DEPARTMENT OF MECHANICAL ENGINEERING

SYLLABI OF COURSES

FOR

B.E. (MECHANICAL) DEGREE PROGRAMME

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FOR
B.E (MECHANICAL) ENGINEERING PROGRAMME

BATCH: 2016-2017

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

COURSE TITLES FOR B.E MECHANICAL ENGINEERING PROGRAMME

FIRST YEAR

Spring Semester		Credit Hours			Fall Semester		Credit Hours		
Course Code	Course Title	Th	Pr	Total	Course Code	Course Title	Th	Pr	Total
CY 109	Applied Chemistry	3	1	4	PH 122	Applied Physics	3	1	4
MT 114	Calculus	3	0	3	HS 104	English	3	0	3
CE 103	Engineering Surveying-I	3	1	4	EE 122	Basic Electricity and Electronics	2	1	3
ME 111	Engineering Drawing	2	1	3	ME 112	Thermodynamics	3	0	3
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

SECOND YEAR

Spring Semester		Credit Hours			Fall Semester		Credit Hours		
Course Code	Course Title	Th	Pr	Total	Course Code	Course Title	Th	Pr	Total
MT 223	Ordinary Differential Equations & Fourier Series	3	0	3	MT 330	Applied Probability & Statistics	2	1	3
ME 215	Internal Combustion Engines	2	1	3	ME 202	Solid Mechanics-I	3	1	4
ME 216	Production Engineering - I	3	0	3	ME 217	Elements of Machine Dynamics & Design	3	0	3
ME 204	Fluid Mechanics-I	3	1	4	ME 209	Materials & Metallurgy	3	1	4
ME 213	Dynamics	2	1	3	ME 214	Computer Programming & Applications	2	1	3
HS 205	Islamic Studies OR	2	0	2					
HS 209	Ethical Behaviour (for Non-Muslims)								

THIRD YEAR

Spring Semester		Credit Hours			Fall Semester		Credit Hours		
Course Code	Course Title	Th	Pr	Total	Course Code	Course Title	Th	Pr	Total
HS 304	Business Communication & Ethics	3	0	3	MT 332	Advanced Calculus & Linear Algebra	3	0	3
ME 313	Solid Mechanics – II	3	0	3	EE 373	Machine Control System	3	1	4
ME 314	Fluid Mechanics-II	3	0	3	ME 305	Machine Design	3	1	4
ME 307	Production Engineering – II	3	1	4	ME 315	Heat & Mass Transfer	3	1	4
ME 312	Powerplant Engineering	3	1	4	ME 403	Refrigeration & Air Conditioning	3	1	4

FINAL YEAR

Spring Semester		Credit Hours			Fall Semester		Credit Hours		
Course Code	Course Title	Th	Pr	Total	Course Code	Course Title	Th	Pr	Total
MF-303	Applied Economics for Engineers	3	0	3	HS 403	Entrepreneurship	3	0	3
ME 306	Mechanical Vibration	3	1	4	MT 441	Advanced Mathematical Techniques	3	0	3
ME 419	Stress Analysis	3	0	3	ME 417	Compressible Flow and Propulsion Systems	3	0	3
ME 420	Operations Management	2	0	2	ME-###	Elective Course 2	2/3	1/0	3
ME-###	Elective Course 1	2/3	1/0	3	ME-409	Mechanical Engineering Project	0	6	6
ME-409	*Mechanical Engineering Project	-	-	-					

ELECTIVE COURSES

ME-421	Gas Turbines
ME-422	Nuclear Power
ME-423	Computer Aided Design / Computer Aided Manufacturing
ME-424	Clean Energy Technology
ME-425	Finite Element Analysis
ME-426	Plant Maintenance

Duration one academic year: Requires literature survey and preliminary work during this Semester

Mechanical Engineering Department

First Year Spring Semester

CY 109 APPLIED CHEMISTRY

Gases
Gas laws, Kinetic gas equation, Vander Waal's Equation, critical phenomenon, Liquidfication 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, Electrodialysis, 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 114 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'Hopitals 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 111 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 since1973 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.

First Year Fall Semester

PH 122 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, 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 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_2 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 104 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 122 BASIC ELECTRICITY AND ELECTRONICS

DC Analysis
Series and Parallel electric circuits: Kirchhoff's voltage law(KVL) and Kirchhoff's current law (KCL), voltage divider and current divider rules; series parallel circuits; Y-Delta conversions; methods of circuits analysis: mesh analysis and nodal analysis; network theorems: superposition, Theremin's Norton and maximum power transfer; Magnetic circuits: magnetic fields, flux density, permeability, reluctance, magnetizing force, hysteresis, Ampere's Circuital law; capacitors and inductors: electric field and dielectric strength; charging and discharging phase of capacitor; capacitor types; faraday's law of electromagnetic induction; Lenz's Law; charging and discharging phase of an inductor.

AC Analysis and Poly Phase Systems
General format of sinusoidal voltage and current; phase relations; average power and power factor, frequency response of basic elements(R, L,C);rectangular and polar form conversions; series-parallel circuits with phase or diagrams; mesh analysis and nodal analysis; Network theorems; passive filters: low pass, high pass, pass band, stop band filters, resonance: series resonant and parallel resonant circuits, poly phase systems.

Electrical Machines
Introduction to electrical Machines; Transformer: basic contraction, operation and types; DC Motors and Generators: construction of DC motors and generators, working principles, equivalent circuits, losses and efficiency calculations; A motors and generators: construction of AC motors and generators, working principles, Equivalent circuits, losses and efficiency calculations, power and torque curves in generators.

Basic Electronics
Introduction to Electronic Engineering; P-N junction: Semiconductor theory, dopings and energy bands, diode models, diode data sheet understanding, diode applications (half wave, full wave and bridge rectifier, clipper and clamper); BJT and FET construction, operation and characteristics curves, Introduction to Digital Electronics; Comparison with Analogue electronics.

ME 112 THERMODYNAMICS

FUNDAMENTAL CONCEPTS & FIRST LAW OF THERMODYNAMICS
Thermodynamics, systems and control volumes, properties of system; State of system; Equilibrium; The State Postulate; Processes, cycles, Quasi equilibrium process; Zeroth law of thermodynamics, pressure.

Forms of energy, macroscopic and microscopic energies, forms of work, First law of thermodynamics, Classical and statistical analysis approaches

PROPERTIES OF PURE SUBSTANCES
Pure substance, Phases, Saturation properties, Property diagrams for the phase-change process, PVT surfaces; Property tables; ideal gas equation of state, Specific heats and relation

ENERGY ANALYSIS OF CLOSED SYSTEMS
Moving boundary work, energy balance, internal energy, enthalpy and specific heats of solids, liquids and gases, polytropic processes;

MASS & ENERGY ANALYSIS OF CONTROL VOLUMES
Conservation of mass, energy analysis of steady flow systems, Steady flow engineering devices including nozzle, diffuser, compressor, turbine and throttling valves

SECOND LAW OF THERMODYNAMICS
Thermal reservoirs; heat engine, thermal efficiency, Kelvin-Planck statement, Clausius statement; Refrigerators and heat pumps; Coefficient of performance, Perpetual-motion machines, Irreversibilities; Carnot cycle, Carnot refrigerator and heat pump.

ENTROPY
Inequalities, Clausius inequality, increase of entropy principle, isentropic processes, minimizing compressor work, multistage compression with intercooling, isentropic efficiencies of steady flow devices

GAS POWER CYCLES
Air-standard assumptions, classification of reciprocating engines (compression ignition, spark ignition, 2 stroke and 4 stroke); Otto cycle; Diesel cycle; Dual combustion cycle; Stirling and Ericsson cycles; Brayton cycle, Combined gas power cycles

VAPOUR POWER CYCLES
Carnot vapor power cycle, Rankine cycle, Deviation of actual vapor power cycles from idealized ones, Increasing the efficiency of a Rankine cycle, Rankine reheat cycle

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

MT 223 ORDINARY DIFFERENTIAL EQUATIONS & FOURIER SERIES

1st 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.

2nd and Higher Orders Equations

Special types of 2nd 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 215 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 216 PRODUCTION ENGINEERING I

Introduction of 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.

Note: Experiments on sand casting will be conducted in the lab.

Permanent Mold Casting (PMC)
Introduction, types of PMC, gravity die casting and its types. Pressure die 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 tike 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.

Note: Experiments on welding processes will be conducted in the lab.

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 204 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, stream lines, 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 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 - 163and164. **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 The last sermon of Hajj of Holy Prophet (PBUH): Relevant extracts.

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.

Second Year Fall Semester

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 202 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; Eccentricloading of long columns. Behaviour of ideal and real struts. Struts with initial curvature Crinkling; Members subjectedto axial and transverse loading.

ME 217 ELEMENTS OF MACHINE DYNAMICS & 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 wore 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

ME 209 MATERIALS AND METALLURGY

Introduction
Importance of Material Science and Engineering, classification of materials, material property charts

Metallic Materials
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, 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

Environmental Degradation
Material degradation, corrosion, Stress corrosion cracking, corrosion prevention,

Advanced Materials
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

ME 214 COMPUTER PROGRAMMING AND APPLICATIONS

Introduction to computer programing, problem-solving techniques using computer programing, 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 programing language

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.

ME 313 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 314 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.

ME 307 PRODUCTION ENGINEERING – 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, predication 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.

ME 312 POWERPLANT ENGINEERING

Cycles
Review of mass and energy balances for steady flow devices, Related properties with Mollier Chart and steam tables; Steam turbine cycles including Rankine, Superheat, Reheat; Regenerative Cycle, Open Type Feed Water Heaters (FWH) , Closed Type FWHs with Drains Cascaded Backwards and Pumped Forward; Gas turbine (Brayton) Cycle Power Plants, Compressors, Combustors, Low NOx combustors, Turbines, Efficiency, Intercooling; Combined Cycle Power Plants, Gas engines, diesel power plants

Combined Heat and Power Systems
Cogeneration of power and process heat, Back Pressure and Extraction Turbines

Fluid Flow through Nozzles
Stagnation properties, critical pressure ratio; convergent and convergent-divergent nozzles (subsonic and supersonic nozzles), Variation of velocity and pressure with area, shock wave

Steam Turbines
Impulse and reaction turbines; Pressure Compounding (Rateau Staging), Velocity Compounding (Curtis Staging), Reheat Factor and Condition Line.
Turbine governing and controls

Steam Generators and Fuels
Types of boilers and their applications; fire tube boilers; water tube boilers; boiler components including feedwater heater, air preheater, economizer and superheater; boiler operation and safety. Internal and external water treatment methods

Fossil fuels including coal, oil and gas; combustion calculations; environmental pollution.

Third Year 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, Diagonolization, Cayley-Hamiton 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.
Cotnrol system types; regulations, Servomechanicsm.
Electrical, hydraulic and pneumatic amplifier.

Instrumentation

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

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 o 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 315 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'slaw

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 flow.

Forced convection with 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 phase change, boiling and condensation.

Heat Exchangers
Classification and preliminary design of heat exchangers, LMTD and 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

ME 403 REFRIGERATION AND 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 andAir 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

Final Year Spring Semester

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 indentical lives, alternatives having different

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 onwerhip, types of stock, partnership & joint stock companies, banking & specialized credit institutions.

Industrial Relations
Labour problems, labour organizations, prevention & settlement of disputes.

ME 306 MECHANICAL VIBRATIONS

Introduction
Elements andfundamental features of a vibratory systems; Simple harmonic motion and its vectorial representation; Constraints, Generalized coordinates and degrees of freedom; Vibration analysis; Damped and undamped systems; Resonance; Classification of dynamic Systems and their models,

Single Degree of Freedom Systems
Free vibration of an undamped translational system and torsional system; Energy Method; Stability conditions;Free vibration with Viscous, Coulomb and Hysteretic Damping; Forced undamped vibration; Formulation of equation of motion for forced vibration; Harmonically excited vibrations; Forced vibration with damping; Response of damped system under harmonic base excitation and under rotating unbalance.

General Forcing Conditions and Response
Periodic forcing function; Fourier series; Harmonic functions; Response under periodic force of irregular form; Transient vibrations.

Two Degree of Freedom Systems

Equation of motion for two degrees of freedom system; Free vibration of damped systems; Torsional system with free vibration; Coordinate coupling and principal coordinates; Forced vibration of damped system

Methods for Finding Natural Frequencies and Mode Shapes
Dunkerley's equation; Rayleigh method; Holzer method; Rayleigh method; Normalization of mode shapes; Matrix iteration method; Eigen value problems

Vibrations of Continuous Systems
Transverse vibration of a string; Longitudinal vibration of beams and rods; Torsional vibration of shafts; Vibrations of a uniform bar with end masses; Free and forced lateral vibrations of simple supported thin beams.

Vibration Control
Vibration Nomograph; Single plane balancing; Two-plane balancing; Whirling of shafts; Critical speeds of shaft, Vibration transducer; Vibration pickups; Vibration exciters; Signal analysis; Dynamic testing of machines and structures; Experimental modal analysis; Condition monitoring and diagnosis

ME 419 Stress Analysis

Elementary Theory of Elasticity
Introduction to Vector & Tensors, 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, stress and strain relationships; Airy's stress function both in Cartesian and polar Coordinates

Non-linear Elasticity: Hyperelasticity; isotropic hyperelasticity; material and spatial description of hyperelastic deformation; compressible Neo-Hookean material

Theory of Plasticity and Viscoelasticity
Yielding of ductile isotopic materials; elastic-perfectly plastic (non-hardening) deformation behavior; classical theories of plasticity; strain hardening; plastic flow rule; elastic-plastic bending of beams; viscoelastic behavior of solids

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

Introduction to Finite Element Analysis
Finite element method; direct stiffness method; elemental and global stiffness matrices; boundary conditions; element strain and stress function

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

ME 420 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 quality 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, EOQ, MS Project, Queueing with Poisson arrivals and exponential service times.

Final Year Fall Semester

HS 403 Entrepreneurship

Understanding the Entrepreneurship Mind-set ,The revolution impact of Entrepreneurship, The individual Entrepreneurship Mind-set, Corporate Entrepreneurship Mind-set ,The Social and Ethical perspectives of Entrepreneurship, Launching Entrepreneurship Ventures, Creativity and innovations, Methods to initiate ventures, Legal challenges in Entrepreneurship, The search for Entrepreneurship Capital, Formulation of Entrepreneurship Plan, The assessment of function with opportunities, The marketing aspects of new ventures, Financial statements in new ventures, Business plan preparation for new ventures, Strategic Perspectives in Entrepreneurship, Strategies growth in Entrepreneurship, Valuation challenges in Entrepreneurship, Final harvest of a new venture

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 Analyse 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 417 Compressible Flow and Propulsion Systems

Review of Elementary Principles
Governing equations for compressible fluid flow: conservation of mass, momentum and energy

General Features of Compressible Flow
Sonic velocity and Mach number, difference between incompressible, subsonic and supersonic flow, propagation of sound waves, equations for perfect gases in terms of Mach number, optical methods of investigation

One Dimensional Isentropic Flow
Isentropic flow of a perfect gas, limiting conditions (choking), effect of area change on flow properties, flow in convergent and convergent-divergent nozzles, Hugoniot equation, applications of isentropic flow

Normal Shock Waves
Formation of shock waves, Weak and Strong waves, stationary and moving shock waves, working equations for perfect gases, operating characteristics of converging diverging nozzle, supersonic diffusers and pitot tube

Two Dimensional Supersonic Flows
Governing equations for oblique shock waves and Prandtl-Meyer flow, Shock Polar, variation of properties across an oblique shock wave, expansion of supersonic flow over successive corners and convex surfaces

Steady Compressible Flow with Friction
Fannoline, friction parameter for a constant area duct, limiting conditions, isothermal flow in long ducts

Compressible Flow with Heat Transfer
Flow in ducts with heating or cooling, thermal choking due to heating, correlation with shocks

Applications in Propulsion
Propulsion applications including rocket nozzles, rocket engine staging, supersonic inlets, and exhaust nozzles for air breathing propulsion systems. Parametric cycle analysis for ramjet, turbojet, turbofan, and turboprop engines

Experimental work on following will be performed in the lab:
use of wind tunnel; determination of Mach Number, drag coefficients of various objects; comparison of aerodynamic designs; pressure distributions on models.

Final Year Elective Courses

ME 421 Gas Turbine

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.

Experiments on BHP pf Gas Turbine, compressor and turbine efficiencies, and specific fuel consumption will be conducted in the lab.

ME 422 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 423 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 424 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. 5

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.

Experiments on determination of radiation with pyranometers, performance of solar collectors, PV modules, effect of wind velocities on power output, effect of tip speed ratio on performance, and fuel cells will be performed in the lab.

ME 425 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 426 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: S
haft 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