

## **FIRST YEAR**

### **FALL SEMESTER**

#### **CY-111 Applied Chemistry**

- **Gases:** Gas Laws. Kinetic gas equation. Vander Waal's Equation, Critical phenomenon. Liquidification of gases, specific heat (molar heat capacity), properties of Solution Surface Tension, Viscosity, Osmosis and Osmotic Pressure.
- **PH-Buffer Solution & Liquids:** Spectrophotometer, Basic concepts of Colloidal Chemistry. Classification purification (dialysis).
- **Thermo-chemistry:** Chemical thermodynamics, Hess's Law. Heat of reaction, Bomb Calorimeter, Relation between H and U measurement of heat reaction.
- **Electrochemistry:** Laws of Electrolysis. E.M.F. series. Corrosion (Theories, inhibition & protection)
- **Water & Sewage:** Sources of water, impurities, hardness, water softening, purification of water for potable and industrial purposes, electro-dialysis and introduction to environmental pollution. Main sources and effects. Sewage treatment.
- **Fuels:** Types of fuels. classification of fossil fuels.
- **Metals & Alloys:** Properties and general composition of metals and alloys such as Iron. Copper. Aluminum. Chromium. Zinc used in engineering field Engineering Materials.
- **Inorganic Engineering Materials:** Cement. Class Organic engineering materials: Polymers. Rubbers. Plastics and Paints, Semiconductors and Dielectric.

#### **MT-114 Calculus**

- **Sets and Functions:** Define rational, irrational and real numbers: rounding off a numerical value to specified value to specified number of decimal places or significant figures: solving quadratic. and rational inequalities in involving modulus with graphical representation: Definition of set, operations. Venn diagrams, DeMorgan's laws, Cartesian product, Relation, Function and their types (Absolute value, greatest integer and combining functions). Graph of some well-known functions. Limit of functions and continuous and discontinuous functions with graphical representation.
- **Differential Calculus:** Differentiations and Successive differentiation and its application: Leibnitz theorem. Taylor and Maclaurin theorems with remainders in Cauchy and Lagrange form, power series. Taylor and Maclaurin series, L Hopitals rule, extreme value of a function of one variable using first and second derivative test, asymptotes of a function. Curvature and radius of curvature of a curve. Partial differentiation, exact differential and its application in computing errors, extreme values of a function of two variables with and without constraints. Solution of non-linear equation, using Newton Raphson method.
- **Integral Calculus:** Indefinite integrals and their computational techniques, reduction formulae, definite integrals and their convergence, Beta and Gamma functions and their identities, applications of integration Centre of pressure and depth of centre of pressure.
- **Sequence Series:** Sequence, Infinite Series, Application of convergence tests such as comparison. Root, Ratio, Raabe's and Gauss tests on the behavior of series.
- **Complex Numbers:** Argand diagram, De Moivre formula, root of polynomial equations, curve and regions in the complex plane, standard functions and their inverses (exponential, circular and Hyperbolic Functions).

## ME-111 Engineering Drawing

### Basics of Engineering Drawing

Drawing instruments and sheets; Importance of conventions and standards in engineering drawing

### Engineering Geometry

Geometrical construction of plane figures, conic sections, cycloidal curves and involute

### Multiview Drawing

Multiview projection and drawing using first and third angle projection methods

### Development of Surfaces

Development of prisms, pyramids, cylinders and cones

### Sectional Views

Sections of solids and machine components

### Pictorial Projections

Types of pictorial views and drawing isometric view

### Dimensioning and Tolerancing

Dimensioning techniques, size and geometric tolerance and their symbols, types of fits

### Intersection of Surfaces

Construction of curves from intersection of solids such as cones, cylinders, prisms and pyramids

### Freehand Sketching of Machine Components

Sketching of temporary and permanent fasteners like bolts, nuts and rivets, shaft couplings, connecting rod, bearings, pulleys, locking devices; Types of thread

### Assembly and Detail Drawing

Types of working drawing, construction of views of the assembled objects / components.

### System and Process Flow Diagrams

Construction of process flow diagrams; symbols for piping, instruments and equipment

## ME-104 Workshop Practice

- Use of carpenter's tools, Exercise in preparing simple joints, Bench fitting practice, Exercise in marking and fittings, Use of measuring instruments.
- Smith's forge, Exercise in bending, Upsetting and swaging.
- Familiarizing the students with the following processes:
  1. Soldering and brazing, Welding, Heat treatment, Molding, and casting.

Simple machine shop processes, such as turning, shaping, Milling and sheet metal work.

## HS-105 PAKISTAN STUDIES

- **Historical and Ideological perspective of Pakistan Movement:** Two Nation Theory, Definition; Claim of Muslims of being a separate nation from Hindus, based upon cultural diversity, Significance: Cultural diversity and interests led to the demand of Pakistan – Lahore resolution, Creation of Pakistan, Factors leading to the creation of Pakistan, Quaid-e-Azam and the demand of Pakistan.
- **Land of Pakistan:** Geo-physical condition, Geo-political and strategic importance of Pakistan, Natural resource, viz: mineral, water and power.
- **Constitutional Process:** Early efforts to make a constitution (1947 – 1956) problems and issues, Salient features of the constitution of 1956 and its abrogation., Salient features of the constitution of 1962 and its abrogation. Constitutional and political crisis of 1971, Salient features of the constitution of 1973, Constitutional developments since 1973 to date with special reference to the amendments to the constitutions.
- **Contemporary issues in Pakistan:** A brief survey of Pakistan Economy. An overview of

current economic situation in Pakistan: problems, issues and future prospects, Social Issues, Pakistani Society and Culture- Broad features. Citizenship: national and international, Literacy and education in Pakistan: problems and issues, State of Science and Technology in Pakistan: A comparison with other countries with special reference to the Muslim world, Environmental Issues, Environmental pollution and its hazard: causes, and solutions, Environmental issues in Pakistan: government policies and measures and suggestions for improvement. Pakistan's role in the preservation of nature through international conventions / treaties.

- **Pakistan's Foreign Policies:** Evolution of Pakistan foreign policy-1947 to date, A brief survey of Relation with Neighbors, Super Power & the Muslim World.
- **Human Rights:** Conceptual foundations of Human Rights, What are Human Rights? Definition, origins & significance, Comparative analysis of Islamic and Western Perspectives of Human rights, UN System for protection Human Rights, UN Charter, International Bill of Human Rights – an overview, Implementation mechanism, other important international treaties and conventions. The convention on the rights of child (CRC), Convention against torture (CAT), Other treaties and Convention. Pakistan's response to Human Rights at national and international levels, Constitutional Provision

## **HS-127 PAKISTAN STUDIES FOR FOREIGN STUDENTS**

### **Chapter 1 – Land of Pakistan**

- Land & People–Physical features and demography
- Geographical and strategic importance of Pakistan
- Natural resources–Mineral, water, and power
- Natural Landscape
- Environmental issues in Pakistan
- Cultural heritage: important remnants of ancient civilizations in Pakistan

### **Chapter 2 – Creation of Pakistan**

- A brief Historical survey of Muslim community in the sub-continent
- Two-Nation theory–its origin & development
- Rationale for Pakistan–Factors leading to the demand of Pakistan
- Emergence of Pakistan
- Role of Quaid-e-Azam the struggle for Pakistan

### **Chapter 3 – Government & Politics in Pakistan**

- Political History of Pakistan–A brief account (1947 to date)
- Constitution of Pakistan 1973–Salient features
- Governmental structure–Federal, Provincial and Local

### **Chapter 4 – Pakistan in the Community of Nations**

- An overview of Pakistan's foreign policy
- Relations of Pakistan with neighbors, Super Powers, and the Muslim World

### **Chapter 5 – Pakistan's Stand Point on Human Rights**

- Constitutional provisions
- Comparative analysis of Western and Islamic perspective of Human Rights

Pakistan's Stand on national and international level

## **ME-113 Computer Aided Drawing**

- **Fundamentals of CAD**

Introduction, The design process, Application of computers for design, Creating the manufacturing data base, Benefits of CAD.

- **Hardware in CAD**

The design workstation, Graphics terminal, Operator input devices, Plotters and other output devices, The central processing unit, Secondary storage.

- **Computer Graphics Software and Data Base**

The software configuration of a graphics system, functions of a graphic package, Constructing the geometry, Data base structure and content, Wire-frame versus solid modeling, other CAD features and CAD/CAM integration.

- **Mathematical Elements of CAD**

Two dimensional transformations, Translation, Scaling and rotation, Concatenation, Various techniques for design optimization, finite element analysis / modeling.

## **SPRING SEMESTER**

### **PH-112 Applied Physics**

- **Introduction:** Scientific notation and significant figures. Types of errors in semi-log and other non-linear graphs).
- **Vectors:** Review of vectors, Vector derivatives. Line and surface Integrals. Gradient of a scalar.
- **Mechanics:** The limits of Mechanics. Coordinate systems. Motion under constant acceleration, Newton laws and their applications. Galilean invariance. Uniform circular motion. Frictional forces. Work and Energy. Potential Energy. Energy Conservation. Energy and our Environment. Angular momentum
- **Electrostatics and Magnetism:** Coulombs Law. Electrostatic potential energy of discrete charges. Continuous charge distribution. Gauss's Law. Electric field around conductors. Dielectrics. Dual trace oscilloscope with demonstration. Magnetic fields. Magnetic force on current. Hall effect. Biot-Savart Law. Ampere's Law. Fields of rings and coils. Magnetic dipole. Diamagnetism, Para Magnetism and Ferromagnetism.
- **Semiconductor Physics:** Energy levels in a semiconductor. Hole concept. Intrinsic and Extrinsic regions. Law of Mass Action. P-N junction. Transistor. Simple circuits.
- **Waves and Oscillations:** Free oscillation of systems with one and more degrees of freedom Solution for Modes. Classical wave equation. Transverse modes for continuous string. Standing waves. Dispersion relation for waves. LC network and coupled pendulums. Plasma oscillations.
- **Optics and Laser:** Harmonic travelling waves in one dimension. Near and far fields. Two-slit interference. Huygens Principle. Single-slit diffraction. Resolving power of optical instruments. Diffraction Grating. Lasers. Population inversion. Resonant cavities. Quantum efficiency. He-Ne, Ruby and CO<sub>2</sub> lasers. Doppler effect and sonic boom.
- **Modern Physics:** Inadequacy of classical physics, Planck's explanations of black body radiation photoelectric effect, Compton effect. Bohr theory of Hydrogen atomic spectra, Reduce mass, De-Broglie hypothesis Braggs Law, Electron microscope, Uncertainty relations Modern atomic model, . Zeeman effect, Atomic nucleus, Mass-energy Relation, Binding energy, Nuclear forces and fundamental forces, Exponential decay and half-life. Radioactive equilibrium in a chain, Secular equilibrium, Nuclear stability, Radiation detection instruments, Alpha decay, Beta decay, Gamma decay attenuation Nuclear radiation hazards and safety, Medical uses

of Nuclear Radiation. Fission, Energy release. Nuclear Reactors. Breeder Reactor. Nuclear Fusion.

## **EA-111 Functional English**

### **Reading:**

- Reading skills importance & strategies
- Reading strategies: Previewing (Worksheets)

### **Reading practice through variety of reading texts and comprehension exercises**

- Study Reading: Study Text
- Reading Strategies: Skimming & Scanning
- Summarizing: Evaluation
- Vocabulary
- Interference
- Precis

### **Listening:**

- Types of listening; active, content, critical, selective
- Problems in listening and coping strategies
- Listening skills and sub skills

### **Note Taking:**

- Techniques for taking notes from lectures, from books (Lecture)
- Note taking in different forms paragraphs, points, figures, processes, tables, graphs etc (Worksheets)

### **Vocabulary Development:**

- Tips/strategies in vocabulary enhancement (Lecture + Worksheets)
- Practice in vocabulary development (Referred Book: English Vocabulary in Use by Michael McCarthy and Felicity O' Dell)
- Inferring meaning from context (Worksheets)
- Word formation (Worksheets)
- Idiomatic expressions (Worksheets)

### **Writing:**

- Process of Writing and Informal Writing strategies (Lecture)
- Writing correctly: sentence structure and punctuation, error correction (Classroom activity)

### **Paragraphs:**

- Structure and types (Lecture)
- Topic and the topic sentence (Lecture + Worksheets)
- Unity, adequate development and coherence in paragraphs (Worksheets)

### **Essays:**

- Types of essays: narrative, descriptive, argumentative (Lecture)
- Structure of essays: thesis statement and the paragraphs (Lecture+ Written Assignments)

### **Short Reports:**

- Structure and format (Lecture)
- Informational and analytical reports (Lecture + Written Assignments)

### **Letters:**

- Style, formatting (digital letter writing), organization and structure of the letter (Lecture)
- Types of letters: routine requests and intimation, invitation, thank you and condolence letters etc. (Lecture +Classroom Activity + Written Assignments)

### **ME-112 Thermodynamics**

- Introduction, Working substance, System, Pure substance, PVT surface, Phases, Properties and state, Units, Zeroth law, Processes and cycles, Conservation of mass.
- Relation of mass and energy, Different forms of energy, Internal energy and enthalpy, Work, Generalized work equation, Flow and non-flow processes, Closed systems, First law of Thermodynamics, Open systems and steady flow, Energy equation for steady flow, System boundaries, Perpetual motion of the first kind.
- Thermodynamic equilibrium, Reversibility, Specific heats and their relationship, Entropy, Second law of Thermodynamic property relation from energy equation, Frictional energy.
- Gas laws, Specific heats of an ideal gas, Dalton's law of partial pressure, Third law of Thermodynamics, Entropy of an ideal gas, Thermodynamic process.
- Cycle work, Thermal efficiency and heat rate, Carnot cycle, Sterling cycle, Reversed and reversible cycles, Most efficient engine.
- Clausius inequality, Availability and irreversibility, Steady flow system.
- Two phase system of a pure substance, Changes of phase at constant pressure, Steam tables, Superheated steam, Compressed liquid and vapour curves, Phase diagrams, Phase roles, Processes of vapours, Mollier diagram, Rankine cycle, Boilers and auxiliary equipment.
- Otto cycle, Diesel cycle, Dual combustion cycle, Four stroke and two stroke engines, Types of fuels.
- Condition for minimum work, Isothermal efficiency, Volumetric efficiency, Multi-stage compression, Energy balance for a two stage machine with intercooler.

### **ME-104 Workshop Practice**

- Use of carpenter's tools, Exercise in preparing simple joints, Bench fitting practice, Exercise in marking and fittings, Use of measuring instruments.
- Smith's forge, Exercise in bending, Upsetting and swaging.
- Familiarizing the students with the following processes:
  1. Soldering and brazing, Welding, Heat treatment, Molding, and casting.
  2. Simple machine shop processes, such as turning, shaping, Milling and sheet metal work.

## ME-115 Statics

- **Statics of Particles:** Forces in a plane, Equilibrium of a particle, Newton's first law, Free body diagram, Forces in space (rectangular components), Equilibrium of a particle in space.
- **Rigid Bodies:** Equivalent systems of forces, Principle of transmissibility, Moment of a force, Couple, Varignon's theorem.
- **Equilibrium of Rigid Bodies:** Free-body diagram, Equilibrium in two and three dimensions, Reaction at supports and connections, Equilibrium of two-force and three force bodies.
- **Analysis of Structures:** Internal forces and Newton's Third Law, Trusses, Simple and space trusses, Methods of joints and sections, Frames and machine analysis.
- **Forces in Beams and Cables:** Shear force and bending moment diagrams, Cables with concentrated and distributed loads.
- **Friction:** Laws of dry friction, Coefficient of friction and angles of friction, Wedges, Square-threaded screws, Journal and thrust bearings, Belt Friction.
- **Distributed Forces:** Centroids and centers of gravity, Areas and lines, Composite plates and wires, Distributed loads on beams, Forces on submerged surfaces, Center of gravity of a three dimensional body and centroid of a volume. Second moment of area and moments of inertia, Polar moment of inertia, Radius of gyration, Parallel axis theorem.
- **Method of Virtual Work:** Work of a force, Virtual work, Real machines and mechanical efficiency, Potential energy and equilibrium, stability of equilibrium.

## SECOND YEAR

### FALL SEMESTER

## ME-214 Computer Programming & Applications

- Introduction to computer programming, problem-solving techniques using computer programming, algorithms and flow-charts.
- Elements of programming language, basic data types, variables and constants, arrays, vectors, matrices, random numbers, arithmetic and logical operators, sequential and conditional execution
- Repetition and iterative execution, custom and built-in functions, libraries, elements of string processing, screen and file I/O
- Plotting and other data visualization techniques, sorting and searching data
- Numerical and analytical techniques for solving mechanical engineering problems, use of built-in thermo- physical property functions, system of linear equations, roots of a polynomial equation, interpolation, curve fitting and numerical integration.
- Use of a state-of-the-art programming language

## EE-124 Basic Electricity and Electronics

- **Fundamentals of Electric Circuits:** Charge, Current, Voltage and Power, Voltage and Current Sources. Ohm's Law
- **Voltage and Current Laws:** Nodes, Paths, loops and Branches, Kirchhoff's Current law, Kirchhoff's Voltage Laws, the single loop.
- **Circuits:** the single node-pair circuits, series and parallel connected. Independent sources, resistors in series and parallel, voltage and current division.
- **Basic Nodal and Mesh Analysis:** Multi-Nodal Analysis, the super node, Mesh Analysis, the

super mesh.

- **Circuit Analysis Techniques:** linearity and Superposition, Source Transformations, Thevenin and Norton Equivalent Circuits, Maximum Power Transfer, Delta-Wye Conversion
- **Capacitors and Inductors:** Capacitors, Inductor, Inductance and Capacitance Combination
- **Basic RL and RC Circuits:** The Source-Free RL Circuit, Properties of the Exponential Response, the Source-Free RC Circuits. the Unit-Steps Function and driven RL Circuits. Natural and forced response and driven RL Circuits.
- **The RLC Circuit:** The Source-Free Parallel Circuit, the over damped parallel RLC Circuits, Critical Damping, the under damped Parallel RLC Circuit. the Source-Free Series RLC Circuit, the complete response of the RLC Circuit. The lossless LC Circuit

### MT-223 Ordinary Differential Equation & Fourier Series

- **First Order Differential Equations:** Basic concept; Formation of differential equations and solution of differential equations by direct integration and by separating the variables; Homogeneous equations and equations reducible to homogeneous form; Linear differential equations of the order and equations reducible to the linear form; Bernoulli's equations and orthogonal trajectories; Application in relevant Engineering.
- **Second and Higher Orders Differential Equations:** Special types of 2nd order differential equations with constant coefficients and their solutions; The operator D; Inverse operator 1/D; Solution of differential by operator D methods; Special cases, Cauchy's differential equations; Simultaneous differential equations; simple application of differential equations in relevant Engineering.
- **Partial Differential Equation:** Basic concepts and formation of partial differential equations; Linear homogeneous partial differential equations and relations to ordinary differential equations; Solution of first order linear and special types of second and higher order differential equations; D' Alembert's solution of the wave equation and two dimensional wave equations; Lagrange's solution; various Standard forms.
- **Laplace Integral & Transformation:** Definition, Laplace transforms of some elementary functions, first translation or shifting theorem, second translation or shifting theorem, change of scale property, Laplace transform of the nth order derivative, initial and final value theorem Laplace transform of integrals. Laplace transform of functions  $t F(t)$  and  $F(t)/t$ , Laplace transform and inverse transforms, convolution theorem, solutions of ordinary differential using Laplace transform.
- **Fourier series:** Periodic functions and expansion of periodic functions in Fourier series and Fourier coefficients; Expansion of function with arbitrary periods. Odd and even function and their Fourier series; Half range expansions of Fourier series, "DFT and FFT, Fourier Spectrum".

### ME-221 Fluid Mechanics-I

- **Fluid Properties:** Properties of fluids such as density, viscosity, compressibility, surface tension and capillarity, types of fluids.
- **Fluid Statics:** Pressure in a fluid at a point, variation of pressure with depth, Homogeneous fluid, Several fluids of different specific weights, Interconnected vessels, Rigid-body motion of fluid, Hydraulic circuits, Force on plane and curved surfaces, Buoyancy and flotation, Stability of a floating body.
- Atmospheric equilibrium, Isothermal state, Adiabatic state, The standard atmosphere.
- **Fluid Dynamics:** System and control volume, classification of flows, velocity and acceleration fields, streamlines, path lines, and streak lines, Equation of continuity, Euler's equations of motion, Bernoulli equation, Energy equation, Impulse and momentum, One



dimensional viscous flow, Laminar and turbulent flow in pipes and ducts, Pipe flow problems, Flow in open channels.

- **Dimensional Analysis:** Buckingham- Pi Theorem, Reynolds' Law of Similitude, geometrical, kinematic and dynamic similarity and related problems.
- **Fluid Measurements:** Measurement of static pressure, Stagnation pressure, flow velocity and flow rate measurement including Venturimeter, orifice meter, nozzle meter.

### ME-222 Dynamics

- **Kinematics of Particles:** Rectilinear and curvilinear motion of particles, Rectangular, Tangential, Normal, Radial and transverse components of velocity and acceleration, Motion relative to a frame in translation.
- **Kinetics of Particles:** Force, Mass and acceleration, Newton's second law, Dynamic equilibrium, Rectilinear and curvilinear motion, Work and energy, Kinetic energy of a particle, Principle of work and energy, Conservation of energy, Impulse and momentum, Impulsive forces and conservation of momentum, Impact, direct and oblique, Angular momentum of particle and a system of particles, Conservation of angular momentum, Variable systems of particles, Systems gaining or losing mass.
- **Kinematics of Rigid Bodies:** Translation, Rotation about fixed axis, General plane motion, Absolute and relative velocity and acceleration.
- **Plane Motion of Rigid Body:** Forces, Acceleration, Energy and momentum, Conservation of linear and angular momentum.
- **Kinetics of Rigid Bodies in Three Dimensions:** Equations of motion of a rigid body about a fixed point, About its mass center or about a fixed axis, Gyroscopic motion.

### ME-223 Engineering Mechanics Lab

Perform experiments related to statics and dynamics

### AU-251 Automotive Propulsion

**Introduction to ICE:** Engine classifications; comparison of SI and CI engines; speed and load control in SI and CI engines; Real ICE cycles; regenerative cycle; supercharging and turbocharging.

**Engine Performance Parameters:** *Thermal Efficiency*, Volumetric efficiency, Mechanical Efficiency, *Specific fuel consumption*, valve timing diagram, Losses in Engines; Friction and Heat transfer; Performance characteristics *curves* of SI and CI engines. *Ignition, Combustion, and knocking.*

**Power Measurement:** Measurement of engine performance parameters; torque, power, *temperature, pressure, flow rate, engine speed and exhaust emissions.* Use of dynamometer and *DAQ system.*

**Fuel Delivery Systems:** Petroleum and non-petroleum fuels; characteristics of SI and CI engine fuels; LPG and CNG as IC engine fuel; Octane and Cetane numbers; lubrication systems and lubricants; *Venturi effect*; Fuel Injection systems in gasoline and CI engines; *injection nozzles. EFI system, Air delivery systems.*

**Low Carbon Propulsion:** Introduction to Fuel cells; types of fuel cell and their application in automobiles; limitations of fuel cells; Introduction to Stirling engines and hybrid power plants for automobiles; downsizing, hybridization, EV propulsion.

**Engine Emission and Control:** *Engine exhaust system, Gaseous and particulate engine emissions, Emission control systems; Pre and post combustion systems; Catalytic Converters,*

## **ME-220 Manufacturing Processes-I**

- **Introduction to Manufacturing:** Types of manufacturing industries, materials used in manufacturing and properties of materials, different processing operation.
- **Sand Casting:**
  - **Introduction:** Sand casting, molding, heating and pouring, solidification and cooling. Pattern: making, material, types, construction, pattern allowances.
  - **Core:** making, types, sand conditioning, testing of sand, molding process, tools and equipment, molding machines, different types of casting, cleaning and finishing of castings, inspection of castings.
- **Permanent Mold Casting (PMC):** Introduction, types of PMC, gravity die casting and its types. Pressuredie casting, Centrifugal casting and their types. Furnaces used in PMC.
- **Metal Forming:** Fundamentals, types, hot, warm and cold working. Bulk Deformation Processes:
  - **Rolling;** rolled products, rolling types: flat, shape, thread, gear, ring rolling, and rolling mill configurations.
  - **Forging;** open die, impression die, press, upset, roll, net shape, isothermal forging and swaging.
  - **Extrusion;** solid & hollow shapes, direct & indirect, hot & cold, continuous & discrete, impact extrusion, hydrostatic.
  - **Drawing;** bar, wire, tube drawing and its types like tube sinking, fixed mandrel, floating plug. Other metal forming processes; roll extrusion, riveting, staking, peening, coining, hubbing, burnishing.
- **Sheet metal forming processes:** Shearing operations: slitting, blanking, piercing, cutoff, parting, dinking, slotting, perforating, notching, semi-notching, lancing, nibbling, trimming, shaving, fine blanking. Bending operations: V bending, edge bending, flanging, curling, hemming, seaming. Drawing operations like deep and shallow drawing, embossing.
- **Welding Processes:** Classification, Fusion welding and its types such as oxyfuel gas welding and oxygen torch cutting, arc welding (shielded metal, flux cored, gas metal, submerged, gas tungsten, plasma, stud welding, Arc cutting), resistance welding (spot, seam and projection. Heating, pressure, current control and power supply for resistance welding). Solid state welding and its types including diffusion welding, friction welding and ultrasonic welding.
- **Other welding processes:** Forge, Roll, Friction, Explosion, Thermic, Electron beam, Laser welding and cutting, Brazing and Soldering.
- **Fabrication of Plastics:** Casting, Blow molding and its types, Compression molding, Transfer molding, Cold molding, Injection molding: injection molding machine, mold design and construction, types of mold, cooling and ejection of mold, Reaction injection molding, Welding of plastics.

## **SPRING SEMESTER**

### **MT-330 Applied Probability and Statistics**

- **Statistics:** Introduction, types of data & variables, presentation of data, object, classifications, tabulations, frequency distribution, graphical representation, simple and

multiple bar diagrams, sartorial and pie-diagram, histogram, frequency polygon, frequency curves and their types.

- **Measure of Central Tendency & Dispersion:** Statistics averages, median, mode, quartiles, range, moments, skew-ness and Kurtosis. Quartile deviation, mean deviation, standard deviation, variance and its coefficient. Significance in related problems.
- **Curve Fitting:** Introduction, fitting of a first and second degree curve, fitting of exponential and logarithmic curves, related problems. Principle of least squares and second order statistics and time series.
- **Simple Regression & Correlation:** Introduction, Scatter diagrams, Correlation & its Coefficient, Regression lines, Rank Correlation & its Coefficient, Probable Error (PE), related problems.
- **Sampling & Sampling Distributions:** Introduction, Population, Parameter & Statistic, Objects of sampling, Sampling distribution of Mean, Standard errors, Sampling & Non-Sampling errors, Random Sampling, Sampling with & without replacement, Sequential Sampling, Central limit theorem with practical significance in related problems.
- **Statistical Inference:** Testing of Hypothesis: Introduction, Estimation, Types of Estimates, Confidence interval, Tests of Hypothesis, Chi-Square distribution/test, one tails & two tails tests. Application in related problems.
- **Probability:** Basic concepts, Permutation & Combination, Definitions of probability, Laws of probability. Conditional probability, Baye's rule. Related problems in practical significance.
- **Random Variables:** Introduction, Discrete & Continuous random variables. Random Sequences and transformations Probability distribution, Probability density function, Distribution function, Mathematical expectations, Moment Generating Function (M.G.F), Markove random walk chain related problems.
- **Probability Distributions:** Introduction, discrete probability distributions, Binomial, Poisson, Hyper geometric & Negative binomial distributions. Continuous probability distribution, Uniform, Exponential & Normal distributions & their practical significance.

### ME-218 Solid Mechanics-I

- **Statically Determinate Frames and Beams:** Types of solid body components, statical determinacy, Shear force and bending moment diagrams; Relationships between loading; Shear force and bending moment.
- **Statically Determinate Stress Systems:** Stress; Direct, shear, hydro-static. Complementary shear stresses; Bar and strut / column, stresses in thin ring and rotating cylinder, stresses in thin shells due to pressure or self-weight.
- **Stress-Strain Relation:** Deformation; Strain; Elastic stress-strain behavior of Materials; Lateral strain and Poisson's ratio; Thermal stress and strain; General stress-strain relationships.
- **Statically Indeterminate Stress Systems:** Interaction of different materials, Interaction of different stiffness components, Restraint of thermal strain; Volume Changes; Constrained materials.
- **Bending Stresses:** Simple bending theory; bending relationships; General case of bending; composite Beams; Eccentric end load.
- **Bending Slope and Deflection:** Deflection curve of the neutral axis; Double Integration and Super-position methods.
- **Theory of Torsion:** Torsion of thin-walled cylinders; Torsion of solid circular shafts; Hollow shafts, Non- uniform and composite shafts, tapered shafts; Torsion of a thin tube of

non-circular section; Torsion of thin rectangular Strip.

- **Theory of Columns:** Euler's theory of buckling; Eccentric loading of long columns. Behavior of ideal and real struts. Struts with initial curvature Crinkling; Members subjected to axial and transverse loading.

## ME-209 Materials and Metallurgy

- **Introduction:** Importance of Material Science and Engineering, classification of materials, material property charts
- **Crystallography:** Types of crystal structures, atomic packing factor, Miller indices of crystallographic planes and directions
- **Imperfections in solids:** Classification of defects, types of point defects and their effects on material properties, dislocations, kinetics of dislocations, dislocation interactions, significance of dislocations on material permanent deformation
- **Mechanical properties of materials:** Deformation behavior of materials under tensile and compressive loads, Hardness testing, Testing of materials under impact loading, fundamentals of fracture mechanics, importance of fracture mechanics, material characterization of fracture surfaces, stress distribution around a crack, fatigue testing, S-N curves, creep deformation behavior & ASTM standards for all mechanical tests
- **Diffusion in materials:** Diffusion theory, equilibrium and non-equilibrium diffusion mechanisms, effect of diffusion on material properties
- **Heat treatment and phase transformation in materials:** Types of heat treatment processes, effects of heat treatment on material structure and properties, concepts of phases in solids, solubility limit in solid solutions, strengthening mechanisms (solid solution and precipitate strengthening), binary phase diagrams, iron-iron carbide phase diagram, diffusional and non-diffusional phase transformation, kinetics of phase transformation
- **Polymers:** Structure of Polymers, Thermoplastics and Thermosetting Polymers, Copolymers, Polymer Crystals, Defects in Polymers Characteristic
- **Applications and Processing of Polymers:** Mechanical Behavior, Viscoelasticity, Fracture, Strengthening Mechanism, Polymer Types, Polymer Processing
- **Ceramics:** Ceramic Structure Imperfections in ceramics, Mechanical Properties
- **Applications and Processing of Ceramics:** Types and Applications, Fabrication and Processing
- **Composites:** Introduction, Particle Reinforced Composites, Fiber Reinforced Composites, Processing of Composites, Sandwich Panels
- Material degradation, corrosion, Stress corrosion cracking, corrosion prevention
- **Nanomaterials:** Classifications of nanomaterials, nanomaterial properties, synthesis and characterization of nanomaterials, significance and application of nanomaterials
- **Advanced high strength steels:** Classification of AHSS, material and mechanical characterization of AHSS, properties and applications of AHSS

## ES-119/ES-205 Islamic Studies

### Chapter 01

- Tauheed: Al-Ambiya-22, Al-Baqarah – 163 & 164.
- Prophet Hood: Al-Imran-79, Al-Huda-7, Al-MaidaOh-3.
- Here-After: Al-Baqarah-48, and one Hadith.

### Chapter 02

- Basic Islamic Practices: Al-Mu' minum-1-11, and two Ahadith

### **Chapter 03**

- Amer-Bil-Ma'Roof Wa-Nahi Anil Munkar:
- The concept of Good & Evil
- Importance and necessity of Da'wat-e-Deen Al-Imran – 110
- Method of Da'wat-e-Deen An-Nehl-125, Al-Imran-104, and two Ahadith

### **Chapter 04**

- Unity of the Ummah: Al-Imran-103, Al-Jujurat-10, Al-Imran-64, Al-An'am – 108, and two Ahadith

### **Chapter 05**

- Kasb-e-Halal: Ta ha-81, Al-A'raf-32-33, Al-Baqarah-188, and two Ahadith

### **Chapter 06**

- Haquq-ul-Ibad: Protection of life Al-Maidah-32
- Right to property Al-Nisa-29
- Right to Respect & Dignity Al-Hujurat-11-12
- Freedom of Expression: Al-Baqarah-256
- Equality: Al-Hujurat-13
- Economic Security: Al-Ma'arij-24-25
- Employment Opportunity on Merit: An-Nisa-58
- Access to Justice: An-Nisa-135

### **Chapter 07**

- Women's Rights: An-Nehl-97, Al-Ahzab-35, An-Nisa-07

### **Chapter 08**

- Relations with Non-Muslims: Al-Mumtahanah-8-9, Al-Anfa'al-61 and The last Sermon of Hajj of Holy Prophet (PBUH): Relevant extracts

### **Chapter 09**

- Seerat (life) of the Holy Prophet (PBUH):
- Birth
- Life of Makkah
- Declaration of Prophet hood
- Preaching & its difficulties
- Migration to Madina
- Brotherhood (Mawakhat) & Madina Charter
- The Holy Wars of the Prophet (Ghazwat-e-Nabawi)
- Hujjat-ul-Wida
- The last sermon of Khutbatulwida: Translation and important points

## **Chapter 10**

- Islamic Civilization:
- In the sub-continent: pre-Islamic civilizations. The political, social & moral impacts of Islamic civilization.
- In the world: academic, intellectual, social & cultural impact of Islam on the world.

### **ME-219 Mechanics of Machines**

- **Machine Dynamics:** Kinematics of Motion; kinetics of Motion; Simple Crank and Cam Mechanisms; Linkages; Types of Links; Structure; Kinematic Pair; Mechanism; Cams
- Kutzbach and Grubler's criteria for planar mechanisms.
- **Types of Mechanisms:** Slider Crank Mechanisms and its Inversions; Design and Kinematic Analysis of Cams. Single Slider Crank Mechanism and its Inversions; Double Slider Crank Mechanism and its Inversions; Four Bar Mechanisms and its Inversions, Design and Kinematic Analysis of Cams.
- **Principles of Design:** Hardness; Creep; Fatigue failure; Soderberg and Goodman Diagrams;; Safety and Reliability in Design
- **Design of Simple Machine Elements:**
- **Joints:** Knuckle, Cotter and Universal joints; Threaded and Riveted Fasteners
- **Couplings:** Flanged and Muff Coupling, Flexible Coupling, Universal Coupling, Oldham Coupling, Chain Coupling, Gear Coupling, Design of Key and Pins; Fluid Couplings.
- **Clutches:** Friction Clutches; Types of Friction Clutches; Design of Single Disc or Plate Clutch, Multiple Disc Clutch, Cone Clutch, Centrifugal Clutch.
- **Springs:** Types of Springs, Helical Spring, Terms used in Helical Spring, Stresses in Helical Spring of Circular wire, The Curvature Effect; Deflection in Helical Spring of Circular wire Eccentric loading; Buckling of compression Springs, Energy stored in springs, Springs in Series and Parallel, Concentric spring, Leaf Springs
- **Flexible Mechanical Elements:** Belts, Flat and Round Belt drives, V Belts, Timing Belts, Design of a Belt Conveyor; Chain Drives, Roller Chains; Design of Chains including Drag Chain Conveyor; Apron Feeder
- **Brakes and Dynamometers:** Types of Brakes; Materials of brake lining; Block or Shoe Brake; Simple Band Brake; Differential Band Brake; Band and Block Brake; Internal Expanding Brake; Dynamometer; Type of Dynamometer; Prony Brake Dynamometer
- **Turning-Moment Diagrams and Flywheel:** Turning Moment of Steam Engine; Turning Moment of Internal Combustion Engine; Turning Moment of Multi-cylinder Engine; Coefficient of Fluctuation of Energy; Coefficient of Fluctuation of Speed. Flywheel; Energy Stored in a Flywheel; Dimensions of the Flywheel Rim.

### **EA-208 Business Communication & Ethics**

#### **Communication Skills (Oral)**

- Definitions and Conditions, Modes; verbal, non-verbal, vocal, non-vocal, sender, receiver, encoding, decoding, noise, context, emotional, relationships, etc.
- Language and perception, Distortion of thought, interference.
- Non-verbal, body language, physical appearance, cultural differences etc.
- Barriers to Comm: ambiguity, context, closure, prediction, pseudo listening.
- Listening: effective listening, benefits and ethics for listener.

- Personal and interpersonal skills/perceptions.
- Communication dilemmas and problems.
- Public Speaking – speaking situations, persuasive speeches/ interviews

### **Written Communication**

- Types of messages and various approaches
- Formal/ Business letters various types
- Memos (brief revision).
- Notices and minutes of meetings, agenda, layout, language, Leadership styles.
- Contracts and agreements (basic theoretical knowledge and comprehension).
- Tenders (basic theoretical knowledge and comprehension).
- Participating in seminars, interviews, writing and presenting conference papers, solving IELTS type papers(Non-examination).
- Business reports (Short and Long) Research / Scientific reports.

### **Engineering / Business Ethics**

- Course objective.
- Need for code of ethics, importance
- Type of ethics, involvement in daily life, professional ethics
- Problems/conflicts/dilemmas in application.
- Review of Pakistan Engineering Council Code of Conduct.

## **THIRD YEAR**

### **FALL SEMESTER**

#### **ME-317 Manufacturing Processes-II**

- **Machine Tools**
  - Machine tools using single point tools, description, functions, operations performed on lathe, shaper, planer, and boring machines.
  - Machine tools using multiple cutting edge tools, description, functions, and operations performed on drilling, milling, gear cutting, broaching machines, and thread manufacturing.
  - Machine tools using abrasive wheels, description and functions of various types of grinding machines, wheel dressing and wheel balancing, honing, lapping, and super finishing operations.
- **Work Holding Devices:** Basic concept and design of different work holding devices like chuck, vices, jigs and fixtures for lathe, milling, drilling etc.
- **Machining Parameters:** Determination of machining time and material removal rate for various machining operations, cutting tools for manufacturing, cutting tool material characteristics, cutting tool materials, tool steels, HSS, sintered carbides, ceramics, tin-coated HSS, diamonds and cubic boron nitrides, tool geometry, tool life, tool wear and machinability, Taylor's tool life model, sharpening and reconditioning of cutting tools, Basic concept and design of jigs and fixtures.
- **Non-Traditional Machining Processes:** EDM, ECM, and ultrasonic machining.

- **Metrology:**
  - Light waves as standard of length, design and operation of linear measuring instruments, slip and block gauges, length bars, limit gauges, sine bar, reference temperature, limits and fits, hole-basis, shaft basis comparators, mechanical, electrical, pneumatic and optical.
  - Errors in measurement, sensitivity, accuracy and variation, economics of measurement, measurement of squareness, flatness, straightness, roundness, gear and screw threads, advanced measuring and inspection non-contact measurement, machine tool metrology, alignment tests, level of installation, spindle straightness, flatness and squareness.
- **Surface Texture and Measurement:** Roughness and measurement of roughness lay, waviness and flaws, CLA and RMS values, prediction and average values of roughness for various manufacturing processes like turning, drilling, milling and grinding.
- **Standardization:** Introduction, Interchangeability, assembly, principles, preparation of standards, application of standards in design and manufacturing. Standards organizations.

### **AU-350 Analog & Digital Electronics**

**Diodes:** P-N Junction formation and operation, Diode data sheet understanding, Diode applications; rectifier, clipper and clampers.

**Amplifiers:** Introduction to Amplifier, amplifier properties, configurations and classifications; BJT based amplifiers: common base, common emitter, common collector, differential and multistage configuration; FET based amplifiers: Common source, common gate, common drain configurations; operational amplifiers and their applications.

**Voltage Regulators:** Introduction to regulators voltage regulators (series & shunt), regulator ICs.

#### **Digital Electronics**

**Logic Gates:** Universality of NAND and NOR gates; SOP and POS forms and simplifications; BCD code and parity method for error detection;

**Integrated Circuit Logic Families:** Digital IC terminology; (current & voltage parameters, propagation delay, speed-power product); TTL and CMOS logic family and IC data sheets understanding;

**Application Circuits:** Decoders; BCD to 7- segment decoders/drivers; encoder; multiplexer and demultiplexer with their applications; Converters: specifications; interfacing with analogue world; Analog-to-digital and digital-to-analog converters; ADC & DAC data sheet understanding.

### **ME-302 Solid Mechanics-II**

- Combined bending and direct stresses. Shear stresses in bending, bending and shear stresses in I-section beams. Asymmetrical bending, Shear stress in thin-walled open sections and shear center, General case of bending of a thin walled open section, Bending of initially curved bars, Beams with small radius of curvature.
- Strain energy under direct stress and in pure shear, Strain energy in bending and torsion, Maximum stress due to a suddenly applied load and due to impact, Bending deflection of a beam from an impact, Shear deflection, Theorems of Castigliano and Maxwell's Reciprocal Theorem.
- Double integration method; Superposition method; Virtual work; Compatibility and equilibrium methods
- Two-directional stress systems; Mohr's stress circle, Principal stresses and planes, Combined bending and torsion, Two-directional strain analysis, Normal and shear strain in terms of coordinate and maximum shear strain, Relationship between elastic constants.



- Thick-walled cylinders, Compound cylinders, Shrink fit, Rotating disk of uniform thickness
- Maximum Principal Stress Theory, Maximum principal strain theory, Maximum shear stress theory, Total strain energy theory.
- Deflection of thin Plates, bending of circular plates with symmetrical loading, Plates with uniform loading, solid plate with different loading conditions, Axi-symmetrical thin shells, bending stresses in thin shells.

### ME-316 Fluid Mechanics-II

- **Fluid Kinematics:** Reynolds Transport Theorem (RTT) and its application to conservation of mass, linear momentum and angular momentum, Equation of streamline in differential form, Fluid element kinematics, Vorticity and Circulation, Stokes' theorem, Differential form of continuity equation.
- **General Theory of Ideal Fluid Flow:** Stream function, Velocity potential function, Flow net, Plane potential flows, uniform flow, line source & sink, free vortex, Superposition of elementary plane potential flows, doublet, flow past stationary and rotating cylinders.
- **Viscous Fluid Flow:** Differential form of linear momentum equation, Euler's equations of motion, Viscous flow of incompressible Newtonian fluids, Stokes' viscosity law for Newtonian fluids, Navier-Stokes equations, steady laminar flow between parallel plates, Couette flow, Hagen-Poiseuille flow, Hydrodynamic lubrication, Reynolds' equation, application to infinitely long & short journal bearings, Lift and drag forces.
- **Boundary Layer Theory:** Boundary layer development on a flat plate, Boundary layer thicknesses, Laminar boundary layer exact solution, Momentum integral analysis, Turbulent boundary layer, Boundary layer with pressure gradient, boundary layer separation and control.
- **Airfoil Theory:** Airfoil geometry and nomenclature, Symmetric & cambered airfoils, Airfoils of infinite and finite span, Characteristic curves, Lift generation, Magnus effect & Kutta-Joukowski theorem.
- **Turbomachines:** Classification, Euler turbine equation, Centrifugal pumps, construction, classification, performance, characteristic curves, NPSH, System curve and operating point, Series and parallel operation of pumps, Hydraulic turbines, analysis of reaction and impulse turbines, Similarity laws for turbomachines, Specific speed.
- **Computational Fluid Dynamics:** Fundamentals, discretization of flow field and equations of motion, discretization methods, Finite difference approximations of first and second partial derivatives, Solution of resulting systems of algebraic equations.
- **Note:** Experimental determination of characteristic curves for pumps, and Impulse, Kaplan and Francis turbines will be performed in the lab.

### MT-332 Advanced Calculus and Linear Algebra

- **Linear Algebra:** Linearity and linear dependence of vectors basis dimension of a vector space, field matrix and type of matrices (singular, non-singular, symmetric, non-symmetric, upper, lower, diagonal tri-diagonal matrix), Rank of a matrix using row operations and special method, echelon and reduced echelon forms of a matrix, determination of consistency of a system of linear equation using rank, transition matrix, basic concept of tensors, eigen value and eigen vectors of a matrix, Diagonalization, Cayley-Hamilton theorem. Applications of linear algebra in Engineering.
- **Euclidean Spaces and Transformation:** Geometric representation of vector, norm of vector, Euclidean inner product, projections and orthogonal projections, Euclidean n spaces n properties Cauchy-Schwarz inequality, Euclidean transformations, apply geometric transformations to plane figure, composition or transformations.
- **Advance Calculus:** Define a stationary point of a function of several variables, define local maximum and saddle point for a function of two variables the stationary points of a several

variables, obtain higher partial derivatives of simple functions of two or more variables, iterated integrals, double and triple integrations with applications (area, centroid, moment of inertia, surface area, and volume, use multiple integrals in solutions of engineering problems.

- **Vector Calculus:** Vector differential operator, directional derivative, gradient, divergence, curl of a vector field, and Laplacian operators with applications. (Solenoid, conservative, etc.). Vector Integrations; Evaluate line integrals along simple paths, apply line integrals to calculate work done, apply Green's theorem in the plane to simple examples, evaluate surface integrals over simple surface, use the Jacobean to transform a problem a new co-ordinate system, apply Gauss' divergence theorem to simple problems, apply Stokes theorem to simple examples.

## ME-323 Machine Design

- **Design of Machine Elements:**
  - **Shafts and Columns:** Shaft Types and Materials; Design of Shafts under Normal and Combined Loading; Static, Cyclic and Shock Loads; Torsional stiffness; Critical speeds; Shaft Materials Introduction to Flexible Shafting; Column; Types of End Conditions; Euler's Column Theory; Connecting Rods and Crank Shafts.
  - **Bearing:** Bearing types and Materials, Friction and Wear, Theory and Application of Lubrication and its Methods; Details design of Journal bearing and Thrust bearings, Rolling Contact Bearings, Bearing life, Bearing Load, Bearing Survival, The Reliability Goal, Selection of Ball and Straight Roller Bearings, Spherical and Tapered roller bearings; Selection of Tapered Roller Bearing.
  - **Plates and Shells:** Introduction to the Design of Pressure Vessels, Thin and Thick Pressure vessels, Stresses in Thin and Thick Pressure Vessel, Compound Cylinders, Stresses in Compound Cylinders, Design of Plates, ASME Codes, Petro-Chemical piping systems; Design of rings and wheels.
- **Gear Design:** General gear theory; Design of the Spur gear, The Lewis formula, the AGMA Stress Formula, The AGMA Strength Formula, Design of any one of the following types of gears; Helical, Worm, Bevel, gear; Gear Trains.
- **Application of Industrial Codes:** Introduction to Industrial Design Codes. Application of at least one Design standards i.e. ASME, BS, ANSI, JIS, DIN, and ISO in the design of Machine Elements and Assemblies.
- **Elements of Micro Electro- Mechanical System (MEMS):** MEMS manufacturing; Lithography, Etching, Micromachining; MEMS Devices; Sensors; Actuators; Springs and Fluid Flow devices.

## ME-318 Heat & Mass Transfer

- **Conduction:** Steady state conduction; one-dimensional heat transfer analysis, general heat diffusion equation for three dimensional geometries for Cartesian, cylindrical and spherical co-ordinates, multi-layered wall, thermal networks, overall heat transfer coefficient & Thermal analysis with internal heat sources. Heat transfer from extended surfaces (fins). Transient conduction & lumped capacitance method.
- **Radiation:** Radiation intensity, black body radiation, Planck distribution, spectral emissive power, Wein's Displacement law, Stefan Boltzmann law, band emission, emission from real surfaces, surface characteristics, Kirchoff's law View Factor, radiation exchange between black and real surfaces, radiation network
- **Convection:** Basic concepts, momentum and thermal boundary layers; dimensional analysis; theoretical analysis for flat plates; laminar and turbulent correlations. Heat transfer with phase change, boiling and condensation.
- **Heat Exchangers:** Classification and preliminary design of heat exchangers, LMTD and

turbu

NTU methods.

- **Mass transfer:** Mass transfer operations; mass transfer through diffusion and mass transfer coefficients; empirical correlations; analogy between momentum, heat and mass transfer; simultaneous heat and mass transfer.

### **EE-376 Feedback Control Systems**

**Introduction:** Introduction to control systems, examples and classifications, Feedback and its characteristics, Nature and representation and of control system problem, Block diagram fundamentals, Linear systems and differential equations, Methods of writing differential equations of physical systems.

**Time Response of Linear Systems:** Types of standardized inputs to linear systems, steady state response and transient Response of systems to standard inputs, response of second order systems time response specifications.

**Laplace Transforms:** Definition, derivation of Laplace transforms of simple functions, Laplace transform theorems, transformations of differential equations of physical systems, inverse transformation techniques, stability, Routh's stability criterion.

**Block Diagram Algebra:** Transfer functions of physical systems, canonical and unity feedback forms of control system block system block diagram, block diagram reduction techniques, signal flow graph algebra, block diagram reduction using signal flow graphs.

**Control System Characteristics:** Classification of feedback systems by type, analysis of system types, error coefficients, error constants, sensitivity, Root locus and application.

**Frequency Response:** Introduction, transfer function of systems in frequency domain, magnitude and phase angle frequency response plots of closed loop control systems.

**Introduction to Digital Control:** Computer as control device, Single-loop digital control system, Digital control: pros and cons, Data Converters, Introduction to Linear Difference Equations (LDE) and z-transform, Overview of digital control system design techniques.

### **MF-303 Applied Economics for Engineers**

**Introduction:** Engineering economy defined; Measures of financial effectiveness; Non-monetary factors and multiple objectives; principles of engineering economy.

**The Economic Environment:** Consumer and producer goods; Measures of economic worth; Price, Supply, & Demand relationship; Production; Factors of production; Laws of return.

**Cost Concepts & Analysis:** Sunk & opportunity costs; Fixed, variable, and incremental costs; Recurring & nonrecurring costs; Direct, indirect, and overhead costs; Standard costs; Breakeven analysis; Unit cost of production; Cost-benefit analysis; Feasibility studies; Value analysis in designing & purchasing.

**Time Value of Money:** Simple interest, Compound Interest, Cash flow diagrams, Interest formulas, Nominal versus effective interest rates, continuous compounding.

**Depreciation and Depletion:** Purpose of depreciation, types of depreciation, economic life, what can be depreciated.

**Comparing Alternatives:** Present economy, Selection among machines, materials, processes, and designs, Payback period method, Present worth method, Uniform annual cost method, Rate of return method, Alternatives having identical lives, Alternatives having different lives.

**Production Concepts & Mathematical Models:** Manufacturing lead time; Production rate; Capacity; Utilization; Availability; Work in process; WIP and TIP ratios.

**Linear Programming:** Mathematical statement of linear programming problems; Graphic solution; Simplex method; Duality problems.

**Capital Financing and Budgeting:** Types of ownership; types of stock; Partnership & joint stock companies; Banking & specialized credit institutions.

**Industrial Relations:** Labour problems; Labour organizations; Prevention & settlement of disputes.

### **AU-323 Vehicle Noise & Vibrations**

**Introduction to Vibration:** components of vibratory system, vibration analysis procedure, damping and natural frequency, harmonic analysis.

**Single Degree of Freedom Systems:** Undamped free vibrations of linear and torsional systems; energy method, damped free vibrations of linear and torsional systems, undamped free and forced vibrations of linear and torsional system.

**Vibration Control:** base excitation and vibration isolation.

**Two Degree of Freedom Systems:** Undamped and damped free vibrations; Undamped and damped steady state forced vibrations, Modal Analysis.

**Methods for Finding Natural Frequencies:** Rayleigh method, Holzer method.

**Fundamentals of Acoustics:** general sound propagation, plane wave propagation, effect of reflecting surfaces on sound propagation, human response to sound.

**Automotive Noise Criteria:** drive by noise tests, interior vehicle noises, exterior noises.

**Automotive Noise Sources:** engine, transmission, intake and exhaust, aerodynamic, tire and braking noise.

**Automotive Noise Control Principles:** sound in enclosures (interior sound), sound energy absorption, sound transmission through barriers.

### **ME-437 Machine Design & Vibration Lab**

Perform experiments related to Machine Design and Mechanical Vibrations

### **AU-333 Chassis System Design**

**Wheels and tires:** Tire operation, rolling radius, Rolling resistance, Static Forces, Longitudinal Force, Cornering forces, Interaction between longitudinal and side forces, testing.

**Suspensions system:** Independent suspensions, Semi-independent suspensions, Rigid axle suspensions, Industrial vehicles suspensions, Testing of wheel.

**Steering system:** Steering mechanism, Rack and pinion steering box, Screw and sector steering box, Steering column, Power steering, Testing of Steering.

**Brake system:** Car brakes, Industrial vehicle brakes, Design of Brake System.

**Transmission system:** Manual gearbox, Shifting mechanisms, Start-up devices, Differentials and final drives, Automatic Gearbox, Car CVTs, Testing of transmission.

Chassis Design: Design of sub-systems through selecting appropriate constructions, determining basic parameters based on design principles, physical laws, standards, design criteria and constraints.

## **FINAL YEAR**

### **FALL SEMESTER**

#### **AU-422 Automotive Transmission & Drives**

**Over view:** Overview of vehicle transmission/drive train components and layouts.

**Clutch:** Design calculations; engagement time; performance during engagement and thermal properties; synchromesh design and gear engagement calculations.

**Manual Transmissions:** Theory and power flow of standard transmissions/transaxles; gearbox; synchronizers; synchromesh design and gear engagement calculations; lubrication of gears.

**Automatic and Semi-Automatic Transmissions:** Hydrokinetic transmissions: fluid coupling and torque converter; epicyclical gears; compounding; performance characteristics; matching; overview of continuously variable transmission (CVT) designs. Comparison of performance attributes for the different types of transmissions.

**Power Train Matching:** Combined engine, transmission and vehicle characteristics, gear ratio selection criteria and calculations, effect of undergearing / overgearing on vehicle performance and fuel economy, impact of engine type and characteristics. Universal and C-V joints; drive shafts; axles and differentials. Fundamentals of power transmission for belts and chains; linkages; cams; functions and principles of operation and applications of governors and gyroscopes.

**Different Systems:** Hydraulic, electro-hydraulic and pneumatic systems: automotive steering, brakes, windows operation and other special applications.

#### **ME-319 Refrigeration & Air Conditioning**

- **Refrigeration cycles:** Reversed Carnot cycle, Vapour-compression and vapour absorption cycles, gas refrigeration cycle, Multiple evaporator and compressor systems.
- **Psychrometry:** Use of psychrometric chart, Relative humidity, Humidity ratio, Dry bulb, Wet bulb and Dew point temperatures, Psychrometric processes
- **Cooling Load Calculations:** Indoor and outdoor design conditions of air conditioning, heating and cooling load calculation, Air conditioning requirements for comfort and industrial processes, Air distributing systems, Design and sizing of ducts, prevention of noise and vibration. Introduction to computer software used in Refrigeration and air conditioning.
- **Refrigeration and Air Conditioning Systems Components:** Compressor, Condenser, Evaporator, Expansion devices, Humidifier, Dehumidifier, Fan, Pump, Blower, grills and registers, cooling tower, Automatic temperature and humidity control systems, Pneumatic, electric and hydraulic systems.
- **Refrigerants:** Desirable properties of a refrigerant, Classification of refrigerants and their comparison, designation systems, secondary refrigerants (brine), Defrosting air circulation

systems.

- **Application of Refrigeration:** Domestic refrigerators, Water cooler, Cold storage, Ice making plants, Heat pump and Dairy industries applications

### **ME-320 RAC and Heat Transfer Lab**

Perform experiments related to RAC and Heat Transfer

### **AU-332 Automobile Instrumentation**

**Electronic Instrumentation & Testing Meters:** Basic electronic instrumentation key components, (Analog /digital) voltmeters, ammeters, ohmmeter and other multi-meter functions, logic analyzers, measurement error handling.

**Sensors and Transducers:** Transducers (resistive, capacitive, inductive), optical measurement system, Automobile air flow rate sensor, engine crankshaft angular position sensor, typical coolant sensor.

**Solid State Sensors and Transducers:** Magnetic measurement, temperature measurement, measurement of different physical quantities.

**Actuators:** Solenoids & relays, electric motors, automobile fuel injection, exhaust gas circulation actuators, digital engine control system.

**Basics of Electronic Engine Control:** Engine performance terms (power, BSFC, torque, volumetric & thermal efficiency, air/fuel ratio, spark timing); electronic fuel control system, and electronic ignition.

**Vehicle Motion Control:** Typical cruise control system, antilock braking system, electronic suspension system, and electronic steering system.

**On-Board Diagnosis:** On-board diagnosis system components, on-board diagnostic and troubleshooting procedures.

## **SPRING SEMESTER**

### **AU-499 Automotive Engineering Project**

A final year design project (FYDP) is the most important activity which requires the students to apply their theoretical and practical knowledge towards the end of an engineering program.

FYDP is a compulsory requirement and involves a range of activities including:

- Literature review
- Problem analysis
- Design, modelling and simulation using various methods and means including hardware and software tools to demonstrate a functional concept including rapid prototyping, where applicable

Design project will encompass complex engineering problems and design of systems, components or processes integrating core areas with appropriate consideration for public health and safety

FYDP will include cultural, societal, and environmental considerations encompassing SDGs. FYDP should lead to an integration of the knowledge and practical skills as required in the Program Learning Outcomes (PLOs)

#### ME-435 Operations Management

- **Industrial Management & Systems:** Introduction to industrial management and administration, System concept, Functions of Management, Managerial decision making, Models as decision aids.
- **Plant Location:** Factors affecting location, Multiplant location, Location analysis, Plant layout, Types of layout, Material handling consideration in layout, Internal and External balancing, product and process layout analysis, Layout comparison.
- **Production Planning and Control:** Product design, Pre-production planning, Production control for intermittent and continuous process; MRP (Material Requirements Planning), MRP inputs and outputs, Types of MRP; Job shop scheduling; Machine arrangement problems; Control for maximum profit; Scheduling techniques.
- **Quality Control:** Sampling risk and economics of sampling; OC (operating characteristic) curve and sampling plan; Average outgoing quality; Sampling methods; Attribute and variable sampling, Concept of control chart, Process Variability; , R, MR, p, np, c and u charts.
- **Methods Analysis:** Process chart; Man-Material flow charts; Work station flow charts; Man-Machine charts. Motion study; Principles of motion economy; Applications, Simo chart.
- **Work Measurement:** Stop watch time study procedures, Timing methods, Performance rating, Total normal time, Allowance factors, Continuous production study, Work sampling procedures, Predetermined motion time techniques. Wage incentive plan and job evaluation.
- **Inventory Control and Forecasting:** Inventory Control, Functions of Inventory, Economic order quantity model, its limitations, Economic lot size, Safety stock, Stock out cost, Inventory systems, Inventory system under uncertainty, Quantity discount; Forecasting; Moving average and weight moving average; Capacity Planning.
- **Project Management:** CPM (Critical Path Method) & PERT (Project Evaluation and Review Technique).

#### MG-481 Entrepreneurship

- **Understanding the Entrepreneurship Mind-Set:** The revolution impact of Entrepreneurship; The individual Entrepreneurship Mind-set; Corporate Entrepreneurship Mind-set; The Social and Ethical perspective of Entrepreneurship.
- **Conceptualizing Entrepreneurship:** Definitions and perspective; Four dimensions of an entrepreneurship venture-individuals, organization, environmental and process.
- **Formulation of Entrepreneurship:** The assessment of function with opportunities; The marketing aspects of new ventures; Financial statements in new ventures; Business plan preparation for new ventures.
- **Launching Entrepreneurship Ventures:** Creativity and innovations; Methods to initiate ventures; Legal challenges in Entrepreneurship; The search for Entrepreneurship.
- **Strategies perspectives in Entrepreneurship:** Strategies growth in Entrepreneurship; Valuation challenges in Entrepreneurship; Final harvest of a new venture.

#### MT-441 Advanced Mathematical Techniques

- **Function of Complex Variable:** Limit, continuity, zeros and poles of a complex function, Laplace equation and Cauchy-Reimann equation, conformal transformation, contour

integration.

- **Error Analysis:** Types of errors (relative, Absolute, inherent, round off, truncation), significant digits and numerical instability, flow chart. Use any Computational tools to Analysis the Numerical Solutions.
- **Finite Difference:** Functions of operators, difference operators and the derivative operators, identities, linear homogeneous and non-homogeneous difference equations.
- **Interpolation & Curve Fitting:** Interpolating polynomials for equal space and unequal space data, Newton's Forward difference and backward difference interpolation, Lagrange's, Newton, Hermit, Spline, least squares approximation, (Linear and non-linear curve), with numerical problem in engineering,
- **Numerical Differentiation:** Forward Difference Method, Backward Difference Method, Central Difference Method.
- **Numerical Integration:** Computation of integrals using simple Trapezoidal rule, Simpson's rule  $1/3^{\text{rd}}$ , Simpson's  $3/8^{\text{th}}$  rule, Composite Simpson's and Trapezoidal rules, computation of solutions of differential equations using (Euler method, Euler modified method, Runge Kutta method of order 4). Special types of integration: Improper Integrals Definitions, Types of improper integral and their convergence.
- **Elliptic Integration:** Introduction and identification of elementary elliptic integrals of first, second and third kinds, Simple applications

#### **AU-438 Electric & Hybrid Electric Vehicles**

##### **Architecture / Configuration of Electric and Hybrid Electric Vehicle**

Economic and Environmental Impact of EVs & HEVs, Configurations of EVs, Architecture of Hybrid Electric Vehicle Drive Trains, Analysis and design principles of Series HEV and Parallel HEV Drive Train, Power Flow in HEVs, Analysis of Series and Parallel HEV Drive Train.

##### **Electric Propulsion Systems (Traction Motors)**

Types of traction motors for EVs / HEVs, Induction Motor Construction and Classification, Induction Motor Drives, Control and Applications in EVs/HEVs, Permanent Magnet Motor Configuration and Optimization, Permanent Magnet Motor Drives, Control and Applications in EVs/HEVs, Role of Switch Reluctance Motors and present issues.

##### **Converters for EVs / HEVs**

AC-DC rectifier, DC-AC Inverter for EV and HEV Applications, Buck (Step-down) converter, Boost (Step-up) Converter, Buck-Boost Converter.

##### **Energy Storage System**

Architecture of the electrical energy management system: Battery System, High speed Flywheels, Ultra-capacitors, Energy Storage System, Types of Batteries and performance parameters, Charging and Discharging rate calculations, Battery technology for automotive applications.

#### **AU-314 Vehicle Dynamics**

**Introduction to Vehicle Dynamics:** Lumped Mass, Sprung & Unsprung Mass, Aerodynamics, Forces on Vehicle, One-mass and Two mass Approximation.

**Forward Vehicle Dynamics:** Determination of centre of mass location of a vehicle, tilting conditions for a vehicle in parking on inclined surfaces, applications of Newton's 2nd law of



motion to vehicle acceleration, finding failure conditions for vehicles during acceleration, determination of centre of mass location on banked road conditions.

**Tire Dynamics:** Effect of speed on rolling friction coefficient of tire, effect of inflation pressure and load on the rolling friction coefficient, effect of Sideslip Angle on Rolling Resistance, effect of camber angle on Rolling Resistance, longitudinal, lateral and camber force effect on tire.

**Steering Dynamics:** Kinematic steering, vehicle with more than two axles, vehicle with trailer, space requirement for a vehicle, four wheel steering.

**Driveline Dynamics:** Engine dynamics, driveline and efficiency, gearbox and clutch dynamics, gearbox design, geometric ratio, progressive ratio gearbox design.

**Suspension Dynamics:** Roll-centre and roll axis, camber variation of double A-arm suspension system, car tire relative angles and their effect on suspension dynamics.

**Applied Dynamics:** Four bar linkage, slider-crank dynamics, instant centre of rotation, universal joint dynamics.

### **AU-313 Combustion, Emission and Pollution**

**Combustion Theory:** Definitions, chemical equations, First Law, chemical equilibrium/Second Law, computer solution techniques.

**Applied Combustion:** Combustion processes in SI and CI engines, combustion characteristics; combustion chamber design for diesel and petrol engines including stratified charge and lean burn; phenomenon of knocking and autoignition.

**Gaseous Pollution:** Formation of gaseous exhaust emissions and toxicity; legislation on exhaust emissions; method of control of CO, HC and diesel smoke; engine particulates; Effect of fuel quality on noise and emissions; lean burn and exhaust gas catalysers; oxygen sensors and control; smoke formation; Basic dispersion factors; effect of pollutants on plant and human life.

**Noise Pollution:** Vehicle internal and external noise characteristics; vehicle noise legislation; vehicle noise sources; effect of operating parameters on engine and vehicle noise; engine noise; linear engine combustion noise model; noise excitation characteristics of engine combustion systems; tire noise sources and effect of road surface on generated tire noise; traffic noise.

### **AU-434 Automotive Service & Dealership**

#### **COURSE CONTENTS**

**Overview of Automotive Service:** Role of Service, Dealer and Dealer Staff (Service Manager, workshop controller, service advisor, maintenance technician, diagnostic technicians, body & paint shop staff), standard automotive workshop areas (mechanical shop, body & paint shop, service station, auto parts warehouse, reception, parking area, AC repair pit, training area, mess, engine overall shop, library etc.), 3S Dealership.

**Service Operation Management:** Standard Service Transaction, Customer Appointments, Work Control, Customer Reception, Reception Diagnosis, Repair Orders, Quality Control, Active Delivery, Follow-up Calls, Customer Database, workshop Control, Vehicle Security

and Immobilizer Systems, use of Workshop Manuals, Wiring Diagrams, Understanding the Periodic Maintenance Procedures as per Manufacturer's standards, Service Fast Track Processes and work Flow Management.

**Development of Communication and Interpersonal Skills:** Service Advisor's Role, Interpersonal Skills in Service Transactions, Positive First Impression, active listening and clear explanation, Complaint Handling, Business Strategies in after sales Industry, Manufacturer's Trainings for after sales Staff, Time Management, Technical Report, Service Bulletin, Warranty Reports.

**Dealership Equipment Workshop and Compliance:** Common tools, special service tools (SST), types of lifts, workshop equipment's, standard & quality control, certifications, Layout, health & safety requirements, flooring, Equipment Installation and Calibration.

### **AU-417 Automotive Paints and Coatings**

**Introduction:** Paints and coatings, Classification of Paints and coatings, Scope of Automotive Paint Industry, Current Paint Manufacturers.

**Automotive Painting Processes:** General Painting Process, Pretreatment, Sand and Shot blasting Sequence of Treatment, Degreasing, Activation, Zinc Phosphating, Baking Oven, Passivation, Pre-Treatment of multi-metal car bodies, Pre-Treatment of Plastic Parts, Car Body Pre Treatment Lines, Primer Surface, Sealing and Underbody Protection, Top Coats and Clear Coats.A

**Electro Deposition (ED) Coatings:** Types of ED coatings. Difference between Anodic and Cathodic ED Paint Process. Layout of an ED Paint Shop. Design of Car ED Lines. General Functions and Equipment of an Electro-coat Line.

**Paint Shop Design and Quality Aspects:** Typical Layout of an Automotive Paint Shop, The designing of an Automotive Paint Shop, Design capacity of Paint Shop, Quality Aspects, measurement of Paint thickness, measurements of basic paint properties (Viscosity, scratch resistance, stone chip resistance), Leak and shower test.

**Paint Defects during Applications and their Prevention:** Paint Defects, Why defect appears and How to repair the defects, Prevention of paint defects.

### **AU-451 Product Design & Development**

#### **Marketing Primer:**

Definitions of Marketing, Product and New Product; B2C and B2B products; Marketing mix; Segmentation, Targeting, Differentiation and Positioning; Cost and value based pricing; Value proposition and Business model canvass. Innovation and Blue Ocean Strategy.

#### **Product Design and Development Process:**

Role of Design in engineering and marketing, Examples of bad designs, Product life Cycle (PLC) curve; Stages of product development process, Booz Allen Hamilton (BAH) model; Stage-Gate model.

#### **Opportunity Identification and Concept generation:**

Types of Opportunities, Market gap analysis, Opportunity screening; Ideation and concept generation, brainstorming, Product attributes and dimensions, Identifying customer needs and values, Design thinking methodology in concept generation; Need-Form-Technology model for product concept.

**Concept Selection and Testing:**

Concept screening and scoring techniques; User testing and feedback, ATAR Model of forecasting, Product protocol.

**Product Design and Development:**

Product architecture, Modularity, Scalability; product platform, Iterative design process; Design for X (Assembly, Manufacturability, Environment, Quality etc.); User-centered design principles; CTQ (Critical to Quality) trees, House of Quality. Prototyping methods and tools, Materials selection for product design, Design thinking in product development.

**Product and Project Management:**

Product launching; Project planning and scheduling; Budgeting and resource allocation; Risk management in product development.

**Introduction of Intellectual property (IP):**

Patents, Copyrights, Trademarks, Trade Secrets and Industrial Designs.

**AU-453 Introduction to Robotics****Fundamentals of Robotics**

Classification of Robots; History of Robotics; Advantages and Disadvantages of Robots; Robot Components; Degrees of Freedom; Robot Configurations; Robot Applications.

**Robot Kinematics and Inverse Kinematics**

Robots as Mechanisms; Homogeneous Transformation Matrices; Forward and Inverse Kinematics of Robots; Denavit-Hartenberg Representation of Forward Kinematic; Inverse Kinematic Solution of Robots; Dexterity

**Differential Motions and Velocities**

Differential Relationships; Differential Motions of a Frame; Interpretation of the Differential Change; Differential Changes Between Frames; Differential Motions of a Robot and Its Hand Frame; Calculation of the Jacobian; Relation between Jacobian and the Differential Operator; Inverse Jacobian.

**Dynamic Analysis and Forces**

Lagrangian Mechanics A Short Overview; Dynamic Equations for Multiple-Degree-of-Freedom Robots; Static Force Analysis of Robots; Transformation of Forces and Moments Between Coordinate Frames.

**Trajectory Planning**

Path vs. Trajectory; Joint-Space vs. Cartesian-Space Descriptions; Basics of Trajectory; Joint-Space Trajectory Planning; Cartesian-Space Trajectories; Continuous Trajectory Recording.

**Sensors and Actuators**

Sensor Characteristics; Position Sensors; Velocity Sensors; Acceleration Sensors; Force and Pressure Sensors; Light and Infrared sensors; Touch and Tactile Sensors  
Characteristics of Actuating Systems; Comparison of Actuating Systems; Hydraulic Devices; Pneumatic Devices; Electric Motors; Microprocessor Control of Electric motors; Speed Reduction.

**AU-454 Autonomous Vehicles****Introduction to Autonomous Vehicles**

Definition, history, and evolution of autonomous vehicles; Levels of autonomy (SAE levels); Current state and future trends in autonomous vehicle technology

**Sensing Technologies**

Overview of sensors used in autonomous vehicles (LiDAR, Radar, Cameras, etc.); Sensor fusion techniques; Challenges and limitations in sensing technologies

### **Perception and Computer Vision**

Image processing and computer vision for object detection and recognition; Deep learning techniques in perception; Case studies on perception algorithms

### **Control Systems and Decision Making**

Basics of control systems in autonomous vehicles; Decision-making algorithms and path planning; Simulations and practical applications

### **Localization and Mapping**

GPS and alternative localization methods; Simultaneous Localization and Mapping (SLAM); Challenges in achieving accurate localization

### **Vehicle-to-Everything (V2X) Communication**

Communication protocols for V2X communication; Cooperative and connected autonomous vehicles (V2V); Security and privacy considerations

### **Regulations and Ethics**

Regulatory landscape for autonomous vehicles; Ethical considerations in autonomous vehicle technology; Case studies on accidents and legal implications

## **AU-455 Automotive Embedded Systems**

### **Introduction**

Basic components of embedded systems, applications in automotive; general features and classification of automotive embedded systems.

### **Microcontroller and Programming**

Internal architecture; controller memory organization; special function registers; addressing modes; programming instructions (arithmetic, data transfer, logical, Boolean and branching); timer operation; serial port operation and modes of operation, interrupts; programme design using interrupts, assembly language programming.

### **Memory and Storage**

Basics of semiconductor memory, Random Access Memory (RAMs), Read-Only Memory (ROMs), Programmable ROMs (PROMs and EPROMs), flash memories, memory expansion, special types of memories, magnetic and optical storage, testing memory chips.

### **CAN and Communication Networks**

Introduction to CAN (Controller Area Network); Network fundamentals and advantages of communication and network modules; Types of communication, Network classification based on SAE, Vehicles Applications of CAN (Controller Area Network), Automotive embedded software applications and AUTOSAR framework.

## **ME-423 Computer Aided Design/Computer Aided Manufacturing**

### **COMPUTER AIDED DESIGN (CAD)**

Introduction, The design process, Application of computers for design, Creating the manufacturing data base, Benefits of CAD.

The design workstation, Graphics terminal, Operator input devices, Plotters and other output devices, The central processing unit, Secondary storage.

The software configuration of a graphics system, functions of a graphic package, Constructing the geometry, Data base structure and content, Wire-frame versus solid modeling, other CAD features and CAD/CAM integration.

Two dimensional transformations, Translation, Scaling and rotation, Concatenation, Various techniques for design optimization, finite element analysis / modeling.

### **COMPUTER AIDED MANUFACTURING (CAM)**

Introduction, basic components of an NC system, The NC procedure, NC coordinate systems, NC motion control systems, Applications of numerical control, Economics and justification 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.

Problems with conventional NC, NC controller technology, Computer numerical control, Direct numerical control, Adaptive control machining systems, Trends and new developments in NC.

Robot anatomy, Accuracy and repeatability, Robot specifications, End effectors, Characteristics of robot applications, Robot cell design, Types of Robot applications

### **ME-425 Finite Element Analysis**

Introduction to general Numerical Techniques; Basic concepts regarding finite element analysis; Matrix stiffness method; Minimum potential energy formulation; Recent developments.

Finite element modeling, element division and numbering scheme; Basic steps in FEA (Pre-processing, solution, post processing); Finite element Analysis of Bar element; Finite element Analysis of Truss; Finite element Analysis of Beam; Finite element Analysis of Frame.

Governing Differential Equations; Transformation of Differential equation into FE equations; Treatment of boundary conditions (Elimination approach, penalty approach); Variational Formulation of boundary value problem; Methods of weighted residuals (Galerkin, Collocation, least square, sub-domain); Rayleigh Ritz Method.

Interpolation techniques (Triangular, Rectangular); shape functions; Lagrange interpolation function; Analysis of one dimensional problems (Linear, Quadratic, Cubic elements); Analysis of two dimensional elements; Integration on master scale, modeling, mesh generation; Gaussian Quadrature formulae, One point form, two point form.

Convergence of solution; Various measures of errors; FEA application to Heat Transfer problems; FEA application to Fluid Mechanics problems; FEA application to Solid Mechanics problems.

Assumptions of plane elasticity; Basic equations; Formulation of Plane stress problems; Explicit expression for Constant strain triangular element stiffness matrix; Finite element solution of a Plane stress problem.

### **ME-430 Mechatronics**

Introduction to Mechatronic Systems: Historical perspective of Mechatronic systems, key components of a mechatronic system; design considerations and specifications.

Mechanisms for motion transmission: Introduction; Rotary to Rotary Motion Transmission Mechanisms: Hydraulics and Pneumatics, Gears; Belt and Pulley. Rotary to Translational Motion Transmission Mechanisms: Lead-Screw and Ball-Screw Mechanisms; Rack and Pinion Mechanism. Cyclic Motion Transmission Mechanisms: Linkages; Cams.

Electronic components for Mechatronics: Basics of Linear Circuits; Equivalent Electrical Circuit Methods; Semiconductor Electronic Devices; Operational Amplifiers; Basic Op-Amp;

Common Op-Amp Circuits; Digital Electronic Devices; Logic ; Decoders ; Multiplexer; Flip-Flops; Digital and Analog I/O; D/A and A/D Converters; Microcontroller and Microprocessor.

Sensors and Actuators: Sensor types or classifications, principles of operation, selection criteria, signal conditioning and calibration, electrical and optical sensors; sensors for measuring displacement, strain, force, pressure, temperature, flow and motion. Actuator types or classifications, principles of operation, selection criteria. Electro-mechanical actuators: permanent magnet DC motors, stepper motors, servo motors; pneumatic and hydraulic actuators, characteristics of sensors & actuators.

System Interfacing using Microcontrollers Data acquisition; Interfacing, Ports, Input/Output, Analog to Digital converter, sampling theory, Digital to Analog converter. Sample and hold, multiplexer, Interfacing switches, LEDs, stepper motors and DC motors to microcontrollers.

Industrial Applications of Mechatronic Systems: Applications in manufacturing, robotics, process control.

### **ME-432 Health Safety & Environment**

Safety Management & Hazard Communication: Understanding safety, hazards and accidents, company policy and management responsibilities, professional certification and societies (NIOSH, NEBOSH, IOSH, OSHA), MSDS (Material Safety Data Sheet).

Accident Prevention & Control: Accident causes & their control, recordkeeping and forms, accident cause analysis, safety & health economics, trainings, concept of hazard avoidance (FMEA, Fault Tree Analysis).

Building & Facilities: Walking & working surfaces, exits, illumination, sanitation, miscellaneous facilities (scaffolding, elevators, boilers etc.), fire protection

Ergonomics & Safety: Facets of Ergonomics, workplace musculoskeletal disorders, ergonomics standards and risk analysis, NIOSH lifting equation.

Health, Toxic & Environment: Toxic substances, measures of exposure, detecting contaminants, ventilation, noise and radiation, flammable and explosive materials.

Personal Protective Equipment & First Aid: Protection need assessment, PPE Training; hearing, eye and face respiratory protection, confined spaces, first aid. Material handling and storage, machine guarding, welding, electrical hazards, construction hazards.

Operations Occupational Safety: Power plant operations (preventing steam/condensate system accidents), safe operations at chemical plants, offshore drilling hazards. Boiler safety & accidents control.

### **MG-483 Supply Chain Management**

- Introduction to Supply Chain management, Historical perspective of Supply Chain, Objective and Importance of Supply chain Decisions, Process views of Supply Chain.
- Financial measures of Supply Chain, Drivers of Supply Chain performance
- Supply Chain designing, Network designing in supply chain, Global supply chain networks
- Coordination in Supply chain , Bullwhip effect
- Transportation in Supply chain

### **AU-430 Quality Management & Reliability**

**Introduction to Quality:** Definition and dimensions of quality, Quality control and Assurance, Cost of quality and its related indices, Vision, Mission and Quality Policy, Customer satisfaction and feedback system.

**Statistical Process Control:** Controls charts for mean standard deviation and proportion defective, process capability indices, Acceptance sampling, single and multiple sampling, introduction to six-sigma, DMAIC.

**Japanese Production System:** Principles and operating strategies, Takt-time, Quality circle, Kanban 5S, Pokayoka, Cost concept, 3M (Mura, Muri, Muda).

**TQM:** Pareto, Flow chart, Cause and Effect diagram, Failure Mode & Effect Analysis (FMEA), Improvement Strategies, Lean concepts and waste reduction methods, PDCA Cycle, KAIZEN, Quality Function Deployment (QFD), Introduction to Quality Management System (ISO).

**Reliability:** Definition, failure rate functions, Hazard functions, Reliability function, Weibull distribution, Bath-tub curve, series parallel reliability network, MTBF, MTTR, Availability, Product liability and warranty.

### **EA-321 Logic & Critical Thinking**

**Introduction to the Study of Logic:** Definitions, Terminology, Concepts of Logic & Critical Thinking. Scope and Impact. Why study logic and critical Thinking- Intellectual Moral Virtues. Basic Principles of Logic: Structure of an Argument, Valid/Invalid versus Sound/Unsound argumentation, Deduction versus Induction, Three classical Aristotelian Laws of Logic, Principle of sufficient reason; Deductive reasoning- Syllogism, Linear ordering, Tree diagrams; and Inductive Reasoning - Valid and invalid arguments. Fallacies.

**Thinking:** Thinking process while working towards goals, making decisions and analyzing issues. Thinking tools and their applications. Simple tools (e.g. facts and opinions, verification of sources and credibility of authorities etc.); Theoretical Frames (e.g. Scientific Methods/Approach etc.) and Formal Tool (e.g. PMI, STAR method, Shewhart Cycle, Socratic Method, RW & D, Quality Thinking- Paul & Elder Framework etc.)

**Thinking Critically:** Critical Thinking standards: clarity, precision, accuracy, relevance, consistency, logical correctness, completeness, and fairness. Barriers to Critical Thinking: Egocentrism, sociocentrism, unwarranted assumptions and stereotypes, relativist thinking, and wishful thinking. Critical Thinking Approach: Thinking actively, using questions for probing situations, evaluating our evidences and their types, Impartial versus adversarial critical thinking.

**Critical Thinking in Everyday Life:** Problem Solving: Defining a problem, attitudes towards problems-general and desired, Problem solving process, case studies on problem analysis Perceiving: Defining perception and its prominence in succeeding through life, Critical thinking and perception, Evaluating the differences in perception (through tests, optical illusions etc.), Perception processes, Factors governing perception, Difficulties / errors in perception process (perceptual errors). Believing and Knowing: Believing versus knowing, values and their types, identifying one's values in life; defining and classifying beliefs, Accuracy scale for evaluating thoughts, Thinking patterns and organizing concepts, Ways to Organize Thoughts, Types of causal relationships – causal chains, contributory and interactive causes.