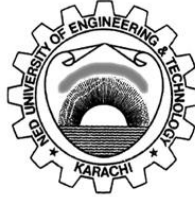


# DEPARTMENT OF MECHANICAL ENGINEERING



## SYLLABI OF COURSES

FOR

**B.E. (MECHANICAL) DEGREE PROGRAMME**

# **DEPARTMENT OF MECHANICAL ENGINEERING**

## **SYLLABI OF COURSES FOR B.E (MECHANICAL) ENGINEERING PROGRAMME**

**BATCH: 2014**

**NED UNIVERSITY OF ENGINEERING & TECHNOLOGY,  
KARACHI-75270, PAKISTAN**

## COURSE TITLES FOR B.E MECHANICAL ENGINEERING PROGRAMME

<b>FIRST YEAR</b>									
<b>Spring Semester</b>					<b>Fall Semester</b>				
<b>Course Code</b>	<b>Course Title</b>	<b>Credit Hours</b>			<b>Course Code</b>	<b>Course Title</b>	<b>Credit Hours</b>		
		<b>Th</b>	<b>Pr</b>	<b>Total</b>			<b>Th</b>	<b>Pr</b>	<b>Total</b>
CY-105	Applied Chemistry	3	1	4	PH-121	Applied Physics	3	1	4
MT-111	Calculus	3	0	3	HS-101	English	3	0	3
CE-103	Engineering Surveying-I	3	1	4	EE-116	Principles of Electrical Engineering	3	1	4
ME-102	Engineering Drawing	3	1	4	ME-103	Thermodynamics	3	1	4
HS-105	Pakistan Studies OR	2	0	2	ME-104	Workshop Practice	0	2	2
HS-127	Pakistan Studies (for Foreigners)				ME-106	Statics	2	1	3
<b>SECOND YEAR</b>									
<b>Spring Semester</b>					<b>Fall Semester</b>				
<b>Course Code</b>	<b>Course Title</b>	<b>Credit Hours</b>			<b>Course Code</b>	<b>Course Title</b>	<b>Credit Hours</b>		
		<b>Th</b>	<b>Pr</b>	<b>Total</b>			<b>Th</b>	<b>Pr</b>	<b>Total</b>
EL-232	Electronics	3	1	4	MT-223	Ordinary Differential Equations & Fourier Series	3	0	3
ME-201	Internal Combustion Engines	3	1	4	ME-202	Solid Mechanics - I	3	1	4
ME-203	Production Engineering - I	3	1	4	ME-204	Fluid Mechanics - I	3	1	4
ME-207	Computer Programming & Graphics	2	1	3	ME-205	Elements of Machine Dynamics & Design	3	1	4
ME-213	Dynamics	2	1	3	ME-209	Materials & Metallurgy	3	1	4
HS-205	Islamic Studies OR	2	0	2					
HS-209	Ethical Behaviour (for Non-Muslims)								
<b>THIRD YEAR</b>									
<b>Spring Semester</b>					<b>Fall Semester</b>				
<b>Course Code</b>	<b>Course Title</b>	<b>Credit Hours</b>			<b>Course Code</b>	<b>Course Title</b>	<b>Credit Hours</b>		
		<b>Th</b>	<b>Pr</b>	<b>Total</b>			<b>Th</b>	<b>Pr</b>	<b>Total</b>
HS-304	Business Communication & Ethics	3	0	3	MT-332	Advanced Calculus & Linear Algebra	3	0	3
MT-330	Applied Probability & Statistics	2	1	3	EE-373	Machine Control System	3	1	4
ME-302	Solid Mechanics - II	3	1	4	MF-303	Applied Economics for Engineers	3	0	3
ME-306	Mechanical Vibration	3	1	4	ME-303	Steam Generation & Steam Turbines	3	1	4
ME-307	Production Engineering – II	3	1	4	ME-304	Fluid Mechanics - II	3	1	4
					ME-305	Machine Design	3	1	4
<b>FINAL YEAR</b>									
<b>Spring Semester</b>					<b>Fall Semester</b>				
<b>Course Code</b>	<b>Course Title</b>	<b>Credit Hours</b>			<b>Course Code</b>	<b>Course Title</b>	<b>Credit Hours</b>		
		<b>Th</b>	<b>Pr</b>	<b>Total</b>			<b>Th</b>	<b>Pr</b>	<b>Total</b>
ME-403	Refrigeration & Air Conditioning	3	1	4	MT-441	Advanced Mathematical Techniques	3	0	3
ME-406	Heat Transfer	3	1	4	ME-402	Gas Turbines	3	1	4
ME-415	Operations Management	3	1	4	ME-405	Gas Dynamics	3	1	4
ME-####	Elective Course 1	3	1	4	ME-####	Elective Course 3	3	1	4
ME-####	Elective Course 2	3	1	4	ME-409	Mechanical Engineering Project	0	6	6
ME-409	*Mechanical Engineering Project	-	-	-					
<b>ELECTIVE COURSES</b>									
	ME-401	Stress Analysis							
	ME-404	Nuclear Power							
	ME-410	Computer Aided Design / Computer Aided Manufacturing							
	ME-412	Clean Energy Technology							
	ME-413	Finite Element Analysis							
	ME-416	Plant Maintenance							
<i>* Duration one academic year: Requires literature survey and preliminary work during this Semester</i>									

# **FIRST YEAR**

## **SPRING SEMESTER**

### **CY 105 APPLIED CHEMISTRY**

#### **Gases**

Gas laws, Kinetic gas equation, Vander Waal's Equation, critical phenomenon, Liquidification of gases, Specific heat (molar heat capacity).

#### **Properties of Solutions and Liquids**

Surface tension, Viscosity, Osmosis, Osmotic pressure, PH-Buffer Solution, Spectrophotometer, Basic concepts of colloidal chemistry, Classification purification (Dialysis).

#### **Thermochemistry**

Chemical thermodynamics, Hess's Law, Heat of reaction, Relation between H and U, measurement of heat of reaction, Bomb calorimeter.

#### **Electrochemistry**

Laws of Electrolysis, EMF series, Corrosion: Theories, inhibition and protection.

#### **Water and Sewage**

Sources of water, Impurities, hardness, Water softening, Purification of water for potable and industrial purposes, Electro dialysis, Introduction to environmental pollution, Main sources and effects, Sewage treatment.

#### **Fuels**

Types of fuels, Classification of fossil fuels.

#### **Metals and Alloys**

Properties and general composition of metals and alloys such as Iron, Copper, Aluminum, Chromium and zinc used in engineering field.

#### **Engineering Materials**

Inorganic Engineering materials: Cement, Glass, Organic Engineering Materials: Polymers, Rubbers, Plastics and Paints, Semiconductors and Dielectric materials.

#### **Practical**

Determination of total alkalinity of a given sample, Determination of total acidity of a given sample, Determination of the amount of ferrous ions in a given sample: Determination of total hardness of a given sample of water, Determination of surface tension of a given sample, Determination of coefficient of a given sample, Determination of chloride ions in a given sample, Determination of bicarbonate and Carbonate ions in a given sample, Determination of turbidity in a given sample by precipitation, Determination of turbidity in a given a sample by spectrophotometer, Plotting of titration curve and determination of total alkalinity in a given sample, Plotting of titration curve and determination of acidity in a given sample, Plotting a calibration curve and determination of ions present in a given sample.

### **MT 111 CALCULUS**

#### **Set and Functions**

Define rational, Irrational and real numbers, Rounding off a numerical value to specified number of decimal places or significant figures, Solving quadratic and rational inequalities in involving modulus with graphical representations, Definition of set, 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.

### **Propositional Logic**

Definition of Proposition, Statement and argument, Logical operators, Simple and compound proposition, various types of connectives, Truth table, Tautology, Contradiction, Contingency and logical equivalence.

### **Boolean Algebra**

Definition, Boolean function, Duality, Some basic theorems and their proofs, Two valued Boolean algebra, Truth functions, Canonical sum of product form, Digital logic Gates and switching circuit designs.

### **Complex Number**

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).

### **Differential Calculus**

Differentiation 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'Hopital's rule, Extreme values 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.

### **Solid Geometry**

Coordinate systems in three dimensions, Direction cosines and ratios, Vector equation of a straight line, plane and sphere, Curve tracing of a function of two and three variables, Surfaces of revolutions, Transformations (Cartesian to polar and cylindrical).

## **CE 103 ENGINEERING SURVEYING - I**

General Principles of Surveying, Determination and plotting of positions, Scales, Errors and degree of accuracy required.

### **Chain Surveying**

Chains and tapes, Optical square and other instruments, Ranging and chaining line errors in chaining, Field book, Plotting chain survey, Obstacle surveying.

### **Compass surveying**

Prismatic and surveyor's compasses, Meridians, Bearings, Declination and local attraction traversing, Adjustment of compass surveying.

### **Theodolite Surveying**

Types of theodolites and their structure handling and care of instruments, Temporary adjustment of Theodolite, Measurement of Bearings and horizontal and vertical angles, Use of theodolite as leveling instrument.

### **Plane Table Surveying**

Plane table and accessories, Adjustment and orientation methods of plane table surveying, Merits and demerits of plane tabling, Contouring with tangent clinometers, Two point and three point problems.

Box sextant structure adjustment and use for measuring angles.

### **Leveling**

General principles of leveling, Optics of surveying, Telescope and their structure, Types of levels, Temporary and permanent adjustment, Methods of leveling, Level books, Reduction of levels and checks.

Leveling for longitudinal section and cross section, Plotting precautions in leveling, Sources of error, Corrections for covalence and refraction.

## **ME 102 ENGINEERING DRAWING**

Drawing equipment and the use of instruments, Basic drafting techniques and standards, Geometrical curves including plane curves, Cycloid, Hypocycloid and involute.

Intersections at various positions of geometrical bodies such as prisms, Pyramids, Cylinders and cones: Development of surfaces of prisms, Pyramids, Cylinders and cones.

Freehand sketching of machine, Engine components, Locking arrangements, Foundation bolts, Stuffing box, Shaft couplings, Foot step bearing pulleys, Engine connecting rod.

Concept of working drawing of component parts of machines and engines size description, Dimensions and specifications, Limit dimensioning and geometric tolerancing, Limits; Fits and tolerances, Conventional symbols.

Sectioning of machine and engine components, Orthographic projections and standard practices.

Isometric views with particular reference to piping and ducting.

## **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 conditions, Geo-political and strategic importance of Pakistan, Natural resource 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, 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 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 hazards, 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 Neighbours, Super Powers and the Muslim World.

### **Human Rights**

Conceptual foundations of Human Rights, What are Human Rights? Definition, origins and Significance, Comparative analysis of Islamic and Western Perspective 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 elimination of all forms of discrimination against women (CEDAW), International 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 provisions, Pakistan's Obligations to international treaties and documents, Human Rights issues in Pakistan – a critical analysis, Pakistan's stand on violation of Human Rights in the international perspective.

## **HS 127 PAKISTAN STUDIES (FOR FOREIGNERS)**

### **Contemporary Issues in Pakistan:**

#### **A brief survey of Pakistan's Economy**

Agricultural and industrial development in Pakistan, Internal and external trade, Economic planning and prospects

#### **Social issues**

Literacy and education in Pakistan, State of science and technology with special reference to IT education, Pakistan society and culture.

#### **Environmental issues**

Hazards of atmospheric pollution, Other forms of environmental degradation, their causes and solutions, Pakistan's role in preservation of nature through international conventions/efforts.

#### **Foreign Policy**

Relations of Pakistan with neighbours, Relations with Super powers, Relations with Muslim world.

#### **Human Rights: Conceptual foundations of Human Rights**

What are Human rights? Definition, significance and importance, Comparative analysis of Islamic and western Perspectives of Human rights.

#### **UN System for Protection of Human rights - an over-view**

UN Charter, International Bill of Human Rights, Implementation mechanism.

#### **Other important international treaties and conventions**

The convention on the elimination of all forms of discrimination against woman, International Convention on the rights of child (CRC), Convention against torture (CAT), Refugee Convention.

#### **Pakistan's response to Human rights at national and international level**

Constitutional Provisions, Pakistan's obligations to international treaties and documents, Minority rights in Pakistan, Pakistan's stand on violation of Human rights in the international perspective.

## **FALL SEMESTER**

### **PH 121 APPLIED PHYSICS**

#### **Introduction**

Scientific notation and significant figures, Types of errors in experimental measurements, Units in different systems, Graphical techniques (Log, Semi-log and other non-linear graphs)

#### **Vectors**

Review of vectors, Vector derivatives, Line and surface integrals, Gradient of 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, Paramagnetism 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 Lasers**

Harmonic traveling 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, Plank's explanations of black body radiation, Photoelectric effect, Compton effect, Bohr theory of hydrogen atom, 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.

## **HS 101 ENGLISH**

### **Study Skills**

Reading, dictionary, library skills, speed reading, writing outlines, note taking,

### **Oral communication**

Confidence building, class discussions, speeches, verbal interaction

### **Advanced reading comprehension:**

Using texts dealing with science, literature and human rights (as per HEC recommendation.)

### **Précis writing**

Rules of précis writing, practice précis.

### **Controlled and guided writing**

Pre writing (planning, information gathering, preparing to write), writing, search for topic sentences, developing a theme, following up ideas and arguments , outline plans etc.

### **Essay writing**

Types of writing – narrative, descriptive, expository, argumentative etc. , Using guided writing to organize essays., Including human rights as essay topics (as per HEC recommendation).

### **Writing short reports**

Short background of report and its importance, memo report, brief reports on events seen / experienced like visit to an exhibition etc.

### **Letter writing**

format and layout, formal letters, types of letters – invitations (acceptance and refusals), condolence, thanks, congratulations, to the editor, chairman class advisor, dean, vice chancellor etc.

### **Applied Grammar**



Morphology, types of sentences, sentence analysis, tenses, jumbled sentences, question tags, homonyms and homophones and their use in sentences, punctuation – sentences and paragraphs, use of idioms

## **EE 116 PRINCIPLES OF ELECTRICITY AND ELECTRONICS**

### **Electric and Magnetic Circuits**

Electric circuits, Kirchoff's laws, Superposition theorem, Substitution theorem. Thevenin's theorem, Norton's theorem, Rosen's theorem of star / mesh transformation, Proof for DC circuits and their application to circuit analysis, Magnetic circuit, Series and parallel circuits, Principles of calculation of ampere turns for magnetic circuits of electromagnets, Transformers, Bipolar and multipolar DC machines Inductances in series and parallel, Hysteretic loss, Eddy current loss, Lifting power of magnet.

### **AC Single phase and Polyphase Systems**

Single-Phase systems, Series, Parallel and series parallel circuits, J operator method and polar method. Resonance and measurement of power and power factor, Polyphase systems, Polyphase generation, Star and delta connections, Voltage and current relations, Measurement of power and power factor, Balanced and unbalanced load analysis.

### **DC Machines**

Construction: Simple lap and wave windings, Equalizing connections and dummy coils, Elementary concept of armature reaction and commutation, Cross and demagnetizing ampere turns, DC generator, Types, EMF equation, Losses, Efficiency, Performance curves, Characteristics, Critical resistance and speed and effect of armature reaction of OCC, Internal and external characteristics from OCC neglecting and accounting armature reaction, Calculation of series ampere turns for level and over compounding. Motors, Principle, Back EMF, Torque, Speed and speed regulation, Types, Characteristics, Performance curves, Losses and efficiency, Speed and torque problems involving magnetization curve, Charging and ignition circuits of automobiles.

### **AC Synchronous Machine**

Construction: Stator single layer, Double layer and concentric windings, Damping windings, Coil span factor, Distribution factor, Leakage and armature reaction, Synchronous impedance, Alternators, Types, EMF equation, Speed and frequency, Losses and efficiency, Alternator on load voltage regulation by synchronous impedance method, Synchronous Motors, Types, Principle of working, Vector diagram on load and its analysis for stator current, Power factor, Torque and mechanical output, Effect of variation of excitation, Losses and efficiency.

### **AC Induction Machines**

Induction Motors, Construction, Types, Rotating field theory, Principle of working, Slip and its effect on motor current quantities, Losses, efficiency and performance curves, Starting, Full load and maximum torque relations, Torque slip characteristics.

### **Transformers**

Construction: Principle of working, EMF equation, Transformation ratios, No load working and vector diagram, Magnetizing current, Vector diagram on load, Equivalent circuit, Open circuit and short circuit tests, Losses, Efficiency and performance curves, All day efficiency, Percentage and per unit R,X and Z Voltage regulation and Kapp's regulation diagram, Transformer as a mutually inductive circuit.

### **Converting Machines**

Rotary converters: Construction, Principle of working, Transformer connections, Voltage and current ratios of single and three phase converters, Mercury arc rectifiers, Construction, Operation, Transformer connections, Voltage and current ratios of single phase and three phase rectifiers.

## **ME 103 THERMODYNAMICS**

### **Thermodynamic Properties**

Introduction, Working substance, System, Pure substance, PVT surface, Phases, Properties and state, Units, Zeroth law, Processes and cycles, Conservation of mass.

### **Energy and its conservation**

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.

### **Energy and property relations**

Thermodynamic equilibrium, Reversibility, Specific heats and their relationship, Entropy, Second law of Thermodynamic property relation from energy equation, Frictional energy.

### **Ideal Gas**

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.

### **Thermodynamic Cycles**

Cycle work, Thermal efficiency and heat rate, Carnot cycle, Sterling cycle, Reversed and reversible cycles, Most efficient engine.

### **Consequences of the Second Law**

Clausius inequality, Availability and irreversibility, Steady flow system.

### **Two-Phase Systems:**

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 ancillary equipment.

### **Internal Combustion Engines**

Otto cycle, Diesel cycle, Dual combustion cycle, Four stroke and two stroke engines, Types of fuels.

### **Reciprocating Compressors**

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:

Soldering and brazing, Welding, Heat treatment, Moulding and casting.

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

## **ME 106 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**

### **SPRING SEMESTER**

#### **EL 232 ELECTRONICS**

##### **Conduction in Solids**

Introduction, Mechanics of conduction, Mobility, Bohr's model for the elements, Energy level diagrams for solids, Conductors, Intrinsic and extrinsic semiconductors, Electron-hole pairs in an intrinsic semiconductor, Distribution of electron and hole in conduction and valence bands, Recombination and lifetime.

##### **Semiconductors and Diodes**

Donor and acceptor impurities, Zero biased, Forward biased and reverse biased junction diodes, Junction diode current equation, Depletion barrier width and junction capacitance, Diffusion capacitance, Zero and Avalanche break down, Hall effect, Fabrication of pn junction, Diodes.

##### **Electron Emission Devices**

Types of electron emissions, Thermionic diode, Volt ampere characteristics, Child Langmuir power Law, Gas filled diode, Thermionic triode, Parameters and characteristics, Tetrode, Pentode, and beam power tubes, Parameters and characteristics.

##### **Simple Diode Circuits and Applications**

Mathematical and graphical analysis of diode circuits, The ideal and non ideal diodes, Piecewise linear models, Analysis of piecewise linear models of vacuum tube and junction diodes, The half wave rectifier, The inductance filter, The inductance capacitance filter circuits, Zener and gas diode, Voltage regulator circuits, Clamping and DC restorer circuits, Voltage doubler circuits, Clipping and limiting circuits.

##### **Bipolar and Field Effect Transistors**

Transistor biasing and thermal stabilization, The operating point, Bias stability, Collector to base bias, Fixed bias, Emitter feedback bias, Stabilization for the self biased circuits, Field effect transistors, Basic principles and theory, Types, FET characteristics, Different configurations-common gate, Common source and common drain, The FET, small signal model, Parameters, Biasing of the FET.

### **Amplifier Circuits**

Introduction “h” parameters, Hybrid model for transistor, Elementary treatment, Low frequency transistor amplifier circuits, Stage cascaded LF.

## **ME 201 INTERNAL COMBUSTION ENGINES**

### **Basic Engine Types and their Operation**

Four-stroke spark ignition engine, Speed and load control in S.I engine, The Four-stroke compression Ignition Engine, Speed and Load Control in C.I engine, The two-stroke cycle, Supercharging, Wankel rotary engine.

### **Testing**

Measurement of engine torque and power, Dynamometer principle, Different types of dynamometers: Measurement of brake and indicated horse power, Mechanical pressure indicators, Use of indicator diagram.

### **Combustion**

Combustion Equations, Heat of Combustion, Higher and lower heating values, Adiabatic flame temperature.

### **Equilibrium Charts**

Idealized cycles and processes, The diesel cycle, The dual cycle, Regenerative cycles, Brayton cycle.

### **Fuels**

The natural fuels, Non-petroleum fuels, Characteristics of S.I and C.I engine fuels, LPG as I.C. engine fuel, Octane and Cetane number, Knock and engine Variable: Autoignition in S.I and C.I engines, Knock and S.I engine, Knock and the C.I engine.

### **Exhaust Gas Analysis and Air Pollution**

Air Pollution and the engine, Air pollution and the fuel, Control of exhaust-Gas constituents.

### **Fuel Metering- SI Engines**

The Engine requirements, The Elementary carburetor, Elements of complete carburetor, Calculation of Air: Fuel ratio, Gasoline injection system.

### **Fuel Metering-CI Engines**

C.I injection systems, C.I engine nozzles.

### **Engine Characteristics**

Heat transfer and the engine valve, Timing diagram.

### **Lubrication**

Engine-Lubrication systems: Engine performance and lubrication, Lubricants of different kinds.

## **ME 203 PRODUCTION ENGINEERING-I**

Types of manufacturing industries, materials used in manufacturing and properties of materials, different processing operation

### **Sand Casting**

Introduction, sand casting procedures, mold terminologies, heating and pouring of molten metal, molten metal problems, solidification process, cooling curve and cast structure for pure metals and alloys, pattern making, pattern material, types and construction of patterns, pattern allowances, core and core making, types of cores, sand conditioning, testing

of sand, molding process, tools and equipment, molding machines, types of casting: green sand casting, dry sand, skin dried sand, sodium silicate molding, shell molding, vacuum molding, plaster molding, ceramic molding, expendable graphite molding, investment casting, EPS casting, cleaning and finishing of castings, inspection of castings.

### **Permanent Mold Casting (PMC)**

Introduction, types of PMC, gravity die casting and its types like slush casting, low pressure and vacuum casting. Pressure die casting and its types such as hot chamber and cold chamber. Centrifugal casting and types. Furnaces used in PMC.

### **Metal Forming**

Fundamentals, types of metal forming processes, temperature in metal forming like hot, warm and cold working.

Bulk deformation processes:

**Rolling;** different types of rolled products, types of rolling such as flat rolling, shape rolling, thread, gear, ring rolling, rolling mill configurations.

**Forging;** open die drop hammer forging, impression die drop hammer forging, press forging, upset forging, roll forging, swaging, net shape forging, and isothermal forging.

**Extrusion;** extrusion of solid and hollow shapes, direct and indirect extrusion, hot and cold extrusion, continuous and discrete extrusion, impact extrusion, hydrostatic extrusion.

**Drawing;** bar drawing, wire drawing, 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 like slitting, blanking, piercing, cutoff, parting, dinking, slotting, perforating, notching, semi-notching, lancing, nibbling, trimming, shaving, fine blanking. Bending operations such as V bending, edge bending, flanging, curling, hemming, seaming. Drawing operations like deep and shallow drawing, embossing.

### **Welding Processes**

Classification of welding processes:

Fusion welding and its types such as oxyfuel gas welding ( and oxygen torch cutting), arc welding (such as shielded metal arc welding, flux cored arc welding, gas metal arc welding, submerged arc welding, gas tungsten arc welding, plasma arc welding, stud welding, Arc cutting), resistance welding (such as spot welding, seam welding, projection welding, Heating, pressure, Current control and Power supply for resistance welding) .

Solid state welding and its types like diffusion welding, friction welding and ultrasonic welding.

Other welding processes: Forge welding, Roll welding, Friction welding, Explosion welding, Thermic welding, Electron beam welding, 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.

## **ME 207 COMPUTER PROGRAMMING & APPLICATIONS**

### **Computer Classification**

Analogue computer, Hybrid computer, Mainframe, Minicomputer, Microcomputer (Personal Computer), Workstation, Super Computer.

### **Basic Units of Computer**

The system central unit, Processing capability, Word handling capability, Memory, Display, Keyboard,

### **Operation Systems:**

With GUI, Without GUI, UNIX, Concepts of LAN and WAN.

### **Application Programs**

Text editor, Presentation, Mathematical modeling, Simulation, Database, Utilities Programs, Programming, Languages.

### **Concept of Computer Programming Languages**

Variables, Constants, Data types (Char, Word, Integer, Floating), Assignments, Expressions, Operator and precedence, Looping, Pointers, Functions or procedures, Recursion, Back tracking, Program Heading and Declaration part, Modules main module, Language constructs (taking examples of C, Pascal or prolog), Structured programming, Software specification, Software design, Software coding, Software testing.

## **ME 213 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 Bodies**

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.

## **HS 205 ISLAMIC STUDIES**

### **Quranic Verses**

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

### **Basic Islamic Practices**

Al – Mu' minun-1-11, and two Ahadith

**Amer – Bil – Ma ' Roof Wa-Nahi Anil Munkar;** the concept of Good and 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

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

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

**Haquq-ul-Ibad;** Protection of life, Al-Maidah-32; Right to Property , Al-Nisa-29; Right to Respect and 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.

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

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

The

### **Seerat (life) of the Holy Prophet (PBUH)**

Birth, life at Makkah, declaration of prophet hood, preaching and its difficulties, migration to Madina, brotherhood (Mawakhat) and Madina Charter, The Holy Wars of the Prophet (Ghazwat-e-Nabawi), Hujjat-ul-Wida., The last sermon of Khutbatulwida: Translation and important points

### **Islamic Civilization**

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

## **HS 209 ETHICAL BEHAVIOUR** (Alternate Course for Non Muslim Students)

### **Ethics – An introduction**

Nature, Scope, sources and significance of Ethics, Ethics and Religion, Ethical Teachings of World Religions.

### **Basic Moral Concepts**

Right and Wrong, Good and Evil

### **An outline of Ethical systems in philosophy**

Hedonism, Utilitarianism, Rationalism and Kant , Self Realisation Theories, Intuitionism.

### **Islamic Moral Theory**

Ethics of Quran and its philosophical basis, Ethical precepts from Quran and Hadith and promotion of moral values in society.

## **FALL SEMESTER**

## **MT 223 ORDINARY DIFFERENTIAL EQUATIONS & FOURIER SERIES**

### **1<sup>st</sup> Order Differential Equations**

Basic concept, Formation of differential equations and solution of differential equations by direct integration and by separating the variables, Homogenous 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.

### **2<sup>nd</sup> and Higher Orders Equations**

Special types of 2<sup>nd</sup> order differential equations with constant coefficients and their solutions, The D-operator, Inverse operator 1/D, Solution of differential by D-operator 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 and 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  $t^n F(t)$  and  $F(t)/t$ , Laplace transform of periodic function, Evaluation of integrals, Definition of inverse 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 functions and their fourier series, Half range expansions of Fourier series, "DFT and FFT, Fourier Spectrum".

## **ME 202 SOLID MECHANICS-I**

### **Statically Determinate Frames and Beams**

Free body diagrams, Determination of forces in frames, Shear force and bending moment diagrams, Relationship between loading shear force and bending moment.

### **Statically Determinate Stress Systems**

Stress, Direct, Shear Hydrostatic and complementary shear stresses, Bar and strut or column: Thin ring or cylinder rotating, Stresses in thin shells due to pressure or self-weight.

### **Stress-Strain Relation**

Deformation; Strain; Elastic stress-strain behaviour 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; General case of bending; Composite Beams; Eccentric end load; Shear stresses in bending

### **Bending: Slope and Deflection**

Deflection curve of the neutral axis; Double integration and Super-position methods.

### **Theory of Torsion**

Torsion of thin-walled cylinder; Torsion of a solid circular shaft; Hollow shafts; Non-uniform and composite shafts, Tapered shaft, Torsion of thin rectangular strip, Torsion in helical springs.

### **Theory of Columns**

Euler's theory of buckling; Eccentric loading of long columns. Behaviour of ideal and real struts. Struts with initial curvature; Crinkling; Members subjected to axial and transverse loading.

## **ME 204 FLUID MECHANICS-I**

### **Fluid Properties**

Properties of fluids such as density, viscosity, compressibility, surface tension and capillary, types of fluids

### **Fluid Statics**

Pascals's law, Pressure in a fluid at a point, variation of pressure with depth, Homogeneous fluid, Several fluids of different specific weights, Interconnected vessels, Constant-velocity rotation of a liquid around-fixed axis,hydraulic circuits, Force on container wall, Force on flat surfaces: Force on curved surfaces, Buoyancy of fluid at rest, Stability of a floating body, Surface tension and capillary tubes.

Atmospheric equilibrium, Isothermal state, Adiabatic state, The standard atmosphere.

### **Fluid Dynamics**

System and control volume, classification of flows, velocity and acceleration fields, stream lines, path lines, and streak lines,Equation of continuity, Euler's equations of motion, Bernoulli's equation, Impulse and momentum, One dimensional viscous flow, Generalized Bernoulli's equation, Laminar and turbulent flow in circular pipes, Pipe flow problems, Flow in open channels.

### **Dimensional Analysis**

Buckingham- Pi Theorem, Reynolds' Law of Similitude, geometrical similarity, 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 205 ELEMENT OF MACHINE DYNAMICS AND DESIGN

### Machine Dynamics

Kinematics of Motion; kinetics of Motion; Simple Crank and Cam Mechanisms; Linkages; Types of Links; Structure; Kinematic Pair; Mechanism; Cams

### Principle of Design

Mechanical properties of Materials; Elasticity; Plasticity; Modulus of Resilience; Modulus of Toughness; Ductility, Brittleness; Endurance limits Hardness; Creep; Stress concentration; Notch Sensitivity; Wear, Theories of Failures including Fatigue failure; Soderberg and Goodman Diagrams; Design Parameters and Operating Conditions; Safety and Reliability in Design

### Introduction to 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.

## ME 209 MATERIALS AND METALLURGY

### Introduction

Material Science and Engineering, importance, Classification of Materials, Advanced Materials

### Metallic Materials

Structure of Crystalline Solids: Unit Cells, Metallic Crystal Structure, Polymorphism and Allotropy, Crystallographic Points, Directions and Planes, Imperfections in Solids, Diffusion: Mechanism, Steady and Unsteady State Diffusion, Factors Influencing Diffusion, Mechanical Properties of Metals, Dislocation and Strengthening Mechanism: Slip Systems, Slip in Single and Polycrystalline Materials, Twin Mechanism, Strengthening Mechanisms in Metals, Recovery, Recrystallization and Grain Growth

Failure: Fracture, Impact Fracture, Fatigue, Creep, Phase Diagrams: Introduction, Equilibrium Phase Diagrams, Binary Isomorphous system, Binary Eutectic Systems, Iron-Iron Carbide Phase Diagram, Microstructure Development, Phase Transformation in Metals Applications and Processing of Metal Alloys

### Ceramics, Glasses and Refractory

Ceramic Structure Imperfections in ceramics, Mechanical Properties

Applications and Processing of Ceramics: Types and Applications, Fabrication and Processing

### Polymer and Rubbers

Structure, 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

### **Composites**

Introduction, Particle Reinforced Composites, Fiber Reinforced Composites, Processing of Composites, Sandwich Panels

### **Environmental Degradation**

Metal degradation by atmosphere, Aqueous and galvanic corrosion, Stress corrosion cracking, Methods of corrosion prevention, Behavior of metal at elevated temperature pyrometer, Oxidation, Scaling and creep, Chemical degradation of ceramic and polymers, Radiation damage of surface, Improvement against degradation.

## **THIRD YEAR**

### **SPRING SEMESTER**

#### **HS 304 BUSINESS COMMUNICATIONS AND ETHICS**

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

Definitions and Conditions, Modes; verbal, non-verbal, vocal, non-vocal, sender, receiver, encoding, decoding, noise, context, emotional maturity, 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).

Notice 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.

#### **MT 330 APPLIED PROBABILITY & STATISTICS**

##### **Statistics**

Introduction, Types of data & variables, presentation of data, object, classifications, Tabulation, Frequency Distribution, Graphical Representation, Simple & Multiple Bar diagrams, Sartorial & Pie-Diagram, Histogram, Frequency Polygon, Frequency Curves & their types.

### **Measures of Central Tendency and Dispersion**

Statistics Averages, Median, Mode, Quartiles, Range, Moments, Skewness & Kurtosis, Quartile Deviation, Mean Deviation, Standard Deviation, Variance & its coefficient, Practical 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, Second order Statistics & Time series.

### **Simple Regression & Correlation**

Introduction, Scatter diagrams, Correlation & its Coefficient, Regression lines, Rank Correlation & its Coefficient, Probable Error (P.E), Related problems.

### **Sampling and Sampling Distributions**

Introduction, Population, Parameter & Statistics, 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 and 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 walks chain/Related problems.

### **Probability Distributions**

Introduction, Discrete probability distributions, Binomial, Poisson, Hypergeometric & Negative binomial distributions. Continuous probability distribution, Uniform, Exponential & Normal distributions & their practical significance.

## **ME 302 SOLID MECHANICS – II**

### **Bending Stress**

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.

### **Elastic Strain Energy**

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.

### **Statically Indeterminate Beams and Frames**

Double integration method; Superposition method; Virtual work; Compatibility and equilibrium methods

### **Stress and Strain Transformations and Relationship**

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.

### **Deformation Symmetrical about an Axis**

Thick-walled cylinders, Compound cylinders, Shrink fit, Rotating disk of uniform thickness

### **Theories of Yielding**

Maximum Principal Stress Theory, Maximum principal strain theory, Maximum shear stress theory, Total strain energy theory.

### **Thin Plates and Shells**

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 306 MECHANICAL VIBRATIONS**

### **Introduction**

Main objectives, Elements of a vibratory system, Fundamental features in vibratory systems, Vectorial representation of simple harmonic motion, Degrees of freedom, Damping.

### **Single Degree of Freedom Systems**

Undamped free vibrations, Damped free vibrations, Forced vibrations.

### **Two Degree of Freedom Systems**

Undamped and damped free vibrations, Undamped and damped steady state forced vibrations.

### **Applications**

Equivalent viscous damping, Balancing of machines, Vibration considerations in machine foundation.

### **Methods for Finding Natural Frequencies**

Rayleigh method, Analytical method and graphical technique, Holzer method.

### **Vibrations of Elastic Bodies**

Free and forced longitudinal vibrations of a uniform bar, Vibrations of a uniform bar with end masses, Free and forced lateral vibrations of simply supported thin beams, Torsional vibration of circular shaft with single rotor and two rotors, Critical speed of rotating shaft with single rotor and two rotors, Critical speed of rotating shafts.

Elementary treatment of analogue computation of vibrations, Simple cases of electromechanical systems and analogies.

## **ME 307 PRODUCTION ENGINEERING - II**

### **Machining Processes and Machine Tools**

Machine tools using single point tools, Description, Functions, operations performed on lathe, Shaper, planer, And boring machines, Work holding devices.

Machine tools using multiple cutting edge tools, Description, Functions, operations performed on drilling, Milling, Gear cutting and broaching machines.

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, Thread manufacturing.

Non-traditional machining processes such as EDM, ECM, and Ultra sonic machining.

### **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.

### **Standardization**

Introduction, Product simplification and diversification, Interchangeability, Selective assembly, Principles, preparation of standards, Application of standards in design and manufacturing, applying for patents, International and national standard organizations.

### **Standards of length**

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.

### **Measurement**

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**

Roughness, Lay, Waviness and flaws, CLA and RMS values, Prediction of roughness in turning, Drilling, milling and grinding.

### **Measurement**

Measurement of roughness, Average values of roughness for various manufacturing processes.

## **FALL SEMESTER**

### **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 ri-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, transitions 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 of transformations.

#### **Advanced Calculus**

Stationary point of a function of several variables, Local maximum and saddle point for a function of two variables the stationary points of several variables, Obtain higher partial derivatives of simple functions of two or more variables, Iterated integrals, Double and triple integrations with applications (Area, Centroids, Moment of inertia, Surface area and volume, Use of 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, Evaluation of line integrals along simple paths, Application of line integrals to calculate work done, Application of Green's theorem in the plane to simple examples, surface integrals over simple surface, Use of the Jacobian to transform problem to a new coordinate system, Application of Gauss' divergence theorem to simple problems, use of Stokes' theorem to simple examples.

## **EE 373 MACHINE CONTROL SYSTEM**

Open and closed loop control, feedback simple control system; sequence control, static switching and logic Switching Algebra.  
Stability, accuracy, frequency and transient response.

### **Time Scale Effects**

Linear control system, determination of system performance and design with reference to stability, Transient response, steady state accuracy and frequency response' Laplace transformation method; Root Locus; Nyquist criteria and Bode plots; Conformal plotting.

Series parallel and feedback techniques of system compensation.  
Three term pneumatic controller for chemical plants.

Control system types; regulations, Servomechanisms.

Electrical, hydraulic and pneumatic amplifier.

### **Instrumentation**

Analysis of the performance of electro mechanical transducers used in control.

## **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 rate, 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 And 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.

## **ME 303 STEAM GENERATION AND STEAM TURBINE**

### **Properties of Steam**

Steam tables, Dryness fraction, Mollier chart.

### **Cycles**

Theoretical steam turbines cycles, Rankine, Reheat, Regenerative.

### **Flow of Steam through Nozzles**

Critical pressure ratio, Convergent and convergent-divergent nozzles.

### **Steam Turbines**

Impulse and reaction turbines, Compounding, Classification of turbines, Internal losses, State point locus and reheat factor.

### **Combined Heat and Power Schemes**

Extraction and back pressure turbines.

Turbine performance and controls.

Steam Generation and Steam Plant, Feed water Heater, Air preheaters, Economizer, Superheaters.

Fuels, Fossil fuel, Coal, Oil and gas, Environmental pollution

### **Water Treatment**

Internal and external treatment methods

## **ME 304 FLUID MECHANICS - II**

### **General Theory of Two and Three Dimensional Ideal Fluid Flow:**

The velocity field, Eulerian and Lagrangian viewpoints, Acceleration of flow particle, Irrotational flow, Relation between Irrotational flow and viscosity, Systems and control volumes, Potential flow, Circulation, Stream function and velocity potential, Uniform flow, Two dimensional source and sink, Simple vortex, The doublet, Lift and drag forces.

### **General Theory of Two and Three Dimensional Viscous Fluid Flow**

Stoke's viscosity law, Navier Stokes equations of motion, Two dimensional flow between parallel plates, Flow in a circular pipe, Creep flow, Reynolds equation, Hydrodynamic lubrication in journal bearing.

### **Boundary Layer Theory**

Boundary layer theory, Laminar boundary layer, Turbulent boundary layer, Boundary layer control, Airfoil cascades.

### **Fluid Machinery**

Similarity relations for turbomachines, Specific speed, Classification of turbomachines, Impulse turbines, Propeller type axial-flow reaction turbine, Multi bladed reaction turbines, Radial flow pumps, Performance curves.

### **Computational Fluid Dynamics**

Introduction, Numerical operations for differentiation and Integration, Programming procedure, Simple exercise problems

## **ME 305 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.

## **FINAL YEAR**

## **SPRING SEMESTER**

### **ME 403 REFRIGERATION AND AIR CONDITIONING**

#### **Refrigeration and Heat Pump Cycles**

Carnot and Joule Cycles reversed, Vapour-compression and vapour absorption cycles, Coefficient of performance, Multiple effect compression, Processing, Multi-stage compression, Efficiencies, Properties of refrigerants and brine.

#### **Refrigeration machines**

Cold air, Vapour-compression, Steam jet and absorption types, Heat pumps, Domestic type, Auxiliaries and controls, Air cycle.

#### **Distribution of Refrigerants**

Direct expansion, Brine grids and control systems, Brine mixing and concentration, Defrosting air circulation systems.

#### **Application of Refrigeration**



Cold storage, Ice-making, Dairying, Quick freezing air-conditioning, Layouts, Load calculation and performance, Solid ice, Solar energy.

### **Cooling Load calculations**

Use of available programs, Ashrae cooling manual.

### **Air-conditioning and Ventilation**

Use of the psychometric charts, Calculation of heat to be removed by an air-conditioning plant, Air conditioning requirements for comfort and industrial processes, Air distributing systems, Design and sizing of ducts, Water cooler, Dehumidifiers, Humidifiers, Automatic temperature and humidity control systems, Pneumatic, electric, and hydraulic systems, Complete calculations for a simple air conditioning system, Prevention of noise and vibration, cooling towers and evaporative condensers.

## **ME 406 HEAT TRANSFER**

Steady state conduction, General equation for three dimensional geometries, One dimensional analysis, Multi layer wall, Overall heat transfer coefficient.

Unsteady state heat transfer for simple geometries, Lumped capacitance method, Internal resistance in solid.

Transfer with internal heat sources, Extended surface heat transfer-fins.

### **Thermal radiation**

Basic concepts, Surface characteristics blackbody, Grey body, Emission in defined wave band, Radiation intensity, Energy exchange in black and grey bodies.

### **Convection Heat Transfer**

Basic concepts, Momentum and thermal boundary layer fundamentals, Dimensional analysis, Theoretical analysis for flat plates, Laminar and turbulent flow.

### **Forced Convection**

Laminar and turbulent flow over flat plates and inside tubes and ducts, Empirical correlations.

### **Free Convection**

Similarity parameter, Boundary layer, Convective coefficients in plates, Empirical correlations.

Heat transfer with change in phase, Boiling, Condensation.

### **Heat Exchangers**

Types, Preliminary design.

### **Mass Transfer**

Mass transfer operations, Diffusion mass transfer, Mass transfer coefficients, Empirical correlations: analogy of heat, Mass and momentum transfer, Simultaneous heat and mass transfer.

## **ME 415 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;  $\bar{X}$ , 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.)

Experiments on following will be conducted in the lab:

Location selection using Factor Rating Method and Centre of Gravity Method, Process charts, time motion study, control charts, acceptance sampling using MIL STD, COQ, MS Project Queueing with Poisson arrivals and exponential service times.

## **FALL SEMESTER**

### **MT 441 ADVANCE MATHEMATICAL TECHNIQUES**

#### **Complex Variable**

Limit, continuity, Zeros and poles of a complex function, Cauchy-Reimann equations, Conformal transformation, Contour integration.

#### **Error Analysis**

Types of errors (Relative, Absolute, Inherent, round off, Truncation), Significant digits and numerical instability, Flow chart

Use of 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, Numerical differentiation, Forward difference method, Backward difference Method, Central difference method.

#### **Interpolation and Curve Fitting**

Lagrange's Newton, Hermit, Spline, Least squares approximation, (Linear and non-linear curves), With numerical problem in engineering.

### **Numerical Integration and Differentiation**

Computation of integrals using simple Trapezoidal rule, 1/3th Simpson's rule, 1/8th Simpson's 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).

### **Improper Integrals**

Definitions, Types of improper integral and their convergence

### **Elliptic Integrals**

Introduction and identification of elementary elliptic integrals of first, second and third kinds, Simple applications

## **ME 402 GAS TURBINES**

### **Ideal Cycles**

Effect of pressure, Temperature, Component efficiency on fuel and air consumption and Power of the simple plant, Inter-cooling, reheat, Heat exchanger cycles, Industrial open and closed plant.

### **Gas Turbine Cycles for Aircraft Propulsion**

Turboprop, Turbofan and turbojet engines, Influence of altitude and flight speed on performance.

### **Centrifugal Compressors**

Principle of operation, Work done and pressure rise, Compressibility effects, Non-dimensional quantities for plotting compressor characteristics.

### **Axial Flow Compressors**

Elementary theory, Degree of reaction, Simple design method, Blade design, Calculation of stage performance, Overall performance, compressibility effect

### **Combustion Systems**

Form of combustion system, Some important factors effecting combustion chamber designing, combustion process, Combustion chamber performance.

### **Axial Flow Turbines**

Elementary theory, Vortex theory, Choice of blade profile, pitch and cord, Estimation of stage performance, Overall turbine performance.

### **Prediction of Performance of Simple Gas Turbines**

Component Characteristics, Off-design operation of the single shaft gas turbine, Equilibrium running of a gas generator, Off-design operation of free-turbine engine, Jet engine.

## **ME 405 GAS DYNAMICS**

### **Introduction**

Basic governing laws, Conservation of mass, Momentum and energy, Limitations to the application of laws

### **Velocity of Sound**

Physical differences between incompressible, sub-sonic and super-sonic gas flow, The Mach Number and Mach Angle, Optical methods of investigation.

### **One Dimensional Gas Flow**

Isentropic flow, Choking in isentropic flow, Operation of nozzles under varying pressure ratios, Some applications of Isentropic flow.

### **Normal Shock Waves**

Formation of shock waves, Weak shock waves, Moving shock waves, Operating characteristics of converging-diverging nozzle, One-dimensional supersonic diffusers, Supersonic pitot tube.

### **Oblique Shocks**

Oblique shock equations, Shock geometry, Shock Polaris, Some special aspects of oblique shock waves.

### **Flow in Ducts**

Flow in constant area ducts with friction, Performance of long ducts at various pressure ratios.

### **Isothermal Flow in Long Ducts**

Flow in ducts with heating or cooling, Choking effects in simple stagnation temperature change, Shock waves with changes in stagnation temperature.

## **ME 409 MECHANICAL ENGINEERING PROJECT**

Selected problems requiring design, development of problem specific software, Preparation of drawings, Fabrication of prototype / models and laboratory experimentation shall be assigned to individual students or groups of students, Grading shall be based on the reports produced by students and their critical evaluation through an oral examination.

## **ELECTIVE COURSES**

### **ME 401 STRESS ANALYSIS**

#### **Elementary Theory of Elasticity**

Vector & Tensor, Traction Vector, Stress at a point, 3D Mohr Circle, Stress equation of equilibrium, Laws of stress transformation, Principal Stresses & Max Shear Stress at a point, Displacement & deformation, Strain & displacement relationships, Strain equations of transformations, Principal strains, Generalized Hook's Law & Elastic Constants, Compatibility, Displacement field, Stress & Strain relationships

#### **Plane Elasticity Theory**

Basic equations and plane elasticity theory, Airy's stress functions both in Cartesian and polar Coordinates

#### **Experimental Stress Analysis**

Analytical, Numerical and Experimental approaches of stress analysis, advantages & disadvantages, Methods/techniques of Experimental Stress Analysis' Introduction of Strain measurements, Construction and working of electrical resistance strain gauge, Strain sensitivity of Metallic alloy and strain gauge, Strain gauge circuits with applications, Rosettes and its different configurations  
Photo elasticity, wave theory of light & Birefringence, Stress optic Law, optical element, types of polar scopes and their applications, light and dark field arrangements, fringe patterns, Compensation and separation techniques  
Brittle Coating, crack patterns, selection & application of different type of coatings, calibration and testing of brittle coatings, temperature and humidity effects, Sensitivity, crack detection

#### **Elementary Plastic and Viscoelastic Analysis**

Different response of material after removal of load, Plastic bending of beams, Plastic Collapse & limit Analysis, Plastic hinge in beams.

#### **Introduction to Finite Element Analysis**

Introduction; Discrete and Continuous Systems, Mathematical Models, Weighted Residual Methods, Finite element solutions

Note: Experimental determination of strain measurements, and analysis using FE package will be performed in the lab.

### **ME 404 NUCLEAR POWER**

#### **Nuclear Physics Review**

Nuclear structure, Nuclear stability, Binding energy and mass-energy equivalence, Radioactivity (natural and artificial), Decay rate, Mean-life and half-life, Radioactive equilibrium, Nuclear reactions, Q value, Fission reaction, Elastic and inelastic scattering reactions.

#### **Reactor Physics**

Neutron reaction, Neutron flux, Cross section for scattering, Absorption and fission, Neutron diffusion Neutron leakage, Solution of diffusion equation for a bare reactor, Albedo and reflector saving, Neutron slowing down, Continuous slowing down model? Lethargy, Slowing down power, Moderation ratio, Fermi age.

### **Reactor Theory**

Nuclear chain reactors, Criticality, The four factor formula, One group critical equation, The critical size, Non-leakage probability, Neutron life cycle.

### **Reactor Kinetics**

Excess reactivity and reactor-period, Xenon poisoning.

### **Types of Nuclear Reactors**

Introduction, Pressurized Water Reactor (PWR), and Primary Loop, Pressurize, Chemical Shim Control A PWR Power plant, Boiling Water Reactor (BWR), and Load Following Control, Current BWR System High Temperature Gas-Cooled Reactor (HTGR), Advanced Gas Cooled Reactors (AGR).

### **Fast Breeder Reactor and Power plants**

Introduction, Nuclear Reactions, Conversion and breeding, Liquid metal fast breeder reactor (LMFBR) Plant arrangements, LMFBR, Gas cooled Fast breeder reactor (GCFBR).

### **Reactor Materials**

Choice of a moderator, The fuel, The coolant, Nuclear fuels.

### **Allied Topics**

Nuclear power economics, Fuel reprocessing, Health hazard due to reactions, Shielding, Nuclear applications for peaceful purposes.

## **ME 410 COMPUTER AIDED DESIGN / COMPUTER AIDED MANUFACTURING**

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

#### **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.

### **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.

### **Robotics Technology and Applications**

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

## **ME 412 CLEAN ENERGY TECHNOLOGY**

### **Generalities**

(a) Energy and utility, planetary energy balance and energy resources, energy utilization and utilization rate, energy and ecology, energy requirements and the population explosion.

(b) Conservation of energy, energy conservation opportunities and management.

(c) Introduction to renewable energy sources: Solar, Wind, Ocean, Geothermal, Biomass including biofuels, Hydrogen coupled with other renewable sources, Hydro power, Thermoelectricity.

### **Solar Energy**

Nature of solar radiation, insolation, architecture and types of solar collectors, Solar Plant configurations, Introduction to Photovoltaic systems, Application software.

### **Wind Energy**

History, availability, data collection, wind turbine configurations and characteristics, principles of aerodynamics, wind turbine analysis and performance calculations, Application software.

### **Oceanic Energy**

Types of ocean energy: Wave energy and its conversion, tidal energy, energy from currents, salination energy and the Osmotic engine, various conversion schemes and their relative merits and demerits, thermal energy and ocean thermal energy converters (OTEC).

### **Biomass Energy**

Composition of biomass, biomass as fuel, Photosynthesis and renewable energy; production and use of biodiesel and ethanol; Merits and demerits.

### **Hydroelectricity**

The resource, Types of hydroelectric plants, Applications, Small scale hydroelectricity, Environmental considerations.

### **Hydrogen Technology and Fuel Cells (FC)**

Hydrogen as energy storage medium, Introduction to production and storage of hydrogen, Electrochemical cells, FC reactions, Thermodynamics and performance of FC, FC classification, FC configurations and applications.

### **Integration**

Existing energy systems; Questions of availability, Pattern of energy use, Economic options; Long term global energy scenarios.

## **ME 413 FINITE ELEMENT ANALYSIS**

### **Introduction**

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

### **Finite element analysis of structural problems**

Finite element modeling, element division and numbering scheme; Basic steps in FEA (Preprocessing, solution, postprocessing); Finite element Analysis of Bar element; Finite element Analysis of Truss; Finite element Analysis of Beam; Finite element Analysis of Frame.

### **Variational formulation and approximation**

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, subdomain); Rayleigh Ritz Method.

### **Isoparametric Formulation**

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.

### **Finite element applications and Error analysis**

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.

### **Plane Elasticity**

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 416 PLANT MAINTENANCE**

### **PRINCIPLES AND PRACTICES OF MAINTENANCE PLANNING**

Basic Principles of maintenance planning, Objectives and principles of planned maintenance activity, Importance and benefits of sound maintenance systems, Reliability and Machine availability, MTBF (Mean Time Between Failures), MTTR (Mean Time To Repair), Factors of availability, Maintenance organization, CMMS (Computerized Maintenance Management System)

### **MAINTENANCE POLICIES**

Maintenance categories (Breakdown, Preventive, Predictive), Merits and de-merits of Preventive maintenance and Predictive maintenance, maintenance schedules, RCM (Reliability Centred Maintenance) analysis

### **PREDICTIVE MAINTENANCE**

Condition monitoring, Economics of condition monitoring, Design of a Predictive Maintenance Programme, Total Plant predictive program, Methods and instruments for Predictive Maintenance (pertaining to Vibration analysis, thermography and relevant techniques)

### **MAINTENANCE METHODS FOR BASIC MACHINE ELEMENTS**

Shaft alignment, Rotor balancing, Bearings, Couplings, Gears and gear boxes, Compressors, Control valves, Conveyors, Lubrication, Fans, Blowers and Fluidizers, Dust Collectors, Pumps, Steam Traps and related equipment.

### **FAILURE ANALYSIS**

Introduction to Root cause failure analysis, General Analysis Techniques, FMEA (Failure Modes and Effect Analysis), Fault-tree analysis, Cause and effect analysis, Sequence of events analysis, Root Cause Failure Analysis Methodology

Experiments on following will be conducted in the lab:

Overall equipment effectiveness, downtime cost, preventive maintenance, FMEA, runout measurement and misalignment in shafts, vibration amplitude, gears, ultrasonic detection.