Detailed Contents of Courses for the M.Engg. Programme in Mechanical Engineering

ME 501 Engineering Design

Total Design: Design process, creativity in design process analysis of interconnected design areas, decision theory and theory of game, information in design, design analysis.

Product Design: Industrial design perception form, clarity and balance lettering colouring, controls and panels form design industrial plants piping, effect of design on cost, Factors affecting product design, Requirements of a good product design, Design specifications and drawings, Product planning, Feasibility studies.

Value Analysis: Concept of value analysis meaning and analysis of functions. Patents standard and codes, contract negotiation.

Geometric Dimensioning & Tolerances: Geometric Dimensioning. Form Controls: flatness, straightness, circularity and cylindricity. Orientation Controls: perpendicularly, angularity and parallelism. Location Controls: position and concentricity. Runout Controls: circular runout and total runout. Profile Control: profile of a line and profile of a surface.

Techniques for Design Optimization: The Mathematical Programming Problem; Global & Local Solutions; One Dimensional Linear Search Techniques; Golden Search Technique, & Fibonacci Series. Multidimensional Search Technique; Problem Analysis & Empiric Parameter Reduction; Variance Analysis as an Aid to Problem Solving.

ME 502 Advanced Stress Analysis

Introduction: Analysis of stress and strain, Review of relation for various types of stresses, Equations of equilibrium, Boundary conditions and Principal stresses. Generalized Hook's law, boundary value problems of Linear Elasticity.

Elasticity applications: Thick tube, Stress concentration due to a Circular Hole in a stress plate, Concentrated load acting on the vortex of a Wedge and Concentrated Force acting on the Free Surface of a Plate.

Elastic-plastic Structures: The occurrence of fracture and the Inadequacies of conventional design concepts. Types of fractures that occur under uniaxial tensile loading. The physical significance of fracture toughness. The role of dislocations in plastic deformation of single and polycrystalline materials.

Contact / Thermal Stresses: Application of Contact Stresses to mating of gear teeth, shaft in a bearing and ball and rollers in bearings. Thermal stresses and thermal strains; applications to turbines and pipes carrying hot fluids.

Viscoelasticity Analysis: Types of time dependence superposition, Boltzmann's integral, Differential from, in phase and out of phase components. Laplace transforms and relationship between viscoelastic parameters. Model materials Maxwell Voigt and standard linear solid.

ME 503 Computer Aided Design (CAD)

Fundamentals of CAD: Introduction, the design process, application of computers for design, creating the manufacturing data base, benefits of CAD. Computers, Input / Output Devices, Storing an Image.

Geometric Modeling: Geometric Modeling Techniques: Multiple-View Two Dimensional Input, Wire Frame Geometry, Surface Models, Geometric Entities: Points Lines, Surfaces, Solids, Tesselated Modeling, Cubic Curves: Hermite Curves, Bezier Curves, B-Spline Curves, Bicubic Surfaces: Hermite Surfaces, Bezier Surfaces, B-Spline Surfaces. Solid Modelers: Solid Modeling Construction Technique: Pure Primitive Instancing (PPI), Spatial Occupancy Enumeration (SOE), Cell Decomposition (CD), Sweeping (S), Constructive Solid Geometry (CSG), Boundry Representation (BREP), Euler Formula , Solid Modeler Storage Data Bases, Feature Recognition, Feature-Based Design Using CSG Construction, Using a BREP for Part Interpretation; Data Transfer Standards.

Computer Graphics: Computer Graphics and the Part Model: Interactive Graphics, Graphics in CAD, Two-Dimensional Graphics, Two-Dimensional Transformations, Three-Dimensional Graphics, Three-Dimensional Transformations, Composite Transformations in Three Dimensions, Projections, Realistic Image Generation.

Concurrent Engineering: Key Definitions; Driving Forces Behind Concurrent Engineering; The Meaning of Concurrent Engineering; Schemes for Concurrent Engineering: Axiomatic Design, DFM Guideline, Design Science, Design for Assembly, The Taguchi Method for Robust Design, Manufacturing Process Design Rules, Computer-Aided DFM, Group Technology. Failure-Mode and Effects Analysis, Summary of Concurrent Engineering Tools.

ME 504 Finite Element Analysis

FEA of One-dimensional Problems: Introduction: Basic Steps in FEA; Modelling, Discretization, Connectivity of Elements, Imposition of Boundary Conditions, Solutions & Post Processing; Applications to Heat Transfer, Fluid Mechanics, & solid Mechanics Problems.

Bending of Beams: Euler-Bernoulli Beam Element, Governing Equations, Application of FE on Beam, Beam Examples, Plane Truss Element, Frame Element, Timoshenko Beam & Frame Element, Inclusion of Constraint Equations.

Finite Element Error Analysis: Approximation Errors, Various Measures of Errors, Convergence of Solutions, Accuracy of Solutions.

Numerical Integration & Computer Implementation: Isoparameteric Formulations, Numerical Integrations, Natural Coordinates, Computer Implementation (Pre-processor, Processor, Post-processor).

FEA of Two-dimensional Problems: Introduction; Single Variable Problems; Boundary Value Problems; Model Equations, Discretization, Weak Form, Finite Element Model, Assembly, Solutions & post processing; Mesh Generation; Imposition of Boundary Conditions; Applications; Parabolic Equations; Hyperbolic Equations.

Interpolating Functions, Numerical Integration & Modelling Considerations: Interpolating Techniques; Triangular, Rectangular, & Serendipity Elements; Coordinate Transformation; Integration on a Master Element; Modelling, Mesh Generation, Load Representation.

Plane Elasticity: Assumptions of Plane Elasticity; Basic Equations, Weak Formulations; Principle of Virtual Displacement in Matrix Form; Finite Element Model, Matrix & Weak Form Model; Evaluation of Integrals.

Bending of Elastic Plates: Classical Plate Model; Finite Element Model; Shear Deformable Plate Model; Displacement field, Virtual Work Statement; Shear Locking & Reduced Integration; Introduction to Time Dependent Problems; Computer Illustrative Examples.

ME 505 Mechanical Vibrations

Fundamentals of Mechanical Vibrations: The use of Newton's law and of Lagranges equation for setting up equations of motion. Techniques for linearisation and vector presentation. Use of energy methods for obtaining a simple analytical model, estimation of the equivalent stiffness and the effective mass or inertia. Use of generalized coordinates. The setting up of a dynamic model based on calculated or measured structural static deflections. Beam and plate vibration. The dynamics of foundations. Coupled modes of vibration.

The dynamic response of real systems to different types of inputs. Energy dissipation in structures, analytical models for different damping systems, the in-phase and quadrature module, the loss factor and equivalence with other expressions describing damping. Typical values and methods for measuring the effective loss factor. Frequency locus plot, mobility and receptance methods applied to multi degree of freedom systems. Response to impact, limitation of the hysteretic damping model, the Duhamel integral, Properties of materials exposed to shock. Non-dimensional equations of motion, vibration testing, types of vibration generators.

Random Vibrations: Introduction to random processes. Frequency decomposition distributions. Ensemble averages, means and autocorrelation. Frequency decomposition of stationary processes. Fourier transforms and spectral density. Properties of narrow band Gaussain distribution. Response of mechanical systems to random vibration. Theories of fatigue due to random vibration. Aspects of design criteria and test specifications, environmental measurement and testing.

Vibration Measurement & Signature Analysis: The need of measurement of vibration phenomena and for methods of analyzing measured data to extract useful information concerning the test structure. Different types of vibration measurement and their applications. Major forms of vibration transducers, methods of operation and limitations. Fourier (or spectral) analysis as a means of interpreting complex vibration behavior harmonic, periodic, random and transient Fourier analyzers. Measurements of structures frequency response properties. Analysis of these data to extract basic properties of natural frequency, mode shapes and damping factors.

ME 506 Acoustics

Fundamentals of Acoustics: Basic law of acoustics, sound power, sound pressure level (SPL) direct radiation, reflection coincidence frequency transmission loss. Units for SPL and for loudness, effect of exposure time. Leg methods of measurement. Range of perception of the human ear, permissible levels, legislation, infra-sound. Noise sources and reduction of noise at source, design and performance evaluation of the mass law, silencers, active noise control (anti-noise).

Analysis of Noise Sources and Vibrations: Lagrange equations, wire, rod, beam, plate vibrations, response of continuous elastic bodies to arbitrary force systems, numerical solutions, nonlinear vibrations. Random and nonlinear vibrations, random motion, response of random excitation. Cumulative fatigue failure, self excited vibration, nonlinear singe degree distributed systems. The dynamic of foundations. Coupled modes of vibrations.

Energy Dissipation and Noise Control: Energy dissipation in structures, analytical modes of different damping systems. Theory and application of acoustical principles of generation, transmission, measurement and controlled of sound and aircraft, appliances, machines and buildings.

ME 507 Power Plant Design

Introduction to Power Plant Design: Design problems covering loads, cycles and equipment for modern power generation, including combustion to nuclear power.

Internal Combustion Engine Plants: Analysis of performance and operating characteristics of automotive engines, combustion, ignition, fuels to lubrication and emissions.

Steam Turbine Power Plant: Principles of design, interaction of various units, fuels, emission.

Gas Turbine Power Plant: Principles of design, interaction of various units, fuels, emission, combined cycle plants.

Emission and Pollution Control: Analysis of emanating gas and pollutants from various types of plants, changes in emission caused by the operating variables, engineering aspects of pollution control.

ME 508 Kinematics & Rigid Body Dynamics

Fundamentals: Classification of mechanisms, constraints and degrees of freedom; kinematics of rigid body in respect of finite displacement of rigid body; matrix methods for describing displacements. Linkage mechanism design: synthesis of a plane four bar linkage for correlated crank displacements (Freudensteins method); coupler displacements specified; various straight line motions. Euler Savary equation; cognate mechanisms (Roberts Theorem); use of inflexion circle for simple planar mechanism design.

Rigid Body Dynamics: Three-dimensional kinematics; angular momentum and the inertia matrix, Eulers and Largranges equations for the general motion of a rigid body, kinematics and dynamic analysis of linkage mechanisms. Application of the mechanical design of manipulators.

Matrix Analysis Applied To Dynamics: Formulation of equations of motion in matrix format and generalized coordinates; properties of the mass and stiffness matrices coordinate transformations, principal coordinates; eigenvalues and elgenvectors (determination and properties). Matrix solutions to undamped and damped free and forced vibration problems, including modal superposition. Receptance and mechanical impedance matrices and their application to complex systems formed by the assembly of subsystems, substructure methods.

ME 511 Materials Science

Polymeric Material: High performance fibre, high performance elastomers, high performance coatings, special polymers, moderately high polymers, engineering polymers. Materials development and modification, multilayer and adhesive technology will also be part of this course. Physical and chemical testing of polymers.

Fundamentals of polymers: Molecular structure, polymerization processes, morphology of polymer molecules, plasticisers and fillers. Composition and characteristics of principal types of polymers, convention constant rate of elongation test, creep tests, isochronous curves and other forms of data presentation, strain recovery and stress relaxation, anisotropy of properties time-dependence of strength and creep rupture, durability under cyclic loading BS impact tests.

Fracture of Polymers: Fundamentals of fracture mechanics, Application of fracture mechanics to polymers, K_C determinations K_C crack speed curves instability, environmental effects impact testing, application to practical problems.

Composites: Composite materials compared with conventional materials, fibre and matrices, composite mechanics, elastic properties, failure processes, failure at notches, notch sensitivity and fracture energy. Fatigue and failure of composite materials. Deterioration of properties

owing to environmental conditions, hybrid composite materials, manufacturing the by hand lay-up, preparing specimen for mechanical testing, Burn off tests to determine fibre volume fracture.

Categories of composites. Properties of glass and other fibers. Matrix materials Composites as monotropic membranes. Mathematical models of stiffness of composites based on mechanics of materials and energy considerations. Elasticity of anisotropic materials. Strength of composites. Outline of methods of manufacturing composites and of their applications.

ME 512 Fracture Mechanics

Fatigue & Fracture: Cyclic stresses, minimum and maximum stresses, and stress ratio. Soderberg and Goodman Criteria. Fatigue at high temperature. Ductile and brittle fracture in steel. Crack initiation, crack growth, crack propagation. Crack propagation laws. Griffith Theory of fracture , stable and unstable crack propagation. Crack nucleation and effect of notch size on crack propagation.

Fracture Behavior of Metallic Materials: Temper embattlement of 9% Cr steels. Flack graphite cast iron. Fracture Behavior of pearlitic steels. Fracture resistance of high alloy tool steels. Advanced welding design. Power sources plates, stability, plastic design, under sea water welding, laser welding.

Non Destructive Testing: Ultrasonic eddy current, acoustic emission, interflowmative holography.

Dislocation theory and applications: Elastic theory, types, sources, motion, interaction of dislocations. Stress fields and stress energies, partial dislocations and stacking faults, principle of work hardening. Dislocations mechanism.

Alternate and alternately activated flow, deformation mechanism. Stress theory process, solid solution and dispersion hardening effect of impurity colours ordering phenomena, diffusion controlled process.

ME 513 Creep

Introduction: Primary and secondary creep. Stress dependence of creep, Temperature dependence of creep and Time dependence of creep. Mode of creep deformation. Dislocation glide and Dislocation climb. Role of grain boundaries during creep deformation.
Creep Theories: Relative creep strengths of engineering materials. Creep under variable stress and temperature conditions, mechanical equations of state.

Application to Design Problems: Creep under complex stress loading equivalent stress and strain criteria; application to practical problems.

ME 514 Advanced Metallurgy

Physical Processing of Metal: Simulation of the role of continuous casting fluxes, Extrusion of Cu alloys, Production of Al Mg alloys from the powder phase. Deformation of austenitic stainless steel,
Extrusion of Al-Mg-Si compacts. Extrusion of Al-Mg alloys, Rolling of Al-Mg alloys, deformation
of flow and pressure requirements for the extrusion of Al-Cu-Mn Mg shapes, The preparation of high modulus low density engineering materials from rapidly solidified powders, Factors controlling the production of tubular shapes from rapidly solidified materials, Engineering materials prepared from rapidly solidified powders using the conform process.

Phase Transformations: Precipitate dissolution in aluminum alloys, Grain boundary precipitation and toughness in Al-Li-x alloys, Constitutional effects of platinum groups metals and refectory metals in nickel based superalloys, Precipitation effects in nickel based alloys containing Mo and W, high temperature titanium alloys, Phase equilibria in recycled martensite formation in titanium alloys.

Structural Aspects of Metals: Microstructure and microchemistry development in alloys, Effect of microstructure on the wear, erosion and mechanical properties of Silceram glass-ceramics, High temperature plasticity and dynamics of recrystallisation in polycrystalline metals, minerals and analogues, The effect of second-phase particles on high temperature deformation, creep fatigue of nimonic alloys, Automated determination of diffraction patterns and textures in the transmission electron microscope, The effects of process variables on the microstructure and toughness of Al-Li based alloys, Microstructure and mechanical properties of triballoys.

Corrosion: Protective coatings for steels in sulphide environments, Properties of metallic coatings, Oxidation and hot corrosion in metals of industrial importance, Laser and other methods of surface treatment for marine corrosion protection.

ME 521 Automation & Controls

Production Operations & Automation Strategies: Automation defined; Types of automation; Reasons for automation; Manufacturing industries; Types of production; Functions in manufacturing; Organization & information processing in manufacturing; Plant layout; Production concepts & mathematical models; Automation strategies.
Automotive Type Automation: Automated flow lines; Methods of workpart transport; Transfer mechanism; Buffer storage; Control functions; Automation for machining operations; Design & fabrication considerations; General terminology & analysis; Analysis of transfer lines without storage; Partial automation; Automated flow lines with storage buffers; Computer simulation of automated flow lines.

Assembly Systems & Line Balancing: The assembly process; Assembly systems; Manual assembly lines; The line balancing problem; Methods of line balancing; Computerized line balancing methods; Flexible manual assembly lines; Types of automated assembly systems; Parts feeding devices; Analysis of multi-station assembly machines; Analysis of a single station assembly machine.

Computer Assisted Optimal Control: Structural model of a Manufacturing process; Steady state optimal control; Adaptive control; On-line search strategies.

Computer Process Control: The computer-process interface; Interface hardware; Computer process monitoring; Types of computer process control; Direct digital control; Supervisory computer control; Programming for computer process control.

ME 522 Computer Aided Manufacturing (CAM)

Conventional Numerical control: Introduction, basic components of an NC system, the NC procedure, NC coordinate systems, NC motion control systems, applications of numerical control, economics and justification.

NC Part Programming: Punched tape in NC, tape coding and format, manual part programming, computer assisted part programming, the APT language, NC programming with interactive graphics, voice NC programming, manual data input, APT word definitions.

Computer Controls in NC: Problems with conventional NC, NC controller technology, computer numerical control, direct numerical control, adaptive control machining systems, trends and new developments in NC.

Group Technology and FMS: The role of group technology in CAD / CAM integration; Methods for developing part families; Classification and Coding: Hierarchical code, Attribute code, Hybrid code, Selecting a coding system, Development your own coding system; Coding systems: OPITZ coding system, MICLASS coding systems; Facility design using group technology; Cell design; Economic modeling in a group technology environment: Production planning cost model, Group tooling economic analysis; Economics of group technology: Benefits in Design, Benefits in manufacturing, Benefits to management, Group technology advantages / disadvantages summarized. Introduction to FMS, FMS workstations, materials handling and storage system, computer control system, planning the FMS, analysis methods for FMS, application and benefits.

Process Planning: The role of process planning in CAD / CAM integration, Approaches to process planning: Manual approach, Variant approach, Generative approach; Process planning systems: CAM-I automated process planning (CAPP), DCLASS, Computer Managed process planning (CMPP), Machinability data system.

ME 523 Operations Research

Linear Programming: Formulation, Graphic solution, Assumptions of LP, The Simplex method, Equality constraints, Inequality constraints, Negative RHS, Duality theory, Primal and dual problems.

Special Types of LP Problems: The transportation problem, Production scheduling, North-west corner rule, Vogel's approximation method, Russell's method, Transshipment problem, Assignment problem, Goal programming, Sensitivity analysis, Parametric programming,

Dynamic programming, Integer programming. Queuing Theory: Basic Queuing process, the birth and death process, Basic model with infinite and finite queue, Limited input source, Priority Queuing model.

Inventory Control Theory: Deterministic Models: Continuous review-uniform demand, shortages permitted, Quantity discount- shortages not permitted.

Stochastic Models: Single- period model with no setup cost, Model with initial stock level, Single- period model with setup cost, Two- period inventory model with no setup cost.

ME 524 Reliability & Quality Engineering

Reliability Measures: The reliability Function; Expected Life; Failure Rate and Hazard Function; Reliability and Hazard Function for well known Distributions such as Exponentional; Normal, Log Normal, Weibull, and Gamma Distributions; Hazard Models and Product Life; Constant Hazard Function, Linearly Increasing Hazard Function, Piecewise Linear Bathtub Hazard Function, Power Function Model, Exponential Model.

Static Reliability Model: Series System, Parallel System, Series & Parallel Combinations, Complex System Analysis, Reliability Considerations in Design.

Reliability Engineering Design: Reliability Design Methodology, Strength and Stress Distributions, Safety Factors and Reliability, Reliability Bounds in Probablistic Design. Transformation of Random Variables. Sums and Differences of Normal Random Variables, Error Analysis, Statistical Tolerancing.

Interference Theory and Reliability Computations: General Expression for Reliability; Reliability Computations for Normally, Log Normally, Exponentionally, Gamma and Weibully Distributed Stress and Strength; Reliability Design Examples.

Reliability in Design and Testing: Dynamic Reliability Models, Reliability Estimation, Sequential Life Testing, Bayesian Reliability in Design and Testing, Reliability Optimization.

Control Charts: Properties of the distribution of sample means, sample range estimation of standard deviation, chance and assignable causes, control charts for mean & range, control charts for mean & standard deviation, control charts for proportion defective & defects per assembly. Tests of significance to compute confidence limits.

Acceptance Sampling: Introduction, OC curve, consumer & producer risks, AQL & LTPD, acceptance sampling for continuous production, acceptance by variables, single, double, & sequential sampling.

Quality, Reliability, & Maintainability: Definitions, management of quality control, economic aspects of quality decisions, capability & variability analysis, various aspects of life testing, reliability, & maintainability, Introduction to ISO 9000, and ISO 14000.

ME 527 Human Factor Engineering

Introduction: Scope of Ergonomics, Human operator as system components; physical size and shape dynamics, anthropmetry, sources and application of energy input sensitivity, central processing capacity, input characteristics, environmental effects, heat and vibration, lightning and noise. Techniques in human factor studies; the assessment of physical activity, subjective assessment technique, methods of work analysis.

Design Requirements: Interface design; space requirements and layout visual presentation of information, auditing presentation of information, machine dynamics, control design, environmental factors, jobs aids, System evaluation.

ME 541 Advanced Thermodynamics

Classical Thermodynamics: Lagrange multipliers, homogeneous functions, Gibbs Phase rule, real gases, mixtures, first, second, and higher order phase transitions; Third law, Thermodynamics of irreversible pressure: Statistical thermodynamics, Onsager relations; kinetic theory; Transport processes; ideal gas properties at high temperatures.

Combined Cycles: Combinations of thermally independent systems, thermally interdependent systems, reciprocating engine, and gas turbine combinations.

Aircraft and Missile Propulsion: Basic propulsion systems, forces resulting from fluid acceleration, propulsive efficiency, turbojet, turbo-fan, turbo-propellers, and thrust augmentation, ram-jet and pulse-jet engines, rockets.

I. C. Engines, Compressors, and Turbines: Application of thermodynamics to I. C. Engines, Compressors & Turbines. Maximum obtainable efficiencies.

ME 542 Energy Management

Introduction: The role of energy manager. Attitudes to energy efficiency, the objective of energy management, priorities, and strategies.

Plant control, Burner control unit, compensator and optimiser, control and use of an energy management system.

Monitoring: Remote monitoring and out-station operation, degree days performance lines and targeting, Audits, Environmental, energy and social.

Energy Modeling & Forecasting: Data on energy resources, and reserves and relation of resources to future options. Energy demand models prices and elasticities, concepts of economic

growth, energy gape concepts, operation research techniques in energy modeling.

Energy Transmission & Utilization: Quality and economics criteria in selection of energy equipment and processes.

Waste Heat Recovery System: Thermal wheels, heat pipes, turbo expanders, heat pumps and the co-generation of heat and power for both heating and cooling systems. Design and balance of total energy systems.

Energy Resources: Fossil and derived fuels, exploration and production techniques. Renewal fuels, solar radiation wind power, wave and tidal energy, bio-fuels, geo-thermal, refuse driven.

Solar Energy Conversion Systems: Solar energy and its conversion for use of society, fundamentals of solar radiation, solar collection and thermal conversion systems. Components, economics of solar power.

ME 543 Combustion Engineering

Principles of Combustion: Thermochemistry, equilibrium, chemical kinetics, flame temperature, flame velocity, flame stability, diffusion flames, spry combustion, detonation, equations of motion including reaction, heat and diffusion.

Application of Combustion: Discussion of combustion problem including pollution fire explosion hazards furnace combustion chambers combusters for reciprocating engineers jets and rockets.

Boiler: Modular sectional and condensing types, burners for fuel, gases liquid and solid fuels and part load characteristics, safety supply, storage, solid fuel storage, mechanical handling, automatic stockers and ash disposals. Fuels and chimney natural and forced draught operation with and without acid condensation. Flue dilution systems, gas analysis for efficiency and pollution monitoring. Control application and feed back the theory to produce practical systems for plant and zone / emitter output controls on off. Step and analogue controls, centralized systems and modern computer control using optimization, self adaptive and self tuning conditions and energy monitoring. Standard, legal aspects, codes of practice for design, installation, operation, insurance and safety.

Environmental Issues: Flue emissions, CO, CO_2 , NO_X , particulars and combustible emissions, acid, rains, asbestos removal.

ME 544 Advanced Heat Transfer

Conduction: Review of analytical methods in heat conduction, melting and freezing, sources and

sinks, anisotropic and composites media, numerical methods for steady and unsteady state problems. Numerical methods for solution of steady and unsteady state conduction problems.

Convection: Analysis of isothermal and non-isothermal boundary layers. Exact and approximate solution of laminar and turbulent flow, variable property and high speed effect, the dimensional analysis. Navier-Stokes equations numerical solutions by velocity and temperature fields in boundary layers of simple and complex shapes.

Radiation Heat Transfer: Radiation properties; black body radiation, shape factor of radiations, net work analogy, and solar radiation.

ME 545 Renewable Energy

Biomass Resources and Conversion: Biomass resources and use for energy. Direct combustion; stove and furnace design Thermochemical conversion; pyrolysis (Charcoal), gasification, liquid fuels. Biochemical conversion; anaerobic digestion, fermentation to alcohol. Physical processing; briquetting, Combustion process. Use of biomass derived fuels in engines.

Hydro Resources (Micro-Hydropower and Pumps): Active and passive components in hydraulic systems and energy transfer. Hydraulic machine types; positive displacement and rotodynamic. Affinity laws and specific speed related to rotodynamic machines, Mini and micro hydro. Turbine types. Pumps run as turbines. End use applications. site evaluations. Hydrological information. Specific aspects of plant design and installation. Water powered pumping devices. Free current water wheels and turbines. Hydraulic ram pumps. Electrical machines.

Solar Energy Resources and Conversion: Solar radiation: passage through the atmosphere; geometry; amount available on earth; solar data. Solar thermal collectors: glazing, evacuation, selective surfaces, concentrators. Solar thermal applications: water and space heating; solar ponds, dryers; distillation. Principles of photovoltaic cells, batteries and inventors. Photovoltaic systems and applications: system sizing; water pumping; lighting and domestic systems; refrigeration.

Wind Energy Resources and Conversion: Wind statistics: wind velocity duration distribution. Historical overview. Horizontal axis and vertical axis wind turbine types. Actuator disc model. Betz performance limit. Effects of solidity, tip speed ration and lift / drag ratio. Practical design considerations. Energy output and its dependence on rated wind speed. Shut down speed. Electricity generating wind turbines and their system integration.

ME 546 Energy Planning

Energy Economics and Planning: Energy economics. The nature and causes of the energy problems. The magnitude of the problems: present and future. Demand-side issues:

determinants; interfueld substitution. Supply-side issues: commercial energy determinants; traditional energy determinants; externalities. Policy issues: pricing policies; distribution issues; energy balances; formulation and execution.

National energy statistics. Definitions of primary, secondary, delivered and useful energy. Problems of interpolation and comparison of energy statistics.

Rural Energy Planning: Patterns of energy demand and supply. Socioeconomic aspects of energy use. Survey methods. Identifying potential solution to needs. Matching solutions to needs. Project planning, monitoring and evaluation.

Financial Evaluation Projects: Project analysis and financial appraisal: discounted cash flow. concept of time preference discount rates. Inflation and interest rates. Project evaluation in terms of present values and internal.

ME 547 Advanced Air-Conditioning & Refrigeration

General: In-door design conditions, outdoor air design conditions, heat gains, heat losses, air diffusion, supply and extraction air flow rates. Advanced psychometry applied to multizone air conditioning system. Mathematical modeling, computer simulations. System using 100% outdoor air re-circulations, year round operation of plants, free cooling systems zone and effect of ventilation requirements. Compression of systems including variable air volume, dual duct induction unit, fan coil unitary heat pump system, self-contained units, Thermal storage. Water steam and ultrasonic types, Legiorznarivies disease and humidifier fever, water treatment.

System Analysis: Heat recovery system efficiency, thermal wheel (regenerator), heat pipes, parallel plate heat exchanger, run around systems; heat pumps. Building fabric heat gains and heat loses. Solar heat gains, glazing types of glasses, transient heating and cooling of building. The structure as climate modifier summer time temperature. Ducted air systems, pressure losses and duct sizing
procedure. Layout considerations. Smoke and fire preventions. Fan types, characteristics and fan laws. Fan noise and energy consumption. Control applications to system, sensing elements, controllers and converting units. Transient analysis of feed back systems. Frequency response analysis system identifications. Stability analysis and compensation Modern Control Theory. Energy consumption Equivalent hours of full load operation. Bin method of predicting annual energy consumption. Variations in system efficiency. Load diagrams and scheduling.

Refrigeration: Review of refrigeration plant for domestic commercial and industrial applications. Variable refrigerant volume air-conditioning system. New development use of alternative compounds. Design for minimum refrigerant quantity refrigerant recovery. Energy efficiency refrigeration cycle, design and influence on reliability. Oil transportation around the system and oil recovery. The application of low and high pressure receivers compensating chambers. Cascade and multi-stage refrigeration system. Multi evaporator and multi

compression system. Rising liquid and suction mains cross connection refrigerant liquid level controllers. Control of plants.

Analysis of Cycles: Vapor compression, lithium bromide / water, water / ammonia solutions, compression with vapor compression system, thermodynamic cycles applied to food and process refrigeration low temperature processes.

Vapor Compression System Analysis: Balance points and system simulation, compressor and condenser performance, condensing unit, graphic and simulation, mathematical analysis, evaporator performance.

ME 548 Advanced Fluid Mechanics

Fluid Dynamics: Laminar and turbulent boundary layer flow with and without heat transfer, boundary layer separation stability transition and control.

Kinematics and dynamics of flow of continuous media, Navier-Stokes equation, simplification, exact and approximate solution. irrational of hydrodynamics stability, turbulence, free shear flows, chemical reactions, and shock expansion.

Rotating Fluid Machinery: Aero dynamics of compressors & turbines, subsonic, transonic and supersonic flow characteristics, secondary flow and stall stability, components matching of total nondimensional representation of performance.

ME 549 Desalination

Desalination Science: Revision courses in Fluid Mechanics, Heat Transfer, Thermodynamics, Chemistry, and Introduction to desalination process basic. (Reverse Osmosis, Electrodialysis, Distillation etc.)

Distillation Engineering: Thermal distillation process, Multistage Distillation Process (M S F), Multiple Effect Boiling Process (MEB) Thermal Vapor Compression Process (TVC), Mechanical Vapor Compression Process etc. Solar desalination; Freeze Desalination Process.

Membrane Process Engineering: Reverse Osmosis process, Ultrafiltration process, Pervaporation; Electrodialysis process, Feed treatment, Post treatment. Prevention and membrane distillation process, Corrosion problems in desalination. Instrumentation & Control, fouling, material selection, Industrial practice, Computing.

ME 550 Numerical Methods in Heat Transfer

Methods of prediction: Experimental investigation and analytical methods; their limitation and strength.

Equations governing transport phenomena: Energy equation, mass conservation equation, momentum equation, Kε-dissipation equation, Physical meaning of parabolic, elliptic and

hyperbolic equations.

Discretization methods: Introduction to method of deriving discretization equations; control volume formulation; numerical solution of heat conduction problem; steady and un-steady one dimensional conduction; two and three dimensional problems; solution of algebraic equation; relaxation.

Convection and Diffusion: Different schemes in comparisons to exact solution; discretization one; tow and three dimensions; boundary condition; false diffusion.

Calculation of the flow filed: Need for a staggered grid; pressure and velocity corrections; SIMPLE and SIMPLER algorithms; different applications.

ME 551 Introductions to Computational Fluid Dynamics

Review of Fluid Transport Equations: Continuity Equation, Momentum Equations, Vorticity Transport Equation, Stream Function Equation, Heat and Mass Transport Equations, Turbulence Transport Equation.

Classification and Application of Partial Differential Equations: Elliptic, parabolic and hyperbolic partial differential equations, Laplace Equation, Heat Equation, Wave Equation, Burger's Equation.

Methods of Discretization of Partial Differential Equations: Taylor Series Expansion, Polynomial Curve Fitting, Galerkin's Integral Method, Control-Volume Method.

Error Analysis: Truncation Errors, Round-off Errors, Aliasing Errors.

Stability Analysis and Convergence: Discrete Perturbation Stability Analysis, Von Nuemann Stability Analysis.

Numerical Solution Methods: Explicit and Implicit Methods, Upwind Differencing, Power Law and Hybrid Differencing. The SIMPLE scheme, The QUICK scheme.

Grid generation, types and grid refinement: uniform, non-uniform, simple, staggered and boundary-fitted grids.

Implementation of Boundary Conditions: Numerical Treatment of Dirichlet, Nuemann, and Mixed type boundary conditions.

Implementation of Boundary Conditions: Numerical Treatment of Dirichlet, Nuemann, and Mixed type boundary conditions.

Hands on experience with CFD software.

ME 552 Turbulence Modeling

Introduction to Turbulence: Observation of different turbulent Flows, Characteristics of

turbulent flows, Turbulent wall-bounded flows, Turbulent free-shear flows, Turbulent equilibrium flows, Near-wall region, Turbulent flows and drag reduction.

Mathematical Background Review*: Tensor Operations, Fourier-transformation, Buckingham theorem.

Continuum Mechanics & Turbulence: Balance equations, Transport equations of turbulent flows, transport equation for velocity field, transport equation for scalar field.

The Eddy Viscosity concept: Boussinessq Analogy, The eddy viscosity, short-coming of eddy viscosity concept

Zero Equation Models: Prescribed Eddy viscosity, Mixing-length hypothesis, Pro & cons of zero equation model

One Equation Models: Exact equation for k, Modeled equation for k, Determination of model coefficients, specification of mixing length

Scalar-flux models: The turbulent Prandtl number, scalar-flux transport equation, algebraic scalar-flux models, introduction to advanced models and use of CFD codes.

TE 505 Advanced Statistics

Probability Distributions & Transformation of Variables: Uniform, Binomial, Hypergeometric, Poisson, Normal, Exponentional, Chi-square, F, & T distributions: Random sampling: Sampling distribution of mean; Central limit theorem.

Statistical Inference & Hypothesis Testing: Confidence & significance level; Sample size determination; Point & interval estimates; Interval estimates for population mean, population standard deviation, & population proportion. Type I, & type II errors; One tail & two tail tests; Tests concerning means & variances.

Linear & Multiple Linear Regression & Correlation: Simple linear regression; Properties of least square estimates; Confidence limits & tests of significance; Choice of a regression model; Correlation. Estimating the coefficients; Adequacy of the model.

Analysis of Variance: One way classification; Tests for the equality of several variances; Single degree of freedom comparisons; Multiple range test; Comparing treatment with a control; Comparing a set of treatments in blocks; Randomized complete block design; Random effects model.

Factorial Experiments: Two-factor experiments; Interaction in two-factor experiments; Two-factor analysis of variance; Three-factor analysis; Choice of sample size.

2^k Factorial Experiments: Yate's technique for computing contrasts; Factorial experiments in incomplete blocks; Fractional factorial experiments; Analysis of fractional factorial experiments.

EM 504 Project Management Framework and Tools

Role of projects in organization's competitive strategy; Standard methodologies for managing projects; Project life cycle; Design-Implementation Interface; Estimation: preliminary and detailed; Contractual risk allocation; Scheduling: PBS; WBS; Integration of scope, time, resource and cost dimensions of a project; Evaluation of labour, material, equipment and subcontract resources; Scheduling techniques including CPM/PERT, GERT, critical chain; Cash flow analysis; Earned value analysis; Cost control; Proposal presentation; Application of software of project management (MS Project, P3).

MS 552 Applied Mathematics-II

Analysis of Variance: One way classification; Tests for the equality of several variances; Single degree of freedom comparisons; Multiple range test; Comparing treatment with a control; Comparing a set of treatments in blocks; Randomized complete block design; Random effects model.

Factorial Experiments: Two-factor experiments; Interaction in two-factor experiments; Two-factor analysis of variance; Three-factor analysis; Choice of sample size.

2^k Factorial Experiments: Yate's technique for computing contrasts; Factorial experiments in incomplete blocks; Fractional factorial experiments; Analysis of fractional factorial experiments.

MS 553 Computer Applications

Hardware: Basic structure of a digital computer; CPU; Types of memory; Input/Output section; Data representation; Binary numbering system; Peripheral devices.

Software: Computer programming languages; Machine language; High level languages; operating systems; virtual storage; Time sharing; Distributed processing.

Role of Computers in Engineering: Applications of computers in engineering problems including design and simulation. Use of Computer Aided Engineering software & Mathematical modeling.

Hierarchy of computers; Local area networks; Manufacturing automation protocol; Management information system; Manufacturing data base; Functions of a manufacturing organization; Hierarchical computer control concept.

MC-501 Electrical and Electronic for Mechanical Engineers

DC Analysis: Kirchhoff Laws, Mesh and Nodal Analysis, Network Theorems: Superposition, Thevinin's and Norton's, Capacitor and Inductor, First and Second-order Networks.

AC Analysis: Circuit Analysis, Single and Three-phase Systems, Real Power and Reactive Power, Power Factor and Correction.

Diodes and Transistors: P and N-type Semiconductor, Diode Applications & Special Purpose Diodes, Transistor Structure and Operation, Bipolar Junction Transistors (BJT) based Amplifiers, BJT as a Switch, Field Effect Transistor (FET) Structure and Operation, FET based Amplifiers, FET as a Switch, Operational Amplifier and Applications.

Digital Systems and Applications: Number System and Logic Gates, Combinational logic circuits and functions, Flip Flop-Counters & Registers, A/D & D/A Conversion and different Applications.

MC-502 Introduction to A.I & Computer Architecture

Types of Intelligence, AI concepts and techniques, AI Programming Languages, LISP, Prolog, predicate calculus, automated reasoning. Knowledge representation with emphasis on Expert Systems, Searching Algorithms, search and optimisation, heuristic search paradigms, game programming.

Components of a Computer System: CPU: ALU and Control Unit, Visible Processor Architecture, Internal Registers, Cache and Main Memory Overview, I/O Subsystem, Programmed and Interrupt Driven I/O, Direct Memory Access, I/O Channels and I/O processors, Microprocessor as building block of a computer.

MC-511 Sensors & Actuators

Sensing Principle: Introduction to Sensing, Static and Dynamic Characteristics of Sensors, Motion and Dimensional Sensors, Force, Torque, and Power Sensors, Pressure, Fluid Flow and Temperature Sensors.

Electrical Actuators: Electro-Magnetic Principle, Classification of Electrical Actuators, DC and AC Motors Modelling and Drivers, Stepper Motors Modelling and Drivers.

Hydraulic and Pneumatic Actuators: Description of Fluid Behaviour, Hydraulic Actuator and System, Pneumatic Actuator and System.

Selection and Applications of Sensors & Actuators: Technological properties, accuracy and precision, response time, Stability, Cost, Applications in process and other industries, Interfacing of sensing devices and actuators to computer systems.

MC-512 Computer Aided Mechanical Design

Introduction to Computer-Aided Design: Engineering design process, CAD/CAM system concept, CAD/CAM hardware and software.

Graphics Concepts: Coordinate transformations (translation, rotation, scaling, and reflection), Projections (parallel vs. perspective, orthographic vs. oblique, isometric), Shading & smoothing.

Geometric Modelling Systems: Set operations, Constructive solid geometry, Boundary representation, and solid modelling methods. Representation of Curves: Parametric and feature-based design, Analytic curves such as line, circle, ellipse, parabola, and hyperbola, Synthetic curves such as cubic spline, Bezier, B-spline, NURBS, Manipulation of curves (segmentation, trimming, blending, offsetting), Re-parameterization of free form curves.

Representation of Surfaces: Analytic surfaces such as plane, cylinder, sphere, Synthetic surfaces such as ruled, revolution, bi-cubic spline, Bezier, B-spline, and Coons. Manipulation of surfaces (segmentation, trimming, blending, offsetting), Surface modelling in Commercial CAD software.

CAD/CAM Data Exchange: Data types and exchange methods (direct, indirect), Neutral data exchange format (IGES, STEP); Numerical Control: CNC machines and their programming; CAD Applications in Mechanical Engineering.

MC-513 Control Theory & Systems

Overview of Classical Control Theory: System Modelling; Transfer Function, Stability, Transient and Steady-State Responses, Frequency Response, Graphical Methods, PID Control, Lead-Log Control, System Identification.

Digital Control Theory: Sampling, Discrete-Time Modelling, Zero-Order Hold Circuit, Pulse Transfer Function, Response Analysis, Position and Velocity Algorithms, Direct Design of Digital Control Algorithm.

State-Space Control Theory: State-Space Modelling and Representation, Transfer Function, Stability, Controllability and Observe-ability, Regulator and Observer Design, Compensator Design by the Separation Principle.

Optimal Control Theory: Linear Quadratic Regulator, Random Processes, Kalman Filters, Optimal Observers, Linear Quadratic Gaussian Control, and Separation Theorem.

MC-514 Kinematics & Rigid Body Dynamics

The Components of Mechanism: Review of Classical Mechanics, Joints, Pairs and Couplings, Mobility, Grashof's Law.

Planar Kinematics Analysis and Modelling: Analytical Methods for Kinematic Analysis, Kinematic Analysis of Pin Connected, Slider-Crank and Direct Contact Mechanisms, Graphical Methods, Velocity and Acceleration Analysis by Vector Mathematics.

Linkage Design: Four Bar Mechanism and Crank-Rocker Mechanism, Drag-Link Mechanism; Designing for Prescribed Velocity or Torque, Function Generators.

Dynamics of Planar Systems: Static Force Analysis, Planar Dynamic Force Analysis, Methods of Linkage Force Analysis, Force Calculations for Gears and Cams, Gyroscopic Forces, Dynamic Modelling and Analysis Techniques Using ADAMS.

Spatial Mechanisms: Mobility, Describing Spatial Motions, Kinematic Analysis of Spatial Mechanisms; Manipulator Kinematics: Homogeneous Transformations, Review of Robot Kinematics; Trajectory Planning: Joint Space Trajectories Point to Point and Continuous Path Motion Cartesian Space Schemes.

Manipulator Dynamics and Control: Lagrange and Newton-Euler Formulation for Manipulator Dynamics, Robot Control, Proportional Integral Derivative (PID) Control, Feed-forward Control.

MC-515 Industrial Automation & Robotics

Principles of Automation: Automation System Components, Discrete Manufacturing Automation, Continuous Process Automation, Strategy for Automation.

Programmable Logic Controllers (PLC): Industrial Control Overview, Structure of PLC, Programming Languages for PLC, Boolean Logic for Process Control, Timers, Counters and Other Functions and Applications.

Digital Communication: Evolution of Factory Communication, Communication Architectures, Open Systems Interconnection, Communication over Public Networks, Description of Selected Automation Buses and Field bus Architecture and Protocol, Intelligent Sensors and Actuators.

Man-Machine Communication: Psychological Considerations, Interface Design Principles, Supervisory Control and Data Acquisition (SCADA); Industrial Robotics: Robots and Manufacturing Automation, Robot Geometry, Economic Evaluation and Justification for Robots and Automation.

MC-521 Advanced Industrial Process Control

A Review of the Fundamentals of Process Control: On/Off, Proportional, Integral, and Derivative; Cascade Control: Principles and application of cascade control, Software cascade controller laboratory; Ratio Control: Principles and application of cascade control, Software cascade controller laboratory.

Dead Time Control: Principles and application of cascade control, Software cascade controller laboratory; Feed forward Control: Principles and application of cascade control, Software cascade controller laboratory.

Nonlinear Compensation and Adaptive Control: Nonlinearities, Compensation for nonlinearities, Role of adaptive tuning, General applications of adaptive control concepts.

Multivariable Control: Control Loop Interactions, relative gain arrays, Software applications of multivariable control; Fuzzy Logic and Processor Controller Tuning: Digital Process Control Systems, Modern Paradigms.

MC-523 Mechanical Design of Mechatronics Systems

Introduction of Mechatronics System Design: Components of mechatronics system, Engineering design process, Development of design specifications; Pneumatic and Hydraulic Actuation systems: Power supplies, Control valves, Actuators, Process control valves, Hydraulic amplifier, Hydraulic intensifiers.

Mechanical System Elements: Springs, Dampers, Mechanical capacitance elements, Mechanical transformers, Mechanical gyrators, Threaded fasteners and power screws, Bearings, Gears, Shafts and associated parts, Clutches and brakes, End effectors and grippers.

Mechanical Actuation Systems: Four-bar mechanisms, Slider-crank mechanisms, Cam-follower systems, Gear trains, Belt and chain drives. Examples of Classical and Modern Mechanisms: Geneva and star-wheel mechanisms, Screw mechanisms, Clamping mechanisms, Snap-action switching mechanisms, Detent and ratchet mechanisms, Couplings and joints.

MC-525 Electrical Machines & Power Electronics

Electrical Machines: Design of transformers, DC machines, Single phase and three phase induction motors, Design of synchronous machines.

Power Electronics: Introduction and Scope, Solid State Devices used as switches in power electronics, power diodes, power transistors, Power MOSFETS, Thyristors, Triacs, Diac, Characteristics of Gate Turn-off Thyristor (GTO), and Reverse Conducting Thyristors (RCT). Series and parallel operation of SCR, LASCR, Thyristor turn on, Integral cycle control and phase angle control, Elementary and advanced firing schemes, Sequence and close loop control. Thyristor Commutation: Self commutation, Impulse commutation, Series capacitor commutation, Parallel capacitor commutation.

Uncontrolled and Controlled Rectifier: Single phase, three phase, Semi converter, Full converter, Dual converter, Analysis and performance, Parameters as harmonic factor, Utilization factor, Power factor, Distortion factor, Rectifiers with purely resistive, Highly inductive and RL loads, AC Voltage Controllers. DC Chopper: Principle, Step-up and Step-down operation, Buck regulator, boost regulator, Buck-boost regulator, Cuk regulator, Choppers using Thyristors.

Inverters: Principles, Half bridge and Full bridge inverters, Constant, Variable and Sinusoidal PW modulation, Modified Sinusoidal Pulse Width Modulation (SPWM); Protection Analysis: Over-voltage, Over-current, di/dt and dv/dt protection, Heat sinks; Electronic Power Supplies: Design and analysis of regulated Power supplies, Switch mode power supplies and Uninterrupted Power supplies.

MC-527 Microprocessor & Interfacing Applications

Microcomputer Structure and Operations: Basic Microcomputer Elements, Typical Microcomputer Structure, CPU, Memory System, Input-Output; Microprocessors* and Memory: Typical 8, 16 and 32-bit Microprocessors, 68HC11 Microprocessor Specification, Memory Technologies.

Assembly Language Programming I: Programming Model of 68HC11, Registers, Fetch, Execute Operation of CPU, Instruction Set; Assembly Language Programming II: Addressing Modes, Basic Operations, Microprocessor Arithmetic, Program Flow Control Using Looping and Branching; Assembly Language Programming III: Stack, Subroutines, Interrupts, Resets.

Bus System I: System Bus Structure, Bus Operation, Cycle by Cycle Operation, Timing and Control, Priority Management; Bus System II: Address Decoding, Mode of Operations of the 68HC11.

Microprocessors Interfacing I: Interfacing concepts, Parallel Input Output, Direct Memory Access; Microprocessors Interfacing II: The Serial Subsystems; Microprocessors Interfacing III: Programmable Timer Operations, Analog Converter Subsystems; Application Examples: Process Control, Robotics, CAI, Medical Physics.

MC-529 Mathematical Modelling and Simulation

Principles of modelling and simulation: Introduction, Model categories, Fields of application, Model development, Model verification and validation, Model simplification, Simulators and simulation, Laplace transformation.

Mathematical Modelling: Mechanical systems (springs, dampers, mass, translational and rotational systems, geared systems), Electrical and electromechanical systems (capacitor, inductor, resistors, analog electronic devices), Hydraulic and pneumatic systems, Thermal systems.

Identification and Simulation: Non-parametric methods transient, Correlation, frequency, Fourier and spectra analysis, Parametric Methods fitting parameterized models to data, Design of identification experiments, Post treatment of data, Choice of model structure, Scaling, Block diagrams, Numeric methods, Model validation and model use, Time response and digital simulation, Stochastic simulation, Monte Carlo methods, Lagrangian optimization and optimal control strategies in mechatronics, Use of computer simulation with MATLAB, SIMULINK and ADAMS/View.

ME-531 Computer Aided Manufacturing

CNC Machine Tools: A historical perspective, Principal of numerical control, Typical CNC machine tools, Tooling for CNC machines, Principal elements of a CNC machine, Axis and motion of CNC machines, Economics and justification.

NC Part Programming: Punched tape in NC, Tape coding and format, Manual part programming, Computer assisted part programming, The APT language, NC programming with interactive graphics, Manual data input, APT word definitions.

CNC Milling Programming: Basic programming commands, Compensation and offset, Fixed cycles, Macro and subroutine programming, Tooling system for CNC milling.

Fundamentals of Sculptured Surface Machining: Introduction to sculptured surface machining, Mathematical background, Sculptured surface machining processes, Process planning for sculptured surface machining, Fundamentals of tool-path generation and validation, Project.

Tool-Path Generation Methods for 3-Axis Sculptured Surface Machining: Introduction to 3-axis CNC tool paths, Types of 3-axis CNC tool paths, Iso-parametric tool Paths, Parallel tool Paths, Iso-cusps tool Paths, Steepest-ascending tool Paths, Project.

Automated Manufacturing Systems: Schemes for concurrent engineering, Axiomatic design, DFM guidelines, Design for assembly, The Taguchi method for robust design, Manufacturing process design rules, Computer-Aided DFM, Group technology, Failure-Mode and Effects Analysis.

Programming in MATLAB: Basic programming concepts, Import CAD data from CAD/CAM software, Tool path generation in MATLAB, Project.

MC-533 Artificial Intelligence & Neural Networks

Machine Intelligence Technologies (Neural Networks): Introduction to Neural Networks, Perception Learning Rule, Hebbian, and Widrow-Hoff Learning, Back propagation, Associative Learning, Competitive and Grossberg Networks. Adaptive Resonance Theory, Hopfield Networks.

Fuzzy Set Theory: Fuzzy Set with Properties, Fuzzy Relations, Fuzzy Arithmetic, Fuzzy Logic, Applications and Fuzzy Control.

Genetic Algorithm: Genetic Algorithm Operations, Standard, Rank, and Rank Space Method; Simulated Annealing: Annealing Process, Simulated Annealing Optimization; Particle Swarm Optimization: Swarm Behaviour, Particle Swarm Optimization.

Artificial Intelligence: Semantic Nets and Description Matching, Generate and Test, Means-Ends Analysis, and Problem Reduction, Nets, Basic Search, and Optimal Search, Trees and Adversarial Search, Rules, Rule Chaining and Planning.

MC-537 RELIABILITY ENGINEERING

Introduction to Statistics: Concepts related to statistics & probability; Distributions including Binomial, Hyper-geometric, Poisson, Normal, Exponential, Weibull, Log Normal, Gamma and Extreme Distributions; Goodness of fit.

Reliability Measures: Reliability Function; Expected Life; Failure Rate and Hazard Function; Reliability and Hazard Function for well known Distributions such as Exponential, Normal, Log Normal, Weibull and Gamma; Hazard Models and Product Life; Constant Hazard Function; Linearly Increasing Hazard Function; Piecewise Bathtub Hazard Function, Power Function Model, Exponential Model.

Reliability Models: Series System, Parallel System, Series & Parallel Combinations, Complex System Analysis (Enumeration, Conditional Probability and, Cut-set Methods), Reliability Considerations in Design.

Reliability in Engineering Design: Reliability Design Methodologies, Strength and Stress Distributions, Safety Factor and Reliability, Reliability Bonds in Probabilistic Design; Transformation of Random Variables, Sum and Differences of Normal Random Variables, Error Analysis, Statistical Tolerance.

Interface Theory and Reliability Computations: General Expression for Reliability; Reliability Computations for Normally, Log Normally, Exponentially, Gamma and Weibull Distributed Stress and Strength.

Reliability in Design and Testing: Dynamic Reliability Models, Reliability Estimation, Sequential Life Testing, Bayesian Reliability in Design and Testing, Reliability Optimization.

Maintainability & Availability: Concepts; Definitions; Preventive Maintenance; Repair Time Distributions; Availability Analysis

MC-539 Micro & Nano Electromechanical Systems

Introduction: Evolution of Micro-sensors and Micro-actuators, MEMS Overview, Emergence of Micro-machines, MEMS Applications; Fundamentals of MEMS Fabrication: Introduction and Description of Basic Processes, Bulk Micromachining, Surface Micromachining, Micro-stereo Lithography for MEMS.

Principles of Micro-sensors and Their Fabrication: Fabrication, Examples of Micro-sensors; Principles of Micro-actuators: Electric Field Driven Actuators, Piezoelectric and Magnetic Field Driven Actuator, Examples of Micro-actuators.

Computer Aided Design of MEMS: Modelling, Analysis and Simulation, MEMS Design Layout, MEMS Design Simulation using Finite Element Analysis.

Nano-materials & Nanotechnology: Perspectives of Nanotechnology, History of nano-materials, The Business of Nanotechnology, present and future applications of nano-materials.

MC-541 Digital Image Processing & Machine Vision

Introduction: Human Vision vs. Machine Vision, Scene Constraints, Optics.

Image Acquisition and Pre-processing: Sensors for Image Acquisition, Camera Interfaces and Video Standards, Image Sampling and Quantization, Image Pre-processing (Point, Global and Neighbourhood Operations), Image Filters, Edge Detection Techniques.

Image Analysis Techniques: Image Segmentation, Edge Based and Region Based Segmentation, Edge Linking and Boundary Detection, Matching, Image Feature Extraction, Mathematical Morphology.

Image Transforms: Continuous Image Mathematical Characterization, Discrete Image Mathematical Characterization, Discrete Fourier Transform, Other Image Transforms; Object Recognition and Image Understanding: Knowledge representation, Pattern Classification, Neural Nets.

Advanced Research Areas in Machine Vision: Geometry for 3D Vision, 3D Objects Representation and Modelling Techniques, Machine Vision: Robot Vision and Industrial Application.

MC-543 Applied Programmable Logic Controls

Discussion Topics: Introduction and installation of S7-200 Micro PLC, Installation of Step7-Micro/WIN Software, Communication overview, Introduction of PLC programming with a sample program, Basic concepts for programming S7-200 CPU, Data types and addressing modes, Symbols for PLC ladder diagrams, Using PLC software to create ladder diagrams and PLC programs, Check the ladder diagram using a software simulator, Connection of input/output devices to PLCs.

Instruction set for PLC programming: Instructions for Bit Logic, Compare, Timer, Counter, Integer math, Real math, Move, Fill, & Table, Logical operation, Shift and Rotate, Conversion, Interrupt & Communications, and Increment & Decrement Instructions, Troubleshooting techniques.

Hands-On Activities: Trigger a stepper motor drive using integrated DC pulse output, Track how long a device has been operating, Timing for staircase lighting, Traffic signal, Queuing system in a bank, Reversible motor starter circuit for changing the rotational direction of three-phase AC induction motor, Star-Delta motor starter.

MC-545 Advanced Robotics

Introduction: Robot anatomy, Classification of robots, Economic considerations, Robotic applications; Welding, Spray painting, Grinding, Parts handling/transfer, Assembly operations, Parts inspection, Medical, Hazardous working environment. Basic components of a robot; The manipulator, Sensory devices, Controller, Power conversion unit.

Mechanical Systems: Translation or Linear motion, Rotational motion, Mechanical work and power. Motion conversion, Rotary-to-rotary, Rotary-to-linear, linkages, couplers, and power transfer.

Control of Actuators in Robotic Mechanism: Closed-loop control in a position servo, Control of a robotic joint, Stepper Motors, Brushless DC motors, Direct-drive actuators, Hydraulic actuators, and Pneumatic systems. Robotic Sensory Devices: Non-optical position, Optical position, Velocity, Accelerometer, and Proximity sensors, Touch and slip sensors. Robot programming and Path planning.

Transformation and Kinematics: Homogeneous coordinates, Homogeneous transformation and

the manipulator, the forward and backward solution, Motion generation, The Jacobian, Motor selection for the robotic joint.

Advance application of Robots: Snake-like Robots: Biomechanical study of snakes, Mobile Robots, Walking robots, and Medical Robots.

ME 504 Finite Element Analysis

FEA of One-dimensional Problems: Introduction, Basic Steps in FEA; Modelling, Discretization, Connectivity of Elements, Imposition of Boundary Conditions, Solutions & Post Processing; Applications to Heat Transfer, Fluid Mechanics, & Solid Mechanics Problems.

Bending of Beams: Euler-Bernoulli Beam Element, Governing Equations, Application of FE on Beam, Beam Examples, Plane Truss Element, Frame Element, Timoshenko Beam & Frame Element, and Inclusion of Constraint Equations.

Finite Element Error Analysis: Approximation Errors, Various Measures of Errors, Convergence of Solutions, Accuracy of Solutions; Numerical Integration & Computer Implementation: Isoperimetric Formulations, Numerical Integrations, Natural Coordinates, Computer Implementation (Pre-processor, Processor, Post-processor).

FEA-Two Dimensional Problems: Introduction, Single Variable Problems; Boundary Value Problems; Model Equations, Discretization, Weak Form, Finite Element Model, Assembly, Solutions & post processing; Mesh Generation; Imposition of Boundary Conditions, Applications; Parabolic Equations; Hyperbolic Equations.

Interpolating Functions, Numerical Integrations & Modelling Considerations: Interpolating Techniques; Triangular, Rectangular & Serendipity Elements; Coordinate Transformation; Integration on a Master Element; Modelling, Mesh Generation, Load Representation.

Plane Elasticity: Assumption of Plane Elasticity; Basic Equations, Weak Formulations; Principle of Virtual Displacement in Matrix Form; Finite Element Model, Matrix & Weak Form Model; Evaluation of Integrals.

Bending of Elastic Plates: Classical Plate Model; Finite Element Model; Shear Deformable Plate Model; Displacement field, Virtual Work Statement; Shear Locking and Reduced Integration; Introduction to Time Dependent Problems; Computer Illustrative Examples.

EE-512 Advanced Digital Signal Processing

Review of discrete signals and systems in temporal and spectral domains, data acquisition, discrete transforms: Discrete Fourier Transform (DFT), Discrete Cosine Transform (DCT), and z-transforms, Digital filters: Infinite Impulse Response (IIR), and Finite Impulse Response (FIR), spectral estimation, adaptive filters, multi-rate signal processing, wavelets and joint time-frequency analysis, and real-time signal processing.