

MECHANICAL ENGINEERING

PROFESSORS

Banerjee BN	bnb	7081
Biswas Gautam	gtm	7656
Choudhury SK	choudhry	7270
Deb K	deb	7205
Dhande SG (Joint appointment with CSE)	sgd	7170
Dixit PM	pmd	7094
Eswaran V	eswar	7429
Ghoshdastidar PS	psg	7019
Hatwal H	hhatwal	7098
Jain V K	vkjain	7916
Kalra MS	msk	7527
Kishore NN	nnk	7049
Kumar P	prkumar	7048
Mallik AK	akmallik	7098
Munshi P	pmunshi	7243
Muralidhar K (Head)	kmurli	7182
Pundir BP	pundir	7684
Vyas NS	vyas	7040

ASSOCIATE PROFESSOR

Sarkar S	subra	7942
Panigrahi PK	panig	7686
Reddy NV	nvr	7362
Dasgupta B	dasgupta	7095

ASSISTANT PROFESSORS

Agarwal AK	akag	7982
Basu S	basu	7506
Bhattacharya S	bhattacs	6056
Bhattacharya B	bishakh	7824
Dutta A	adutta	7995
Khandekar S	samkhan	7038
Kar KK (Joint appointment with MSP)	kamalkk	7687
Mahesh S (Joint appointment with AE)	smahesh	7060
Ramkumar J		
Saxena A	anupams	7988
Saha AK	aksaha	7869
Venkitanarayanan P	venkit	7528
Sharma I	ishans	6152
Sharma B L	bis	6173

EMERITUS PROFESSOR

Ghosh A	amitabha	7010
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EMERITUS FELLOW

Sengupta A (Joint appointment with NET)	osegu	7035
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Convenor, DUGC :	P. S. Ghoshdastidar	psg	7019
Convenor, DPGC :	S. Basu	sbasu	7506
Faculty Counsellor :	P. Venkitanarayanan	venkit	7528

The Department of Mechanical Engineering trains students in the methods of engineering science and in the application of these methods to conceive, analyse and design engineering systems.

The professional programme of the department includes a deeper study of a number of engineering

sciences (to which the students are introduced at the core curriculum level), theoretical and experimental solution of physical problems, and design of systems relevant to the contemporary industrial world. The areas introduced by the department include Energy Conversion and Power Systems, Heat Transfer and Fluid Mechanics, Mechanics of Solids and Stress Analysis, Manufacturing Science, Industrial Engineering, Automatic Controls and Engineering Design and Optimisation. Laboratory experience is considered an important part of the mechanical engineering programme. There are course-oriented laboratories where a student does experimental work leading to a better understanding of physical phenomena.

The department of mechanical engineering has a postgraduate programme leading to M. Tech. and Ph. D. degrees in four broad streams: Solid Mechanics and Design, Fluid Mechanics and Thermal Sciences, Manufacturing Sciences and Mechatronics. Within these streams, new areas which receive vigorous attention include Fracture mechanics, Experimental mechanics, Flow control, Optical measurements, Alternative fuels, Computer Aided Manufacturing, Computational Fluid Dynamics and Heat Transfer, Genetic Algorithms, Smart Materials, Rapid prototyping, Microscale transport, Micro measurements and sensors, Nanomechanics, and Mechatronics. In the postgraduate programme, the emphasis is on the development of a broad background in a particular stream followed by a deeper study of a research topic.

CURRENT COURSE STRUCTURE FOR B.TECH. STUDENTS MECHANICAL ENGINEERING

	S E M E S T E R							
	FIRST	SECOND	THIRD	FOURTH	FIFTH	SIXTH	SEVENTH	EIGHTH
C O U R S E	PHY102	PHY101	MTH203	HSS-I-2	HSS-II-1	SE-1	SE-2	HSS-II-2
	MTH101	CHM101	CHM201	ESO204	ME321	ME301	ME300	ME452
	TA101	MTH102	TA201	ESO214	ME341	ME351	ME401	ME461
	ESC102	ESC101	ESO202	ME231	ME352	ME353	ME451	DEL-2
	PE101	PHY103	ESO210	ME251	ME361	ME371	ME453	DEL-3
	HSS-I-1/ ENG112N	ME100 PE102			OE-1	DEL-1	ME471 OE-2	OE-3

ME 100 Introduction to Profession	ME 251N Graphics In Mechanical Design
ME 231N Fluid Mechanics	ME 251N Engineering Design and Graphics
ME 321N Advanced Mechanics of Solids	ME 341N Heat & Mass Transfer
ME 352N Theory of Mechanisms & Machines	ME 361N Manufacturing Technology
Open Elective-I	
ME 301N Energy Systems-I	ME 351N Design of Machine Elements
ME 353N Dynamics &Vibration of Machinery	ME 371N M.E. Laboratory I
Departmental Elective-I	
Science Elective-I	
ME 300 Summer Industrial Training	ME 401N Energy Systems II
ME 451N Project-I	ME 453N Automation & Control
ME 471 M.E. Laboratory II	Open Elective-II
Science Elective-II	
ME 452N Manufacturing Systems	ME 461N Project-II
Open Elective-3	
Departmental Elective-2	
Departmental Elective-3	
HSS-4	

COURSE DESCRIPTION

ME 100 L-T-P-D-[C] 1-0-2-0-[0]	INTRODUCTION TO MECHANICAL ENGINEERING Historical perspective; description of devices used in power production; energy storage and transmission; manufacturing and automation; new materials; future trends including interfacing with microprocessors, sensors, actuators, and virtual systems; demonstration and hands-on laboratory.
ME 231N L-T-P-D-[C] 3-0-0-1-[4]	FLUID MECHANICS Reynolds Transport Theorem; Integral form of continuity, momentum and energy; Eulerian and Lagrangian view-points; Constitutive relations; Navier Stokes equations: Exact solutions; Potential flow; Boundary layer theory; Separation and drag; Turbulent flow: Reynolds averaged equations; Turbulent flows in pipes and channels; compressible flows.
ME 251N L-T-P-D-[C] 2-0-3-0-[4]	ENGINEERING DESIGN AND GRAPHICS Prereq. TA 101N Theory of general engineering design; conceptual design; embodiment design involving layout and form; designing to standard; basic sketching; machine drawing including fits and tolerances, machine elements, assembly drawing and list of parts; geometric modeling; project based lab session including sketching and geometric modelling using a software package; drawing project on reverse engineering.
ME 300	SUMMER INDUSTRIAL TRAINING Six weeks training after the sixth semester in the Industry.
ME 301N L-T-P-D-[C] 3-0-0-0-[4]	ENERGY SYSTEMS-I Energy resources: Fossil fuels, Hydrogen energy, Solar thermal, Nuclear fuels, and renewable energy sources. Direct energy conversion: Solar Photo voltaic, MHD power, Fuels cells. Energy Release: Combustion of fossil fuels, Adiabatic flame temperature, Modern boilers, mountings and accessories. IC engine fundamentals: SI and CI Engines, real cycles. Combustion in SI and CI Engines: performance and trial of Engine. Refrigeration and Airconditioning: Reciprocating single and multi-stage compressors, Refrigeration cycles, Psychrometric processes, Airconditioning systems.

<p>ME 311 L-T-P-D-[C] 3-0-0-0-[4]</p>	<p>REFRIGERATION& AIR CONDITIONING</p> <p>Refrigeration Cycles: vapour absorption and thermo-electric refrigeration systems. Refrigerants: multistage refrigeration. Load calculations. Design of various elements of a refrigeration unit, psychrometry. Applications : ice plant, water-coolers, cold storage, comfort airconditioning etc.</p>	<p>Prereq. ME 301, #</p>
<p>ME 321N L-T-P-D-[C] 3-0-0-0-[4]</p>	<p>ADVANCED MECHANICS OF SOLIDS</p> <p>Continuum concepts; Stress field (Cauchy's principle, equilibrium equation); Deformation (strain tensor, compatibility); Principle of virtual work; Constitutive equations; Uniqueness and superposition; Boundary value problems in plane stress and plain strain, torsion of non circular cross section, Kelvin problem and 3-D problems; Failure theories, plasticity, fracture mecahnics; Stress waves in 1-D; Large deformations; Numerical and Experimental methods.</p>	<p>Prereq. ESO 204</p>
<p>ME 341N L-T-P-D-[C] 3-0-0-1-[4]</p>	<p>HEAT AND MASS TRANSFER</p> <p>Conduction: 1-D & 2-D Steady State conduction with and without heat sources- Analytical and Numerical Solutions; 1-D & 2-D Transient Conduction- Analytical and Numerical Solutions; Convection; Velocity, Thermal and Concentration Boundary Layers; Heat Transfer in External Flows; Heat Transfer in Internal Flows; Turbulent Heat Transfer; Free Convection; Boiling & Condensation; Heat Exchangers; Radiation: Black Body Radiation, The Gray Surface; Radiation shields.</p>	<p>Prereq. ME 231N</p>
<p>ME 351N L-T-P-D-[C] 3-0-2-0-[4]</p>	<p>DESIGN OF MACHINE ELEMENTS</p> <p>Material and manufacturing in design; materials selection; reliabilty based design; modes of failure, failure theories; fracture and fatigue; analysis synthesis and selection of machine component including spring, joining and fastening methods; shaft, keys, coulings, bearing and lubrication, brakes, and gears; project based lab session involving analysis and design of machine using software packages.</p>	<p>Prereq. ME 251</p>
<p>ME 352N L-T-P-D-[C] 3-0-0-0-[4]</p>	<p>THEORY OF MECHANISMS AND MACHINES</p> <p>Kinematic pair, diagrams and inversion. Mobility and range of movement. Displacement velocity and acceleration analysis of planar linkages. Dimensional synthesis for motion, path and function generation. Cam profile synthesis. Gears, Dynamic force analysis, flywheel, inertia forces and balancing for rotating and reciprocating machines.</p>	

<p>ME 353N L-T-P-D-[C] 3-0-0-0-[4]</p>	<p>DYNAMICS AND VIBRATIONS OF MACHINERY</p> <p>Three dimensional motion of rigid bodies kinematics and kinetics. Gyrodynamics. Vibrations of single, two and multiple degrees of freedom systems, free and forced vibrations; Time and frequency domain analysis, Free vibration of one dimensional continuous systems, approxi-mate methods.</p>	
<p>ME 355 L-T-P-D-[C] 3-0-0-0-[4]</p>	<p>INTRODUCTION TO TRIBOLOGY</p> <p>The tribological system: Common modes of failure and common solutions. Theories of friction and wear; Lubrication, Properties of lubricants. Boundary, hydrodynamic, hydrostatic, elasto-hydrodynamic lubrication and bearings based on these principles. Thermo-elastic deformation and fluid sealing. Lubrication methods.</p>	<p>Prereq. ESO 212</p>
<p>ME 356 L-T-P-D-[C] 3-0-0-0-[4]</p>	<p>ANALYSIS AND SYNTHESIS OF LINKAGES</p> <p>Advanced techniques of kinematic analysis and synthesis of mechanisms. Spatial kinematics and space mechanisms. Error analysis. Optimization techniques and computer applications in synthesis of mechanisms. Dynamic, elastodynamic and kineto-elastodynamic analysis.</p>	<p>Prereq. ME 252</p>
<p>ME 358 L-T-P-D-[C] 3-0-0-0-[4]</p>	<p>AUTOMOTIVE MECHANICS</p> <p>Reciprocating automotive engines including their lubricating and cooling systems, ignition and electrical systems, carburation and fuel injection systems, fuel supply system, transmission system, breaking system, steering, chassis and suspension.</p>	
<p>ME 359 L-T-P-D-[C] 3-0-0-0-[4]</p>	<p>INTERNAL COMBUSTION ENGINES</p> <p>Classification, Construction, Valve arrangements. Fuels, Fuel air cycle. Combustion, Effect of engine variables, Combustion chambers, Carburation and fuel injection, Knocking. Engine cooling, Friction and lubrication Supercharging. Wankel engine. Testing and performance. Pollution.</p>	
<p>ME 360 L-T-P-D-[C] 3-0-0-0-[4]</p>	<p>COMPUTER AIDED MANUFACTURING</p> <p>Direct numerical control (DNC) and computer numerical control (CNC), adapative control of manufacturing processes. Manufacturing system concepts. Computer processes monitoring and control, off-line use of computers. Computer aided design. Computer-process interface, programming, introduction to FMS.</p>	

ME 361 L-T-P-D-[C] 3-0-0-0-[4]	MANUFACTURING TECHNOLOGY	Prereq. TA 202
	Introduction to manufacturing processes, Metal casting; Foundry automation. Plastic deformation; load estimation: High velocity forming; defects. Metal cutting; tool specification system. Merchants' theory; Tool life; Economics of machining. Mechanics of grinding. Common shaping processes for plastics; defects and product design. Joining processes, solidification of welds, TIG, MIG, resistance welding; design considerations and weld quality. Unconventional machining processes, RP processes. Rapid tooling techniques. Metrology: limits, fits and tolerance. Automated inspection and CMM; Selection of manufacturing processes for a given product.	
ME 363 L-T-P-D-[C] 3-0-0-0-[4]	DESIGN OF MACHINE TOOLS	
	Analysis of machine tool systems from the point of view of kinematics, strength and rigidity. Design of drive systems. Design of machine tool structures, static and dynamic points of view. Design of spindles, bearings, slides and guides. Control systems for machine tools. Design aspects of conventional machine tools and case studies.	
ME 365 L-T-P-D-[C] 3-0-0-0-[4]	NUMERICAL CONTROL OF MACHINE TOOLS	
	Data processing machines. Continuous sampled data on digital control systems. Positioning, straight cut and contouring control systems. Numerical control application. Machine tools and their relation to numerical control. Manual and computer aided programming, specialized manufacturing applications.	
ME 371 L-T-P-D-[C] 0-0-6-0-[0]	MECHANICAL ENGINEERING LAB I	Prereq.: ESO 214, ME 361, ME 231
	Experimentation in machine dynamics, Materials, Manufacturing Sciences and Fluid mechanics.	
ME 373 L-T-P-D-[C] 3-0-0-0-[4]	MEASUREMENT AND CONTROL OF FLOW SYSTEMS	
	Similarity, errors, dynamic response, Pitot tube, hot-wire anemometer, laser Doppler velocimeter, optical techniques for field measurement, image processing, volume-averaged measurement, uncertainty analysis. Signal processing and compensation for probe characteristics, data acquisition, feedback control, adaptive control, practical configurations, lab work.	

<p>ME 374 L-T-P-D-[C] 0-0-0-0-[4]</p>	<p>MECHANICAL ENGINEERING RESEARCH</p> <p>To learn about a topic in depth through independent study under the guidance of a faculty member from the department. Based on a Original Research Project/ design project/experimental project.</p>
<p>ME 401N L-T-P-D-[C] 3-0-0-0-[4]</p>	<p>ENERGY SYSTEMS-II</p> <p>Thermal power plants: Gas and steam power cycles, Regenerative and reheat cycles, Lorenz and Kalina cycles. Turbo Machinery: Classification Similitude and specific speeds, Euler turbine equation, Velocity triangles. Turbine and compressor cascades. Axial-flow turbines and compressors: Stage efficiency and characteristics, Radial equilibrium, Governing. Fans, blowers and compressors: Slip factor, performance characteristics. Hydraulic Machines; Pelton wheel, Francis and Kaplan turbines, Draft tubes, Pumps, Cavitation, Fluid coupling and torque converter.</p>
<p>ME 402 L-T-P-D-[C] 3-0-0-0-[4]</p>	<p>POWER SYSTEMS</p> <p>Power plant layout, Plant performance and operation characteristics. Coal handling units and furnaces, ash handling systems and dust collectors. Water and fire-tube boilers, modern boilers, boiler mountings and accessories, safety devices. Natural, forced, induced and balanced drafts. Steam gas and hydraulic turbines. Diesel power plants, Cogeneration with steam power plant. Nuclear power plants.</p>
<p>ME 404 L-T-P-D-[C] 3-0-0-0-[4]</p>	<p>DIRECT ENERGY CONVERSION Prereq. ME 304 #</p> <p>Electrochemical effects and fuel cells. Thermionic systems: Thermionic emission and conversion. Thermoelectric systems: Kelvin relations, power generation, properties of thermoelectric materials, fusion plasma generators. Recent experiments.</p>
<p>ME 423 L-T-P-D-[C] 3-0-0-0-[4]</p>	<p>FINITE ELEMENT METHODS IN ENGINEERING</p> <p>Introduction to I-D FEM Problems in structural mechanics using two dimensional elements. Plane stress, plane strain, axisymmetric analysis. Three dimensional stress analysis; Shell analysis. Solution of heat conduction, fluid flow, vibration, stability, and non-linear, large scale systems.</p>
<p>ME 427 L-T-P-D-[C] 3-0-0-0-[4]</p>	<p>COMPOSITE MATERIALS</p> <p>Structures and method of preparation of fibres and fibre reinforced composites. Micromechanics and prediction of elastic constants. Strength of</p>

composites. Properties of laminated composites and their constitutive equations. Laminates. Interfacial mechanics and properties. Applications.

ME 430

NUMERICAL FLUID FLOW AND HEAT TRANSFER

L-T-P-D-[C]
3-0-0-0-[4]

ODE, matrix methods, root finding. Classification of PDE, finite differences, Steady and unsteady conduction, explicit and implicit method, advection-diffusion problems, upwinding, boundary-layers. Navier-Stokes equations, MAC and SIMPLE, finite element method for heat conduction.

ME 442

OPTIMIZATION METHODS IN ENGINEERING DESIGN

L-T-P-D-[C]
3-0-0-0-[4]

Classical optimization methods, unconstrained minimization. Univariate, conjugate direction, gradient and variable metric methods, constrained minimization, Feasible direction and projections. Integer and Geometric programming, genetic algorithms, simulated annealing techniques, design applications.

ME 443

SOLAR ENERGY THERMAL PROCESSES

L-T-P-D-[C]
3-0-0-0-[4]

Fundamentals of solar radiation Review of fluid mechanics and heat transfer. Flat plate collectors, Focussing collectors, Solar water and air heating systems, solar cooling and dehumidification, solar energy storage, solar electric power, solar distillation of saline water and solar stills, solar cookers, solar pond and its thermal performance.

ME 449

INTERACTIVE COMPUTER GRAPHICS AND DESIGN

L-T-P-D-[C]
3-0-2-0-[5]

Interaction devices and techniques, geometrical transformations, viewing in three dimensions, modelling and object hierarchy, raster algorithms, display, representation of 3-D shapes, rendering of surfaces and solids, hidden lines, edge and surface removal, shading models, shadows.

ME 450

COMPUTER AIDED ENGINEERING DESIGN

L-T-P-D-[C]
3-0-0-0-[4]

Methodology of interactive, graphical, engineering design: Discretization, optimization, simulation in CAED. Design of curves and surfaces. Applications in conveyor systems, sheet metal working, tool design, pumps etc. Design of volumes. Intersection of surface and interference of volumes.

ME 451N

PROJECT-I

L-T-P-D-[C]
0-0-6-0-[4]

Project work involving the analysis, synthesis, material/component selection and detailed design of a mechanical system including the preparation of working

drawings. The system may be integrated with electronics, electrical, hydraulic and other systems. Projects may be selected by students from any of the four streams, Fluid mechanics and Thermal sciences, Solid Mechanics and Design, Manufacturing Science and Robotics.

ME 452N
L-T-P-D-[C]
0-0-4-0-[2]

PROJECT-II

Fabrication of a prototype based on the work done in project-I. Qualitative performance evaluation and appropriate modification of a prototype.

ME 453N
L-T-P-D-[C]
3-0-0-0-[4]

AUTOMATION AND CONTROL

Modeling, Analysis, and Simulation of Dynamic System; Mechanical, electronic, electrohydraulic and electromechanical systems; Stepper and Servo-motors; use of MATLAB; State-Space, Laplace and frequency domain system behaviour; Bode, Nyquist, and root-locus plots; open and closed loop control systems; stability and sensitivity; PID, Phase lag and Phase lead compensation; Sampled data systems and Digital controllers; DA/AD converters; Microprocessors; Sensors and actuators; interfacing with computers.

ME 454
L-T-P-D-[C]
3-0-0-0-[4]

INDUSTRIAL DESIGN

Ergonomics-Estimation of performance and power requirements of Vehicles, Power Hydraulics, the form and function of Industrial Structures, product costing and pricing, the choice of suitable technologies, new engineering materials and their usage and costs. Case studies in engineering design, Industrial model making. Industrially sponsored project studies.

ME 457
L-T-P-D-[C]
3-0-2-0-[4]

ENGINEERING DESIGN CREATIVITY

Concepts and Practice: 2-D and 3-D form analysis in product design and in architecture; Aesthetics and Design; Evolution of design from craft to modern products; Technology and Society; Problem definition; Functional requirements, independence and hierarchy, constraints, non-uniqueness etc; Generation of ideas, courage, communication, decision making, synthesis and analysis. Robust design; Forms of traditional and modern societies - misfits between form and context, elimination of misfits, feedback. Studio Work : Design and fabrication of a product

ME 461
L-T-P-D-[C]
3-0-0-0-[4]

MANUFACTURING SYSTEM

Prereq. ME 361N

Introduction to manufacturing system's concepts, manufacturing automation, flow lines and assembly systems. CAD/CAM; NC, CNC and DNC, adaptive control;

Manual and computer assisted part programming. Automated storage/retrieval systems; materials handling system including AGV; robot applications in manufacturing. Process planning, CAPP, scheduling and sequencing. GT and its benefits. Cost analysis, break even analysis and depreciation. Material management; inventory; MRP and MRP II; Just in time(JIT). Quality assurance and control; SQC, control charts; sampling; T.Q.M, Manufacturing system Simulation. FMS, CIMS, network and database for Mfg. system.

<p>ME 462 L-T-P-D-[C] 3-0-0-0-[4]</p>	<p>TOOL DESIGN</p> <p>General considerations in tool design. Work holding devices, design of jigs and fixtures. Design of press working tools. Blanking and piercing dies. Design of tooling for deep drawing. Design of limit gauges.</p>	<p>Prereq. ME 253 & ME 362</p>
<p>ME 464 L-T-P-D-[C] 3-0-0-0-[4]</p>	<p>MODERN MACHINING METHODS</p> <p>Introductory to unconventional machining processes. Abrasive jet machining, ultrasonic machining, abrasive water jet machining, abrasive flow machining, water jet machining, electro chemical machining, electro discharge machining. Electron beam machining, laser beam machining and plasma arc machining. Design of tooling.</p>	
<p>ME 466 L-T-P-D-[C] 3-0-0-0-[4]</p>	<p>FOUNDARY ENGINEERING, 3-0-0-0-4</p> <p>Bond formation, properties of various moulding materials, principles of solidification and structure of castings, risering and gating, centrifugal casting, continuous casting, investment casting, pressure die casting. Introduction to powder metallurgy.</p>	<p>Prereq. ME 362</p>
<p>ME 471N L-T-P-D-[C] 0-0-6-0-[4]</p>	<p>MECHANICAL ENGINEERING LAB</p> <p>Experimentation in automation and control, Solid Mechanics, Heat transfer, Energy conversion.</p>	<p>Prereq.: ME 301N, ME 321, ME 341, ME 453N</p>
<p>ME 471 L-T-P-D-[C] 0-0-6-0-[3]</p>	<p>MECHANICAL ENGINEERING LABORATORY III,</p> <p>This course includes experimentation in Energy Conversion, Experimental stress analysis and Manufacturing science.</p>	<p>Prereq. ESO 214, ME 342, ME 362 and Concurrently ME 403</p>
<p>ME 611 L-T-P-D-[C] 3-0-0-0-[4]</p>	<p>REFRIGERATION SYSTEMS</p> <p>Thermodynamic analysis of vapour-compression, air and non-conventional refrigeration systems, application and optimization of multistage and cascade</p>	

refrigeration systems, refrigerants, fan pump, evaporator and condenser selection, Solar powered refrigeration, heat pump.

ME 613

L-T-P-D-[C]

3-0-0-0-[4]

THERMAL ENVIRONMENTAL CONTROL

Moist air and psychrometric processes. Physiological principles of thermal comfort, calculation of cooling and heating loads; ADP determination, solar radiation and shading devices, duct design; Heat and mass transfer in air washers, cooling towers, finned heat exchangers; Air dehumidification.

ME 616

L-T-P-D-[C]

3-0-0-0-[4]

THERMAL TURBOMACHINES

Turbomachine theory, potential flow to two dimensional cascades and experimental correlation, Conformal mapping and similarity methods. Methods for solving direct and inverse cascade problems for compressible flow, Axi-symmetric through flow, Advanced cycles, Stress analysis of components.

ME 617

L-T-P-D-[C]

3-0-0-0-[4]

ADVANCED THEORY OF TURBOMACHINERY

The equations of motion in rotating coordinate system, effects of Coriolis and Centrifugal forces, energy equation, classification of turbomachines; two-dimensional cascade theory and experimental results; two dimensional flow analysis of axial impellers; three dimensional flow in axial turbomachines, radial equilibrium, secondary flows and loss estimation; off-design performance; radial and mixed flow machines; multistage axial compressors and turbines; prediction of stage performance and stacking; rotating stall and surge; turbine blade heat load and blade cooling;

ME 620

L-T-P-D-[C]

3-0-0-0-[4]

MECHANICS OF MATERIALS

Analysis of stress and strain; Constitutive relationships; Failure theories; Torsion of non-circular sections. Plane stress and plane strain problems; Viscoelasticity, Structure and behaviour of polymers, behaviour of unidirectional composite and orthotropic lamina; Failure theories for fibre composites.

ME 621

L-T-P-D-[C]

3-0-0-0-[4]

INTRODUCTION TO SOLID MECHANICS

Theory of constitutive equations with special emphasis on elasticity, plasticity and viscoelasticity. Solution of problems to illustrate effects of elasticity, thermo-elasticity, plasticity and viscoelasticity.

ME 622

L-T-P-D-[C]

3-0-0-0-[4]

THEORY OF ELASTICITY

Analysis of stress and strain; Equilibrium, Compatibility and constitutive equations; Plane problems; Stress functions; Applications; Complex potentials

in two dimensional and axisymmetric problems; Variational methods; Anisotropic elasticity; Finite deformation elasticity.

ME 623

L-T-P-D-[C]

3-0-0-0-[4]

FINITE ELEMENT METHODS IN ENGINEERING MECHANICS

Introduction to I-D FEM. Problems in structural mechanics using two dimensional elements; Plane stress, plane strain, axisymmetric analysis; Three dimensional stress analysis; Shell analysis; Solution of heat conduction, fluid flow, vibration, stability, and non-linear, large scale systems.

ME 625

L-T-P-D-[C]

3-0-0-0-[4]

APPLIED DYNAMICS AND VIBRATIONS

Review of single degree of freedom systems; Generalised coordinates, constraints, virtual work; Lagrange's equation; Continuous systems; strings, beams; Raleigh-Ritz and Galerkin's methods; Dynamics of rigid bodies in three dimensions; Euler angles; Euler's equations of motion, Gyrodynamics.

ME 626

L-T-P-D-[C]

3-0-0-0-[4]

VIBRATION OF CONTINUOUS SYSTEMS

Vibration of discrete systems with single and multi degree of freedom. Hamilton's principle, Lagrange's equations. Longitudinal vibration of bars, lateral vibration of straight and curved beams, vibration of membranes and plates, free and forced vibrations. Effect of damping. Wave motion in continuous systems.

ME 627

L-T-P-D-[C]

3-0-0-0-[4]

NON-LINEAR VIBRATION

Phase space, singular points, limit cycle; Analytical methods, perturbation techniques, equivalent linearization; Duffing's equation, jump phenomenon, Van der Pol equation. Stability criterion; Floquet's theory, Hill's and Mathieu's equations, Bifurcation and chaos.

ME 628

L-T-P-D-[C]

3-0-0-0-[4]

RANDOM VIBRATIONS

Introduction to probability theory, random processes, response of single, multi and infinite degrees of freedom systems to stationary random excitations. Failure due to random excitation. Brief discussion on measurement and processing of random data.

ME 630

L-T-P-D-[C]

3-0-0-0-[4]

NUMERICAL FLUID FLOW AND HEAT TRANSFER

ODE, matrix methods, root finding. Classification of PDE, finite differences, Steady and unsteady conduction, explicit and implicit method, advection-

diffusion problems, upwinding, boundary-layers, Navier-Stokes equations, MAC and SIMPLE finite element method for heat conduction.

ME 631

L-T-P-D-[C]

3-0-0-0-[4]

VISCOUS FLOW THEORY

Stress-deformation relations, Navier-Stokes equation, exact solutions, two dimensional and axisymmetric boundary layers, Separation, Compressible boundary layers, Elements of stability theory, Turbulent flow: logarithmic law of the wall, effect of wall roughness, two and three equation models, fluid-solid interaction.

ME 632

L-T-P-D-[C]

3-0-0-0-[4]

HYDRAULIC TURBO MACHINES

Classification, characteristics, Euler's equation, efficiencies, prerotation, vortex theory, methods to find the flow characteristics of a given runner geometry. Methods for finding plate profiles. Cavitation, prediction of cavitation inception, cavitation factor, similarity laws, NPSH, cavitation machines.

ME 634

L-T-P-D-[C]

3-0-0-0-[4]

ADVANCED COMPUTATIONAL FLUID DYNAMICS

Discretisation procedure in Finite-difference and Finite-volume. Navier-Stokes, Energy equations. Staggered rectilinear grids. Explicit methods : MAC, SMAC. Implicit Methods, SIMPLE and SIMPLER. Matrix methods, conjugate gradient method, strongly Implicit Procedure. Grid-Generation: Algebraic, Transfinite, Poisson equation methods. Finite-difference Navier-Stokes solution on non-orthogonal grids, transformation. Collocated grids. Finite-volume methods on non-orthogonal grids. Turbulence modelling, k-e modelling

ME 635

L-T-P-D-[C]

3-0-0-0-[4]

INTRODUCTION TO FLUID MECHANICS

Continuum, fluid deformation; Equations of continuity, momentum and energy, Navier-Stokes equations; Potential Theory: Blasius' theorem, method of images. Linearized N-S equations, lubrication theory, creeping flows. Boundary layers, Momentum Integral and similarity techniques; Turbulence, Reynold's equations, flow through pipes and over flat surfaces.

ME 636

L-T-P-D-[C]

3-0-0-0-[4]

GAS DYNAMICS

One dimensional steady isentropic flow, normal and oblique shock; Fanno and Rayleigh lines. Prandtl-Mayer expansion. Isentropic flow in ducts, design of nozzles. Shock tube, small disturbance theory, flow past thin bodies, similarity rules. Hodograph plane, method of characteristics.

ME 637

L-T-P-D-[C]

3-0-0-0-[4]

ELEMENTS OF KINETIC THEORY AND RAREFIED GAS DYNAMICS

Velocity distribution function, B. element's equation, dynamics of collisions, standard molecular models, macroscopic equations, stress tensor and heat flux

vector, slightly non-isentropic flow, dissipation coefficients, free molecular, near free molecular and near continuum flows, Couette flow, flow through tubes, S. Caption of B. element's equation.

ME 638

L-T-P-D-[C]

3-0-0-0-[4]

STRUCTURAL DYNAMICS OF WIND TURBINE ROTORS

Modelling of wind turbine rotor blade, Uncoupled equations of motion for flapping, lead-lag and feathering motions. Study of blade motion and deflection. Estimation of the Rotor, Hub and Tower loads. Blade instabilities in coupled motion.: Flap-lag, Pitch-lag, Pitch-flap flutter and divergence, stall flutter.

ME 640

L-T-P-D-[C]

3-0-0-0-[4]

FUNDAMENTALS OF HEAT TRANSFER

Governing equations. Extended surfaces, transient conditions. Convection in laminar and turbulent boundary layer and flow through tubes. Free and forced convection, correlations, Boiling and condensation. Heat exchangers. Radiation exchange between surfaces.

ME 641

L-T-P-D-[C]

3-0-0-0-[4]

CONDUCTION AND RADIATION

Conduction: Steady and unsteady problems and their solutions in cartesian, cylindrical and spherical coordinates. Separation of variables. Duhamel's theorem. Laplace transform. Problems involving change of phase. Inverse heat conduction, Microscale heat transfer, Radiation: Radiative exchange among black and grey and spectral surfaces, Shape factors. Applications to cavities and enclosures. Integral equations approach. Radiation from gases, vapours and flames.

ME 642

L-T-P-D-[C]

3-0-0-0-[4]

CONVECTIVE HEAT AND MASS TRANSFER

Conservation equations, boundary layers, free convection, forced convection. Heat transfer in laminar and turbulent, internal as well as external flows, mixed convection. Combined convection and radiation. Boiling and Condensation. Molecular diffusion in fluids, mass transfer coefficient. Simultaneous heat and mass transfer; Applications.

ME 643

L-T-P-D-[C]

3-0-0-0-[4]

COMBUSTION AND ENVIRONMENT

Flame phenomena in pre-mixed combustible gases. Diffusion flames-analysis of single fuel droplet, chemical reactions. Burning in convective atmosphere, spray combustion, fire modelling, radiation in flames, formation and control of pollution, Combustion chambers.

ME 644

L-T-P-D-[C]

3-0-0-0-[4]

NATURAL CONVECTIVE HEAT AND MASS TRANSFER

External flows, similarity, heat transfer from inclined surfaces, free convection flows, plumes, wakes, buoyant flows. Flow in stratified media. Stability of natural convection flows, transition, turbulent heat transfer correlations.

- ME 645** **ADVANCED TECHNIQUES IN HEAT TRANSFER**
L-T-P-D-[C]
3-0-0-0-[4] Perturbation methods, transform methods, complex variables, eigen functions and series solution methods. Measurements of flow and temperature fields, optical methods, interpretation of data, design of experimental methods. Numerical method.
- ME 646** **DESIGN OF HEAT EXCHANGE EQUIPMENT**
L-T-P-D-[C]
3-0-0-0-[4] Types of heat exchangers, definitions and quantitative relationships, analytical and numerical solution procedures. Thermal and hydraulic design of heat exchangers; Review of mechanical design, codes, materials for construction, corrosion damage, testing and inspection, costing.
- ME 647** **INTRODUCTION TO TURBULENT FLUID MECHANICS**
L-T-P-D-[C]
3-0-0-0-[4] Measure of turbulence, diffusivity, length scales. Reynolds equation. Mixing length models. Homogeneous, isotropic turbulence, correlation and energy spectrum functions, integral micro scales. Grid turbulence, jets, wakes and mixing layers, boundary layers, logarithmic-law near walls.
- ME 648** **COMPUTER AIDED DESIGN OF THERMAL SYSTEMS**
L-T-P-D-[C]
3-0-0-0-[4] Simulation of thermal processes, application to casting, extrusion, heat treatment, thermal design of heat exchangers, electronic circuitry. Optimization search method and geometric programming, control strategy, data storage and retrieval. Expert systems.
- ME 649** **EXPERIMENTAL METHODS IN THERMAL SCIENCES**
L-T-P-D-[C]
3-0-0-0-[4] Probes and transducers; Calibration; Turbulence measurement via statistical measures; Single and multi-point correlations; Signal conditioning; Optical methods, Interferometry, Schlieren, shadowgraph, LCT, Laser Doppler velocimeter; Transient and frequency response. Computer aided data acquisition, tomography.
- ME 650** **SOLAR SYSTEM MECHANICS**
L-T-P-D-[C]
3-0-0-0-[4] Introduction to the Solar System, The 2- and restricted 3- body problem, Hamiltonian dynamics, dynamics, Rotational and tidal effects, Application : Trajectory planning, Orbital transfers, Interplanetary missions. Shapes of solar system bodies, Spin-orbit coupling, Perturbation methods and effects : The disturbing function, secular perturbations, resonance, and chaos, Planetary rings.
- ME 651** **KINEMATIC ANALYSIS AND SYNTHESIS OF MECHANISMS**
L-T-P-D-[C]
3-0-0-0-[4] Kinematic elements and pairs, mechanisms with lower and higher pairs, geometry

of motion, type number and dimensional synthesis of mechanisms, analytical and graphical methods of analysis and synthesis of linkages, Coupler curve synthesis, spatial mechanisms, cams and gears.

ME 652

L-T-P-D-[C]

3-0-0-0-[4]

PRINCIPLES OF DYNAMICS

Review of kinematics and kinetics of a particle and a rigid body in plane motion. Euler's equations; Methods of analytical dynamics, Lagranges equations; Hamilton's principle; Dynamics in phase space and introduction to stability theory; Applications to engineering problems.

ME 653

L-T-P-D-[C]

3-0-0-0-[4]

ADVANCED DYNAMICS OF MACHINERY

Kinematics and dynamics of rigid bodies and system of rigid bodies. Dynamic force and motion analysis of mechanisms and machines with rigid links. Elastodynamics and kineto-elastodynamic analysis of mechanisms with flexible members. Balancing of linkages.

ME 654

L-T-P-D-[C]

3-0-0-0-[4]

MECHANICS OF GROUND VEHICLES

Simple dynamical models of ground vehicles, mechanics of pneumatic tires, mechanics of vehicles-terrain interaction, performance characteristics of road vehicles, Handling characteristics. Directional stability, wheel shimmy, vehicle ride characteristics.

ME 655

L-T-P-D-[C]

3-0-0-0-[4]

INTERACTIVE COMPUTER GRAPHICS AND DESIGN

Interaction devices and techniques, geo-metrical transformations, viewing in three dimensions, modelling and object hierarchy, raster algorithms, display, representation of 3-D shapes, rendering of surfaces and solids, hidden lines, edge and surface removal, shading models, shadows.

ME 656

L-T-P-D-[C]

3-0-0-0-[4]

DYNAMICS OF MULTIBODY SYSTEMS

Vector functions, reference frames, derivatives of vector functions. Kinematics. Mass/Inertia distribution. Generalized forces and energy functions. Formulation of equations of motion. Linearization and integrals of equations of motion. Extraction of information from equations of motion. Computational issues. Dynamics of a combination of rigid and flexible bodies.

ME 657

L-T-P-D-[C]

3-0-0-0-[4]

HYDRAULIC AND PNEUMATIC CONTROL SYSTEMS

Linear and Rotary actuators, valves and their characteristics. Flow forces on valve spools, valve design, control actuators. Hydraulic power packs, torque motor, electrohydraulic valves, FES, DPF, SLEW servovalves, Electrohydraulic servo systems; Pneumatic control elements; Pneumatic servo systems.

ME 658 L-T-P-D-[C] 3-0-0-0-[4]	NUMERICAL CONTROL OF MACHINE TOOLS Basic principle of numerical control, Classification of NC systems,. NC part programming-manual and computer aided. Drives, feedback devices, Counting devices used in NC system. Interpolators for Manufacturing system. Control loops for NC system, Adaptive control, Industrial robots.
ME 659 L-T-P-D-[C] 3-0-0-0-[4]	GEOMETRIC MODELLING FOR COMPUTER AIDED DESIGN AND MANUFACTURE Geometric modelling, intrinsic and parametric representations, differential geometry of curves and surfaces. Bezier’s curves, rational parametric curves and surfaces. Non-uniform rational B-splines (NURBS), Coon’s and Bezier surface patches. Ruled, lofted, revolved and swept surfaces, solid modelling.
ME 661 L-T-P-D-[C] 3-0-0-0-[4]	MACHINING SCIENCE I Mechanics of chip formation, chip curl. Bluntness and cutting forces. Thermal aspects of machining. Tool wear, tool life and economics of machining. Mechanics of grinding, forces and specific energy, temperature. wheel wear and surface finish.
ME 662 L-T-P-D-[C] 3-0-0-0-[4]	MACHINING SCIENCE II General classification of unconventional machining, chemical machining, electric discharge machining, Abrasive Jet and Ultrasonic Machining, electron beam machining, laser beam machining, ion beam machining, plasma arc machining; Comparative evaluation of different processes; Conventional machining with modifications.
ME 663 L-T-P-D-[C] 3-0-0-0-[4]	METAL FORMING Fundamentals of plasticity, yield and flow, anisotropy, instability, limit analysis, slipline field theory. Applications to forging, wire and tube drawing, deep drawing, extrusion and rolling. High velocity forming.
ME 666 L-T-P-D-[C] 3-0-0-0-[4]	ANALYSIS AND DESIGN OF MACHINE TOOLS Considerations in designing spindle bearing. Functions of guides and slide ways. Static and dynamic analysis of m/c tool structures. Control and automation of m/c tools. Special topics.
ME 668 L-T-P-D-[C] 3-0-0-0-[4]	VIBRATION AND NOISE IN MACHINE TOOLS AND PRESSES Forced vibrations; Machine tool chatter, dynamics of metal cutting; Chatter in some typical machine tools; Effect of flexible mounting on chatter; Chatter

in coupled machine tool systems; Theory of chatter with several degrees of freedom; Theory of impact dampers; Dynamics of machine tool structures.

ME 671

L-T-P-D-[C]

3-0-0-0-[4]

EXPERIMENTAL STRESS ANALYSIS

Strain Gauge, strain rosettes and transducer applications. Photoelasticity, materials and their selection. Introduction to 3-D photoelasticity. Brittle coating methods, Moire method of strain analysis and non-destructive testing using x-rays and ultrasonic devices.

ME 672

L-T-P-D-[C]

3-0-0-0-[4]

EXPERIMENTAL METHODS IN STRESS ANALYSIS

Photoelasticity. Stress-optic law. Photoelastic coatings Strain-optic law, photoelastic materials. Role of Digital Image processing techniques for automation. Strain gauges, Rosette analysis, Transducers, Case studies. Introduction to Brittle coatings, Moire, Holography, Speckle and Caustics.

ME 681

L-T-P-D-[C]

3-0-0-0-[4]

MATHEMATICS FOR ENGINEERS

Properties of Vector Algebra, Vector space, subspace, basis, null and range space, invertibility and matrix representation; Cartesian Tensor notation and vector analysis; Matrices and Matrix algebra, Echelon form, orthogonalization; Eigen values and eigenvectors of a linear operator; First and second order ODEs, Linear Differential equations with constant coefficients and equidimensional equations; Second order linear homogenous differential equations and their solutions; Methods of Taylor and Frobenius, Laplace and Fourier transforms, Fourier series; Legendre and Bessel functions; Sturm Louville Problem; classification of PDEs; Analytical solution of linear PDEs.

ME 683

L-T-P-D-[C]

3-0-0-0-[4]

COMPUTATIONAL TOPICS IN ENGINEERING APPLICATIONS

Elementary Matrix Computation, Systems of Linear Equations, Eigenvalue Problems and singular Value Decomposition, Numerical Differentiation, and Integration, System of Polynomial Equations, Systems of Nonlinear Equations, Nonlinear Optimization, Curve and surface Approximations, Numerical solution of Ordinary Differential Equations, Boundary Value Problems, Differential Algebraic Equations, Numerical Solution of Partial Differential Equations.

ME 685

L-T-P-D-[C]

3-0-0-0-[4]

PROGRAMMING AND NUMERICAL ANALYSIS

MATLAB, Mathematical modeling, algorithms, Taylor series expansion, root finding, interpolation, extrapolation; Solution of linear algebraic systems, determinant, inverse: norms and condition number; Solution of non-linear algebraic systems. Numerical integration. R. K. Method, Solution of ODE and linear PDEs by finite differences.

ME 686 L-T-P-D-[C] 3-0-0-0-[4]	MODELLING AND SIMULATION FOR ENGINEERING PROBLEM SOLVING Black box and distributed parameter models, transient response. Model testing; stochastic vs deterministic models; Inverse problems; Experimental techniques; Geometrical modelling and configuration design; Principles of simulation, discrete event simulation. Applications.
ME 687 L-T-P-D-[C] 3-0-0-0-[4]	HEAT TRANSFER IN MATERIALS PROCESSING Review of Fundamentals. Finite Difference and Finite Element Methods. Modelling of thermal transport in manufacturing of metal based components, plastics, chemicals; drying, waste processing, glass fibre making, crystal growing, food processing. Design of a material processing equipment.
ME 688 L-T-P-D-[C] 3-0-0-0-[4]	OPTICAL MEASUREMENT TECHNIQUES IN MECHANICAL ENGINEERING Introduction to lasers, Mach-Zender Interferometer, schlieren, Shadowgraph, Mie scattering, Image processing, scattered light photo-elasticity, method of caustics, speckle, holography, optical comparators, transmission tomography, 3-D temperature profile measurements, direct/iterative reconstruction algorithms, limited data problem, error analysis.
ME 689 L-T-P-D-[C] 3-0-0-0-[4]	MICROSCALE THERMAL ENGINEERING Micro-Mechanical systems (MEMS), Micro Channels, Heat pipes, jets, valves, Heat Sinks, Solar cells, Bearings, Pumps, Heat pipes, Jets, valves, Heat sinks, Solar Cells, Bearings, Pumps, Flow Sensors and actuators, Fins, Drug delivery systems, Mass, Momentum, Heat and charge transport equations, Characteristic Non-dimensional parameters, Microscale Heat conduction, Heat transport in thin films and at solid-solid interfaces, Convective diffusion phenomena, Enzyme-substrate reactions, channel flow with soluble or rapidly reacting walls, solutions of electrolytes, Electric double layer, Electrokinetic phenomena, electroosmosis, Electro-osmotic pumps, Surface tension driven flows, Coating flows, Thermocapillary flows, Molecular dynamics simulations.
ME 690 L-T-P-D-[C] 3-0-0-0-[4]	Alternative Fuels and Advances in IC Engines Combustion and Fuels, Combustion process in SI and CI engines, Petroleum based liquid fuels and refining, Liquid alternative Fuels, Advantages, potential, problems associated with utilization, Vegetable oils, Biodiesel, Emulsified fuels, Effect on Lubricating oils, Gaseous Alternative Fuels, Hydrogen, Compressed Natural Gas, Liquified petroleum Gas, Di-methyl ether, Hythane, Multi-fuel engines, Modern developments in IC Engines, EGR, MPFI, GDI, HCCI, Turbocharged engines, Optical Measurement techniques, Fuel atomization and spray visualization techniques, Laser doppler Anemometry, Particle image velocimetry, 3D and

Holographic PIV, optical engines, sources and Nature of various types of pollutants: Pollution monitoring instruments and techniques, Control measures, emission legislations.

ME 698
L-T-P-D-[C]
3-0-0-0-[4]

ADVANCED TOPICS ON ENGINEERING OPTIMIZATION

Multi-objective optimization, Robust design techniques (variation reduction techniques), Optimal control, stochastic programming. Role of Optimization in CAD: Why optimization? Optimization-Geometric modeling-Analysis. Implementation Issues: computational time versus accuracy, Interfacing with geometric modelling and analysis softwares, Graphics interfacing, Choice of Hardware platform. Application to engineering design problems, comparison with existing solutions.

ME 698A
L-T-P-D-[C]
3-0-0-0-[4]

SPECIAL TOPICS

ME 699

M. TECH. THESIS

ME 721
L-T-P-D-[C]
3-0-0-0-[4]

THEORY OF PLASTICITY

Yield surfaces. Deformation and flow theories; Theory of plastic constitutive equations; Axisymmetric and spherically symmetric problems; Slipline theory and application to problems of extrusion, drawing and indentation; Wave propagation in plastic materials.

ME 722
L-T-P-D-[C]
3-0-0-0-[4]

FRACTURE MECHANICS

Introduction to linear Elastic Fracture Mechanics. Elasto-Plastic fracture mechanics. Dynamic and Computational fracture. fracture of composite materials. Damage mechanics and experimental analysis.

ME 723
L-T-P-D-[C]
3-0-0-0-[4]

WAVE PROPAGATION IN SOLIDS

Waves in infinite and semi-infinite elastic media. Reflection and refraction at plane interface. Dispersion of waves in bounded solids. Waves in rods and plates. Solution of transient problems. Rayleigh waves. Waves in anisotropic materials. Introduction to waves in viscoelastic and plastic media.

ME 727
L-T-P-D-[C]
3-0-0-0-[4]

COMPOSITE MATERIALS

Structures and method of preparation of fibres and fibre reinforced composites. Micromechanics and prediction of elastic constants; Strength of composites; Properties of laminated composites and their constitutive equations; Laminates; Interfacial mechanics and properties; Applications.

ME 728 L-T-P-D-[C] 3-0-0-0-[4]	FRACTURE AND FATIGUE Fracture: Energy release rate, crack tip stresses and deformation fields, plastic zone, Elasto-plastic fracture through J-integral and CTOD, Dynamic fracture, Testing for Fracture. Toughness. Fatigue: Crack nucleation and growth, Fatigue life prediction, Statistical analysis.
ME 729 L-T-P-D-[C] 3-0-0-0-[4]	MODELLING OF MECHANICAL PROPERTIES OF MATERIALS <p style="text-align: right;">Prereq. ME 621</p> Introduction, Homogenisation, Ductile Materials, Dislocations, single crystal plasticity, Size effects on mechanical properties, Thermodynamics of constitutive modelling, Examples of constitutive models, Modelling of very small structures.
ME 741 L-T-P-D-[C] 3-0-0-0-[4]	COMBUSTION ENGINES AND POLLUTION Thermo-chemistry, Chemical Equilibrium, Kinetics; Laminar and Turbulent Flame propagation in SI Engines, Unburned and Burned Mixture States, Flame Quenching; Fuel Injection, Spray Atomization, Penetration and Evaporation, Fuel-Air-Mixing and Burning Rates in CI Engines; Pollutant Formation in Engines, Zeldovich Mechanism, Soot Formation; Vehicle Emissions and standards; Emission control Technologies, Catalytic Control, Engine Design and Fuel effects, New Advances; Emission Measurement
ME 742 L-T-P-D-[C] 3-0-0-0-[4]	BOILING AND CONDENSATION Pool boiling: Nukiyama Experiment, theory of vapour bubble formation, Mechanism of CHF, various models and correlations. Flow Boiling, Homogeneous, and heterogeneous models, Boiling enhancement techniques. Heat Pipes. Design of boilers, Film and dropwise condensation. Nusselt's analysis of laminar film condensation on vertical flat plate, single horizontal tube and vertical array of tubes. Laminar-wavy and turbulent film condensation. Film condensation inside horizontal tubes, condensation enhancement techniques, design of condensers, special topics: Computer simulation of boiling.
ME 751 L-T-P-D-[C] 3-0-0-0-[4]	COMPUTER AIDED ENGINEERING DESIGN Methodology of interactive, graphical, engineering design; Discretization, optimization, simulation in CAED. Design of curves and surfaces. Applications in conveyor systems, sheet metal working, tool design, pumps etc. Design of volumes. Intersection of surface and interference of volumes.
ME 752 L-T-P-D-[C] 3-0-0-0-[4]	OPTIMIZATION METHODS IN ENGINEERING DESIGN Classical optimization methods, unconstrained minimization; Univariate, conjugate direction, gradient and variable metric methods, constrained minimization, Feasible direction and projections. Integer and Geometric programming, genetic algorithms, simulated annealing techniques, design applications.

ME 753 L-T-P-D-[C] 3-0-0-0-[4]	RELIABILITY BASED DESIGN Determination of reliability. Reliability analysis of weakest-link and fail systems. Reliability based design of mechanical and structural components. Application of statistical methods to stability problems. Reliability engineering in production and manufacturing systems. Dynamic reliability.
ME 754 L-T-P-D-[C] 3-0-0-0-[4]	OPTIMAL CONTROL SYSTEMS Principles of optimality, Hamilton-Jacobi-Bellman equation. Calculus of variations: Piecewise smooth external. Constrained extrema, Two point boundary value problems, linear regulator problems, linear tracking problems. Pontryagin's minima principle, Numerical methods for finding optimal controls. Quasilinearization techniques.
ME 755 L-T-P-D-[C] 3-0-0-0-[4]	SPECIAL TOPICS IN TRIBOLOGY Friction and wear in boundary lubrication, tribological properties of materials. Friction instabilities and stick slip; Rolling motion. Macro and micro-slip; Tyre-road interactions. Elasto-hydrodynamic lubrication; Friction-induced thermomechanical interactions; Foil bearings.
ME 756 L-T-P-D-[C] 3-0-0-0-[4]	VIBRATION CONTROL Factors affecting level of vibration, vibration reduction at the source, vibration control by structural design, selection of materials. Vibration control by additive damping; Dynamic vibration absorbers, vibration and shock isolators, Active control.
ME 757 L-T-P-D-[C] 3-0-0-0-[4]	DYNAMICS OF ROTATING MACHINERY Rotor-bearing interaction. Flexural vibration, critical speeds of shafts, Effects of anisotropic bearings, unbalanced response of an assymmetric shaft. Gyroscopic effects. Aerodynamic effects. Equivalent discrete system. Geared and branched systems. Fluid film bearings: Steady state characteristics of bearings. Rigid and flexible rotor balancing. Measurement techniques.
ME 758 L-T-P-D-[C] 3-0-0-0-[4]	ADVANCED METHODS IN ENGINEERING DESIGN Principles of Design, Optimum Design, Failure Considerations in Design, Robust design, Reliability, Ergonomics Considerations in design.
ME 759 L-T-P-D-[C] 3-0-0-0-[4]	ADVANCED TOPICS IN NON-TRADITIONAL MACHINING PROCESSES A brief review of non-traditional machining processes, Analysis of mechanical,

thermal and Electrochemical type non-traditional machining processes. Analysis of micro-machining processes. Tool design for selected non-traditional machining processes. Modeling and simulation of selected processes. A comparative study of various processes. Application of CNC concepts to non-traditional machining processes machines. Computer aided process planning of non-traditional processes.

ME 760

L-T-P-D-[C]

3-0-0-0-[4]

MODERN CONTROL OF DYNAMIC SYSTEMS

Concepts from Linear system Theory. Modern Control systems: Solution of state-space equations, State transition matrix. State-space analysis of multi-variable systems; Multi-loop systems and multi-variable block diagrams. State-space representation of control systems, Transfer matrices, Transformation from continuous to discrete time representations; Impulse and pulse response matrix; Modal decomposition, State feedback regulators; Constant gain state-feedback design. Design of controllers: Full and reduced order observer design; Integration of controller and observer; Eigen-structure assignment; Optimum controller design; Robust control. Distributed Parameter Systems:

ME 761

L-T-P-D-[C]

3-0-0-0-[4]

COMPUTER AIDED MANUFACTURING

Direct numerical control (DNC) and computer numerical control (CNC): adaptive control of manufacturing processes. Manufacturing system concepts. Computer processes monitoring and control, off-line use of computers. Computer aided design. Computer-process interface; programming, introduction to FMS.

ME 762

L-T-P-D-[C]

3-0-0-0-[4]

INTRODUCTION TO ROBOTICS

Types of Robots. Spatial transformation and kinematics of open chain linkages. Mobile robots, Actuators, sensors, programming and control. Applications - motion planning, grasping and industrial automation.

ME 763

L-T-P-D-[C]

3-0-0-0-[4]

ROBOT MANIPULATORS: DYNAMICS AND CONTROL

Review of robot manipulators. Manipulator kinematics, dynamics and control. Singularity and workspace analysis. Introduction to manipulator design.

ME 764

L-T-P-D-[C]

3-0-0-0-[4]

COMPUTER INTEGRATED MANUFACTURING SYSTEMS

Software tools for CIMS. Basics of DBMS, DSS, distributed computing and LAN and FAN. Shop floor automation and automatic identification techniques, CAD/CAM. Industrial robotics: Single and mixed product manufacturing, robotized assembly. GT applications. FMS: analysis. Automated material handling.

ME 765 L-T-P-D-[C] 3-0-0-0-[4]	MANUFACTURING AUTOMATION Automation strategies, flow lines, automated assembly systems, transfer systems; Vibratory bowl feeders, non-vibratory feeders. Part orienting, feed track, part placing and part escapement systems; Programmable automation, industrial robotics; Flexible manufacturing systems; Automation equipment.
ME 766 L-T-P-D-[C] 3-0-0-0-[4]	ROBOT MOTION PLANNING Configuration spaces of mobile vehicles and manipulators, Geometric modelling and sensor based map building. Path planning and obstacle avoidance. Object manipulation and grasping. Design of user interfaces and simulation. Algorithms for assembly and biological aspects of motion and intelligence.
ME 767 L-T-P-D-[C] 3-0-0-0-[4]	EVOLUTIONARY ALGORITHMS IN SEARCH AND OPTIMIZATION Traditional optimization methods. Simple genetic algorithms- reproduction, crossover and mutation. Analysis of GA-operators; Deception; Multimodel and multiobjective optimization; Engineering applications. Introduction with applications for Evolution strategy and Simulated annealing.
ME 768 L-T-P-D-[C] 3-0-0-0-[4]	ARTIFICIAL INTELLIGENCE IN ENGINEERING Computational techniques for representing and solving problems. Biological Perspectives. Representation, production systems and search. Heuristics. First order logic and resolution. Fuzzy logics. Planning spatio temporal reasoning, learning. Qualitative reasoning. Neural nets. Applications from engineering.
ME 769 L-T-P-D-[C] 3-0-0-0-[4]	ADVANCED TOPICS IN ROBOTICS Advanced techniques of kinematics and dynamics of mechanical systems. Parallel-actuated and closed-loop manipulators. Redundant manipulators. Mobile robots and path planning. Complaint motion and grasping. Sensing and vision. Nonlinear control of robots. Any other relevant topic.
ME 770 L-T-P-D-[C] 3-0-0-0-[4]	MATERIALS SELECTION IN MECHANICAL DESIGN The evolution of engineering materials; Materials and the design process; Functional requirements of engineering materials; Materials selection based on properties alone; Materials selection based on properties & shape; Processing, materials & design; Materials property data. Latest developments in the use of materials; New materials; Case studies.

ME 771
L-T-P-D-[C]
3-0-0-0-[4]

SMART MATERIALS AND STRUCTURES

Materials for both actuation and sensing: Piezoelectric Materials, Magnetostrictive Materials, Materials for actuation: Shape Memory alloys Magnetic shape memory material, Electro/Magneto rheological fluids; Materials for sensing: Optical fibre; Composite smart materials and micromodelling related issues; Energy based approach: Hellinger-Reissner Principle, Variational Formulation, Finite Elements Modelling of Vibration of smart Laminates; state space based analysis & design of smart controllers, Concepts of Controllability & observability; Pole placement Techniques; Intelligent system with integrated sensors & actuators; Self-sensing actuators; Placement of Smart Actuators/Sensors - Vibration damping.

ME 772
L-T-P-D-[C]
3-0-0-0-[4]

MECHATRONICS

Fundamentals of the integration of mechanical and electronic subsystems using computer based control. Details of different types of sensors, actuators, DAC/ADC and micro controllers. Control systems design and modeling of computer controlled electro-mechanical systems. Industrial automation and robotics. Practical applications of mechatronics, design issues and industrial techniques currently in use.

ME 777
L-T-P-D-[C]
3-0-0-0-[4]

PLASTIC PART MANUFACTURING AND TOOL DESIGN

Fundamentals of Polymer Technology; Properties of Solid and Molten Polymers; Selection of Materials and Manufacturing Methods; Extrusion Equipment and Processing techniques; Injection Moulding; Blow Moulding, Rational Moulding, Compression and Transfer Moulding, Thermoforming; Resin Transfer Moulding; Rapid Prototyping and Tooling processes. Other Manufacturing methods (Machining, Joining, Finishing, Assembly) CAD/CAM of Dies/Moulds/Tools; Flow analysis.

ME 778
L-T-P-D-[C]
3-0-0-0-[4]

ENGINEERING ACOUSTICS AND ITS CONTROL

Wave propagation in solids and fluids. Admittance and impedance concepts for infinite and finite acoustic waveguides. Sound radiation from vibrating structures: Measurement of radiated power, elementary radiators, sound radiation from bending waves. Passive attenuation of structure-borne sound : Damping models, effect of elastic interlayers, blocking masses, changes of material and cross-section. Active control of structure-borne sound : Elements of frequency domain control system analysis and synthesis, wave absorbing controllers for rods, beams, and plates.

ME 780 **MULTIOBJECTIVE OPTIMISATION: THEORY, METHODS AND APPLICATIONS**
L-T-P-D-[C]
3-0-0-0-[4] Fundamentals of optimisation with single objective. Karush-Kuhn-Tucker Conditions, Lagrangian Multipliers. Introduction to multiobjective optimisation problem. Solution concepts (Efficiency, Weak Efficiency and Proper Efficiency). Scalarization Techniques. Structure of Efficient set. Karush-Kuhn-Tucker Conditions for multiobjective problems. Lexicographic ordering

ME 799 **Ph. D. Thesis**