy Sources”.

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

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.
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

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.