



SYLLABI OF COURSES

FOR

B.E. (MECHANICAL) DEGREE PROGRAMME

DEPARTMENT OF MECHANICAL ENGINEERING

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

BATCH: 2023

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

COURSE TITLES FOR B.E MECHANICAL ENGINEERING PROGRAMME

FIRST YEAR									
Fall Semester					Spring Semester				
Course Code	Course Title	Credit Hours			Course Code	Course Title	Credit Hours		
		Th	Pr	Total			Th	Pr	Total
CY-111	Applied Chemistry	2	0	2	PH-112	Applied Physics	2	1	3
MT-114	Calculus	3	0	3	ES-111	Functional English	2	0	2
ES-105	Pakistan Studies OR	2	0	2	ME-104	Workshop Practice	0	2	2
ES-127	Pakistan Studies (for Foreigners)				ME-115	Statics	3	0	3
ME-111	Engineering Drawing	2	1	3	ME-112	Thermodynamic	3	0	3
ME-113	Computer Aided Drawing	0	1	1	ME-214	Computer Programming and Applications	2	1	3
EE-124	Basic Electricity and Electronics	2	1	3					
EA-200	Community Service	-	-	NC					
SECOND YEAR									
Fall Semester					Spring Semester				
Course Code	Course Title	Credit Hours			Course Code	Course Title	Credit Hours		
		Th	Pr	Total			Th	Pr	Total
MT-223	Ordinary Differential Equations and Fourier Series	3	0	3	MT-330	Applied Probability & Statistics	2	1	3
ME-221	Fluid Mechanics-I	3	0	3	ME-218	Solid Mechanics-I	3	0	3
ME-222	Dynamics	3	0	3	ME-209	Materials & Metallurgy	3	1	4
ME-223	Engineering Mechanics Lab	0	1	1	ES-205	Islamic Studies OR	2	0	2
ME-220	Manufacturing Processes-I	3	1	4	ES-209	Ethical Behaviour (for Non-Muslims)			
ME-224	Internal Combustion Engine	3	0	3	EA-208	Business Communication & Ethics	3	0	3
					ME-219	Mechanics of Machine	3	0	3
THIRD YEAR									
Fall Semester					Spring Semester				
Course Code	Course Title	Credit Hours			Course Code	Course Title	Credit Hours		
		Th	Pr	Total			Th	Pr	Total
ME-317	Manufacturing Processes-II	3	1	4	MT-332	Advanced Calculus & Linear Algebra	3	0	3
ME-321	Power Plant Engineering	3	0	3	EL-305	Instrumentation and Control	3	1	4
ME-322	IC Engine and Power Plant Lab	0	1	1	ME-323	Machine Design	3	0	3
ME-302	Solid Mechanics-II	3	1	4	ME-318	Heat & Mass Transfer	3	0	3
ME-316	Fluid Mechanics-II	3	1	4	ME-319	Refrigeration & Air Conditioning	3	0	3
EA-####	Social Science (Elective)	2	0	2	ME-320	Refrigeration & A/C & Heat Transfer Lab	0	1	1
					##-####	Foreign Language-I			NC
FINAL YEAR									
Fall Semester					Spring Semester				
Course Code	Course Title	Credit Hours			Course Code	Course Title	Credit Hours		
		Th	Pr	Total			Th	Pr	Total
MF-303	Applied Economics for Engineers	3	0	3	MG-481	Entrepreneurship	3	0	3
ME-436	Mechanical Vibration	3	0	3	MT-441	Advanced Mathematical Techniques	3	0	3
ME-437	Machine design and Vibration Lab	0	1	1	ME-409	Mechanical Engineering Project	0	3	3
ME-409	*Mechanical Engineering Project	0	3	3	ME-417	Compressible Flow and Propulsion Systems	3	0	3
ME-419	Stress Analysis	3	0	3	ME-435	Operations Management	3	0	3
ME-####	Management Elective Course	2	0	2	ME-####	Technical Elective Course 2	3/2	0/1	3
ME-####	Technical Elective Course 1	3/2	0/1	3					
##-####	Foreign Language-II			NC					
<u>TECHNICAL LECTIVE COURSES</u>									
	ME-421	Gas Turbines (3+0)							
	ME-422	Nuclear Power (3+0)							
	ME-423	Computer Aided Design / Computer Aided Manufacturing (2+1)							
	ME-424	Clean Energy Technology (3+0)							
	ME-425	Finite Element Analysis (2+1)							
	ME-426	Plant Maintenance (3+0)							
	ME-429	Water Treatment and Desalination (3+0)							
	ME-430	Mechatronics (2+1)							
	ME-431	Tribology (3+0)							
	ME-438	AI and Internet of Things (2+1)							
<u>MANAGEMENT ELECTIVE COURSES</u>									
	ME-432	Health, Safety and Environment (2+0)							
	ME-433	Low for Engineers (2+0)							
	ME-434	Total Quality Management (2+0)							
<u>SOCIAL SCIENCE ELECTIVE COURSES</u>									
	EA-219	Professional Ethics (2+0)							
	EA-228	Sociology and Development (2+0)							

First Year Fall Semester

CY-111 APPLIED CHEMISTRY

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

RECOMMENDED BOOKS

(01) *Chemistry (The molecular nature of matter and change)* by Martin Selberg

MT-114 CALCULUS

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

RECOMMENDED BOOKS

(01) *Calculus & Analytical Geometry* Howard Anton

(02) *Engineering Mathematics* by Anthony Croft

(03) *Calculus* by Thomas & Finney

ES-105 PAKISTAN STUDIES

- **Historical and Ideological perspective of Pakistan Movement:** Two Nation Theory, Definition; Claim of Muslims of being a separate nation from Hindus, based upon cultural diversity, Significance: Cultural diversity and interests led to the demand of Pakistan – Lahore resolution, Creation of Pakistan, Factors leading to the creation of Pakistan, Quaid-e-Azam and the demand of Pakistan.

- **Land of Pakistan:** Geo-physical condition, Geo-political and strategic importance of Pakistan, Natural resource, viz: mineral, water and power.
- **Constitutional Process:** Early efforts to make a constitution (1947 – 1956) problems and issues, Salient features of the constitution of 1956 and its abrogation., Salient features of the constitution of 1962 and its abrogation. Constitutional and political crisis of 1971, Salient features of the constitution of 1973, Constitutional developments since 1973 to date with special reference to the amendments to the constitutions.
- **Contemporary issues in Pakistan:** A brief survey of Pakistan Economy. An overview of current economic situation in Pakistan: problems, issues and future prospects, Social Issues, Pakistani Society and Culture-Broad features. Citizenship: national and international, Literacy and education in Pakistan: problems and issues, State of Science and Technology in Pakistan: A comparison with other countries with special reference to the Muslim world, Environmental Issues, Environmental pollution and its hazard: causes, and solutions, Environmental issues in Pakistan: government policies and measures and suggestions for improvement. Pakistan's role in the preservation of nature through international conventions / treaties.
- **Pakistan's Foreign Policies:** Evolution of Pakistan foreign policy-1947 to date, A brief survey of Relation with Neighbors, Super Power & the Muslim World.
- **Human Rights:** Conceptual foundations of Human Rights, What are Human Rights? Definition, origins & significance, Comparative analysis of Islamic and Western Perspectives of Human rights, UN System for protection Human Rights, UN Charter, International Bill of Human Rights – an overview, Implementation mechanism, other important international treaties and conventions. The convention on the rights of child (CRC), Convention against torture (CAT), Other treaties and Convention. Pakistan's response to Human Rights at national and international levels, Constitutional Provision

RECOMMENDED BOOKS

- (01) *Pakistan Studies* by M. R. Kazmi
 (02) *Constitutional and Political History of Pakistan* by Hamid Khan
 (03) *Pakistan's Foreign Policy* by Abdul Sattar
 (04) *Issues in Pakistan's Economy* by Akbar Zaidi

ES-127 PAKISTAN STUDIES (FOR FOREIGNERS)

- **Chapter 1 - Land of Pakistan:**
 - a) Land & People – Physical features and demography
 - b) Geographical and strategic importance of Pakistan
 - c) Natural resources – Mineral, water, and power
 - d) Natural Landscape
 - e) Environmental issues in Pakistan
 - f) Cultural heritage: important remnants of ancient civilizations in Pakistan
- **Chapter 2 - Creation of Pakistan:**
 - a) A brief Historical survey of Muslim community in the sub-continent
 - b) Two-Nation theory – its origin & development
 - c) Rationale for Pakistan – Factors leading to the demand of Pakistan
 - d) Emergence of Pakistan
 - e) Role of Quaid-e-Azam the struggle for Pakistan
- **Chapter 3 - Government & Politics in Pakistan:**
 - a) Political History of Pakistan – A brief account (1947 to date)
 - b) Constitution of Pakistan 1973 – Salient features
 - c) Governmental structure – Federal, Provincial and Local
- **Chapter 4 - Pakistan in the Community of Nations:**
 - a) An overview of Pakistan's foreign policy
 - b) Relations of Pakistan with neighbors, Super Powers, and the Muslim World
- **Chapter 5 - Pakistan's Stand Point on Human Rights:**
 - a) Constitutional provisions
 - b) Comparative analysis of Western and Islamic perspective of Human Rights
 - c) Pakistan's Stand on national and international level

RECOMMENDED BOOKS

(01) *Pakistan Affairs* by M. Ikram Rabbani

(02) *Old Roads - New Highways 50 years of Pakistan* by Victoria Schofield

ME-111 ENGINEERING DRAWING

- Drawing instruments and sheets; Importance of conventions and standards in engineering drawing
- Geometrical construction of plane figures, conic sections, cycloidal curves and involutes.
- Multi view projection and drawing using first and third angle projection methods
- Development of prisms, pyramids, cylinders and cones
- Sections of solids and machine components
- Types of pictorial views and drawing isometric view
- Dimensioning techniques, size and geometric tolerance and their symbols, types of fits
- Construction of curves from intersection of solids such as cones, cylinders, prisms and pyramids
- Sketching of temporary and permanent fasteners like bolts, nuts and rivets, shaft couplings, connecting rod, bearings, pulleys, locking devices; Types of thread
- Types of working drawing, construction of views of the assembled objects / components.
- Construction of process flow diagrams; symbols for piping, instruments and equipment

RECOMMENDED BOOKS

(01) *Engineering Drawing and Design* by David Madsen

EE-124 BASIC ELECTRICITY AND ELECTRONICS

- **Fundamentals of Electric Circuits:** Charge, Current, Voltage and Power, Voltage and Current Sources. Ohm's Law
- **Voltage and Current Laws:** Nodes, Paths, loops and Branches, Kirchhoff's Current law, Kirchhoff's Voltage Laws, the single loop.
- **Circuits:** the single node-pair circuits, series and parallel connected. Independent sources, resistors in series and parallel, voltage and current division.
- **Basic Nodal and Mesh Analysis:** Multi-Nodal Analysis, the super node, Mesh Analysis, the super mesh.
- **Circuit Analysis Techniques:** linearity and Superposition, Source Transformations, Thevenin and Norton Equivalent Circuits, Maximum Power Transfer, Delta-Wye Conversion
- **Capacitors and Inductors:** Capacitors, Inductor, Inductance and Capacitance Combination
- **Basic RL and RC Circuits:** The Source-Free RL Circuit, Properties of the Exponential Response, the Source-Free RC Circuits. the Unit-Steps Function and driven RL Circuits. Natural and forced response and driven RL Circuits.
- **The RLC Circuit:** The Source-Free Parallel Circuit, the over damped parallel RLC Circuits, Critical Damping, the under damped Parallel RLC Circuit. the Source-Free Series RLC Circuit, the complete response of the RLC Circuit. The lossless LC Circuit

RECOMMENDED BOOKS

(01) *Fundamentals of Electric Circuits* by Charles Alexander

First Year Spring Semester

PH-112 APPLIED PHYSICS

- **Introduction:** Scientific notation and significant figures. Types of errors in semi-log and other non-linear graphs).
- **Vectors:** Review of vectors, Vector derivatives. Line and surface Integrals. Gradient of a scalar.
- **Mechanics:** The limits of Mechanics. Coordinate systems. Motion under constant acceleration, Newton laws and their applications. Galilean invariance. Uniform circular motion. Frictional forces. Work and Energy. Potential Energy. Energy Conservation. Energy and our Environment. Angular momentum
- **Electrostatics and Magnetism:** Coulombs Law. Electrostatic potential energy of discrete charges. Continuous charge distribution. Gauss's Law. Electric field around conductors. Dielectrics. Dual trace oscilloscope with demonstration.

Magnetic fields. Magnetic force on current. Hall effect. Biot-Savart Law. Ampere's Law. Fields of rings and coils. Magnetic dipole. Diamagnetism, Para Magnetism and Ferromagnetism.

- **Semiconductor Physics:** Energy levels in a semiconductor. Hole concept. Intrinsic and Extrinsic regions. Law of Mass Action. P-N junction. Transistor. Simple circuits.
- **Waves and Oscillations:** Free oscillation of systems with one and more degrees of freedom Solution for Modes. Classical wave equation. Transverse modes for continuous string. Standing waves. Dispersion relation for waves. LC network and coupled pendulums. Plasma oscillations.
- **Optics and Laser:** Harmonic travelling waves in one dimension. Near and far fields. Two-slit interference. Huygens Principle. Single-slit diffraction. Resolving power of optical instruments. Diffraction Grating. Lasers. Population inversion. Resonant cavities. Quantum efficiency. He-Ne, Ruby and CO₂ lasers. Doppler effect and sonic boom.
- **Modern Physics:** Inadequacy of classical physics, Planck's explanations of black body radiation photoelectric effect, Compton effect. Bohr theory of Hydrogen atomic spectra, Reduce mass, De-Broglie hypothesis Braggs Law, Electron microscope, Uncertainty relations Modern atomic model, . Zeeman effect, Atomic nucleus, Mass-energy Relation, Binding energy, Nuclear forces and fundamental forces, Exponential decay and half-life. Radioactive equilibrium in a chain, Secular equilibrium, Nuclear stability, Radiation detection instruments, Alpha decay, Beta decay, Gamma decay attenuation Nuclear radiation hazards and safety, Medical uses of Nuclear Radiation. Fission, Energy release. Nuclear Reactors. Breeder Reactor. Nuclear Fusion.

RECOMMENDED BOOKS

(01) *Physics by Halliday, Resnick and Krane*

(02) *University Physics by Hugh D. Young and R. A. Freedman*

(03) *Physics for Scientist and Engineers by Serway and Jewett*

ES-111 FUNCTIONAL ENGLISH

Reading:

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

Reading practice through variety of reading texts and comprehension exercises

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

Listening:

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

Note Taking:

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

Vocabulary Development:

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

Writing:

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

Paragraphs:

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

Essays:

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

Short Reports:

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

Letters:

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

RECOMMENDED BOOKS

(01) *Language in Use: Pre-Intermediate Classroom Book* by Android Doff and Christopher Jones

(02) *English Vocabulary in Use: Upper-Intermediate* by Michael McCarthy and Felicity O'Dell

(03) *Study Listening* by Lynch

(04) *Cambridge Vocabulary* by Pauline Cullen

ME-104 WORKSHOP PRACTICE

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

RECOMMENDED BOOKS

(01) *Mechanical Workshop Practice* by K. C. John

(02) *Workshop Technology Part-1*, by W. A. J. Chapman

(03) *Workshop Processes, Practices and Materials* by Bruce J. Black

ME 115 STATICS

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

RECOMMENDED BOOKS

(01) *J.L. Meriam, Engineering Mechanics: Statics, 9th Ed. Wiley, 2018.*

(02) *R.C. Hibbeler, Engineering Mechanics: Statics, 13th Ed. Pearson Education Inc., 2013.*

ME-112 THERMODYNAMICS

- Introduction, Working substance, System, Pure substance, PVT surface, Phases, Properties and state, Units, Zeroth law, Processes and cycles, Conservation of mass.
- Relation of mass and energy, Different forms of energy, Internal energy and enthalpy, Work, Generalized work equation, Flow and non-flow processes, Closed systems, First law of Thermodynamics, Open systems and steady flow, Energy equation for steady flow, System boundaries, Perpetual motion of the first kind.
- Thermodynamic equilibrium, Reversibility, Specific heats and their relationship, Entropy, Second law of Thermodynamic property relation from energy equation, Frictional energy.
- Gas laws, Specific heats of an ideal gas, Dalton's law of partial pressure, Third law of Thermodynamics, Entropy of an ideal gas, Thermodynamic process.
- Cycle work, Thermal efficiency and heat rate, Carnot cycle, Sterling cycle, Reversed and reversible cycles, Most efficient engine.
- Clausius inequality, Availability and irreversibility, Steady flow system.

- Two phase system of a pure substance, Changes of phase at constant pressure, Steam tables, Superheated steam, Compressed liquid and vapour curves, Phase diagrams, Phase roles, Processes of vapours, Mollier diagram, Rankine cycle, Boilers and auxiliary equipment.
- Otto cycle, Diesel cycle, Dual combustion cycle, Four stroke and two stroke engines, Types of fuels.
- Condition for minimum work, Isothermal efficiency, Volumetric efficiency, Multi-stage compression, Energy balance for a two stage machine with intercooler.

RECOMMENDED BOOKS

(01) *Thermodynamics: An Engineering Approach* by Yunus A. Cengel & Michael A. Boles

(02) *Fundamentals of Engineering Thermodynamics* by Moran & Shapiro

ME-214 COMPUTER PROGRAMMING AND APPLICATIONS

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

RECOMMENDED BOOKS

(01) *MATLAB: A Practical Introduction to Programming and Problem Solving* by Stormy Attaway

Second Year Fall Semester

MT-223 ORDINARY DIFFERENTIAL EQUATIONS & FOURIER SERIES

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

RECOMMENDED BOOKS

(01) *Advanced Engineering Mathematics* by Erwin Kreyszig

(02) *Differential Equations* by G. Zill

(03) *Introduction to Differential Equations* by J. Faraw

ME-221 FLUID MECHANICS I

- **Fluid Properties:** Properties of fluids such as density, viscosity, compressibility, surface tension and capillarity, types of fluids.

- **Fluid Statics:** Pressure in a fluid at a point, variation of pressure with depth, Homogeneous fluid, Several fluids of different specific weights, Interconnected vessels, Rigid-body motion of fluid, Hydraulic circuits, Force on plane and curved surfaces, Buoyancy and flotation, Stability of a floating body.
- Atmospheric equilibrium, Isothermal state, Adiabatic state, The standard atmosphere.
- **Fluid Dynamics:** System and control volume, classification of flows, velocity and acceleration fields, 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.

RECOMMENDED BOOKS

- (01) *Fundamentals of Fluid Mechanics* by Munson, Young & Okiishi
 (02) *Fluid Mechanics* by Frank, M White
 (03) *Engineering Fluid Mechanics* by C T, Crowe, D F Elger
 (04) *Fluid Mechanics* by Joseph Franzini

ME-222 DYNAMICS

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

RECOMMENDED BOOKS

- (01) *R.C. Hibbeler, Engineering Mechanics: Dynamics, 14th Ed. Pearson Education Inc., 2015.*
 (02) *J.L. Meriam, Engineering Mechanics: Dynamics, 8th Ed. Wiley, 2015.*

ME-220 MANUFACTURING PROCESSES-I

- **Introduction to Manufacturing:** Types of manufacturing industries, materials used in manufacturing and properties of materials, different processing operation.
- **Sand Casting:**
 - **Introduction:** Sand casting, molding, heating and pouring, solidification and cooling. Pattern: making, material, types, construction, pattern allowances.
 - **Core:** making, types, sand conditioning, testing of sand, molding process, tools and equipment, molding machines, different types of casting, cleaning and finishing of castings, inspection of castings.
- **Permanent Mold Casting (PMC):** Introduction, types of PMC, gravity die casting and its types. 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 like tube sinking, fixed mandrel, floating plug. Other metal forming processes; roll extrusion, riveting, staking, peening, coining, hubbing, burnishing.

- **Sheet metal forming processes:** Shearing operations: slitting, blanking, piercing, cutoff, parting, dinking, slotting, perforating, notching, semi-notching, lancing, nibbling, trimming, shaving, fine blanking. Bending operations: V bending, edge bending, flanging, curling, hemming, seaming. Drawing operations like deep and shallow drawing, embossing.
- **Welding Processes:** Classification, Fusion welding and its types such as oxyfuel gas welding and oxygen torch cutting, arc welding (shielded metal, flux cored, gas metal, submerged, gas tungsten, plasma, stud welding, Arc cutting), resistance welding (spot, seam and projection. Heating, pressure, current control and power supply for resistance welding). Solid state welding and its types including diffusion welding, friction welding and ultrasonic welding.
 - **Other welding processes:** Forge, Roll, Friction, Explosion, Thermic, Electron beam, Laser welding and cutting, Brazing and Soldering.
- **Fabrication of Plastics:** Casting, Blow molding and its types, Compression molding, Transfer molding, Cold molding, Injection molding: injection molding machine, mold design and construction, types of mold, cooling and ejection of mold, Reaction injection molding, Welding of plastics.

RECOMMENDED BOOKS

- (01) *DeGarmo's Materials and Processes in Manufacturing* by J. T. Black
 (02) *Fundamentals of Modern Manufacturing: Materials, Processes, and Systems* by Mikell P. Groover
 (03) *Manufacturing Engineering and Technology* by Serope Kalpakjian & Stephen R. Schmid

ME-224 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, Use of On-board Diagnostics.
- **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 of SI Engine:** The Engine requirements, The Elementary carburetor, Elements of complete carburetor, Calculation of Air: Fuel ratio, Gasoline injection system, Stratified charging.
- **Fuel Metering of CI Engine:** C.I injection systems, C.I engine nozzles, Homogeneous Charge Compression Ignition (HCCI)
- **Engine Characteristics:** Heat transfer and the engine valve, Timing diagram.
- **Lubrication:** Engine-Lubrication systems: Engine performance and lubrication, Lubricants of different kinds.

RECOMMENDED BOOKS

- (01) *V Ganesan, Internal Combustion Engines, 4th Ed. McGraw Hill Education, 2017.*
 (02) *W. Pulkrabek, Engineering Fundamentals of the Internal Combustion Engine, 2nd Ed. Pearson, 2003.*

Second Year Spring Semester

MT-330 APPLIED PROBABILITY & STATISTICS

- **Statistics:** Introduction, types of data & variables, presentation of data, object, classifications, tabulations, frequency distribution, graphical representation, simple and multiple bar diagrams, sartorial and pie-diagram, histogram, frequency polygon, frequency curves and their types.
- **Measure of Central Tendency & Dispersion:** Statistics averages, median, mode, quartiles, range, moments, skew-ness and Kurtosis. Quartile deviation, mean deviation, standard deviation, variance and its coefficient. Significance in related problems.
- **Curve Fitting:** Introduction, fitting of a first and second degree curve, fitting of exponential and logarithmic curves, related problems. Principle of least squares and second order statistics and time series.
- **Simple Regression & Correlation:** Introduction, Scatter diagrams, Correlation & its Coefficient, Regression lines, Rank Correlation & its Coefficient, Probable Error (PE), related problems.

- **Sampling & Sampling Distributions:** Introduction, Population, Parameter & Statistic, Objects of sampling, Sampling distribution of Mean, Standard errors, Sampling & Non-Sampling errors, Random Sampling, Sampling with & without replacement, Sequential Sampling, Central limit theorem with practical significance in related problems.
- **Statistical Inference:** Testing of Hypothesis: Introduction, Estimation, Types of Estimates, Confidence interval, Tests of Hypothesis, Chi-Square distribution/test, one tails & two tails tests. Application in related problems.
- **Probability:** Basic concepts, Permutation & Combination, Definitions of probability, Laws of probability. Conditional probability, Baye's rule. Related problems in practical significance.
- **Random Variables:** Introduction, Discrete & Continuous random variables. Random Sequences and transformations Probability distribution, Probability density function, Distribution function, Mathematical expectations, Moment Generating Function (M.G.F), Markove random walk chain related problems.
- **Probability Distributions:** Introduction, discrete probability distributions, Binomial, Poisson, Hyper geometric & Negative binomial distributions. Continuous probability distribution, Uniform, Exponential & Normal distributions & their practical significance.

RECOMMENDED BOOKS

(01) *Introduction to Statistics by Walpole*

(02) *Mathematical Statistics by Hogg and Craig*

(03) *Exploring Statistics by Larry J. Kitchens*

ME-218 SOLID MECHANICS I

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

RECOMMENDED BOOKS

(01) *Mechanics of Materials by R.C. Hibbeler*

(02) *Mechanics of Engineering Materials by Warnock, F.V, P P Benham and R.J. Crawford*

(03) *Mechanics of Materials by Ferdinand P. Beer & E. Russell Johnston, Jr & John T. Dewolf & David F. Mazurek*

(04) *Strength of Materials and Structures by Case, J.,L. Chilver and C.T.F. Ross*

ME-209 MATERIALS AND METALLURGY

- **Introduction:** Importance of Material Science and Engineering, classification of materials, material property charts
- **Crystallography:** Types of crystal structures, atomic packing factor, Miller indices of crystallographic planes and directions
- **Imperfections in solids:** Classification of defects, types of point defects and their effects on material properties, dislocations, kinetics of dislocations, dislocation interactions, significance of dislocations on material permanent deformation
- **Mechanical properties of materials:** Deformation behavior of materials under tensile and compressive loads, Hardness testing, Testing of materials under impact loading, fundamentals of fracture mechanics, importance of fracture mechanics, material characterization of fracture surfaces, stress distribution around a crack, fatigue testing, S-N curves, creep deformation behavior & ASTM standards for all mechanical tests
- **Diffusion in materials:** Diffusion theory, equilibrium and non-equilibrium diffusion mechanisms, effect of diffusion on material properties
- **Heat treatment and phase transformation in materials:** Types of heat treatment processes, effects of heat treatment on material structure and properties, concepts of phases in solids, solubility limit in solid solutions, strengthening mechanisms (solid solution and precipitate strengthening), binary phase diagrams, iron-iron carbide phase diagram, diffusional and non-diffusional phase transformation, kinetics of phase transformation

- **Polymers:** Structure of Polymers, Thermoplastics and Thermosetting Polymers, Copolymers, Polymer Crystals, Defects in Polymers Characteristic
- **Applications and Processing of Polymers:** Mechanical Behavior, Viscoelasticity, Fracture, Strengthening Mechanism, Polymer Types, Polymer Processing
- **Ceramics:** Ceramic Structure Imperfections in ceramics, Mechanical Properties
- **Applications and Processing of Ceramics:** Types and Applications, Fabrication and Processing
- **Composites:** Introduction, Particle Reinforced Composites, Fiber Reinforced Composites, Processing of Composites, Sandwich Panels
- Material degradation, corrosion, Stress corrosion cracking, corrosion prevention
- **Nanomaterials:** Classifications of nanomaterials, nanomaterial properties, synthesis and characterization of nanomaterials, significance and application of nanomaterials
- **Advanced high strength steels:** Classification of AHSS, material and mechanical characterization of AHSS, properties and applications of AHSS

RECOMMENDED BOOKS

(01) *Material Sciences & Engineering – An Introduction by William D. Callister*

(02) *Principles of Material Sciences & Engineering by William F. Smith*

ES-205 ISLAMIC STUDIES

Chapter 01

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

Chapter 02

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

Chapter 03

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

Chapter 04

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

Chapter 05

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

Chapter 06

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

Chapter 07

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

Chapter 08

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

Chapter 09

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

Chapter 10

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

RECOMMENDED BOOKS

(01) *Thematic Study of Holy Quran & Hadith* by Dr. Saeedullah Qazi

(02) *The Noble Quran (Quranic Translation)* by Dr. Mohsin Khan & Dr. Taqi Uddin Hilali

(03) *The Sealed Nector: A book on the biography of Holy Prophet (PBUH)* by Saif ur Rehman Mubarakpuri

ES-209 ETHICAL BEHAVIOUR (Alternate Course for Non Muslim Students)

- **Introduction to Ethics:**
 - Definition of Ethics
 - Definition between normative and positive science
 - Problem of freewill
 - Method of Ethics
 - Uses of Ethics
- **Ethical Theories:**
 - History of Ethics: Greek Ethics, Medieval, Modern Ethics
 - Basic concept of right and wrong: good and evil
 - Utilitarianism, hedonism, self-realization: egoism, intuitionism, rationalism
 - Kant's moral philosophy
- **Ethics & Religion:**
 - The relation of Ethics to religion
 - Basic ethical principles of major religions: Hinduism, Judaism, Buddhism, Zoroastrianism, Christianity, Islam
- **Ethics, Society, and moral theory:**
 - Ethical foundation of Rights and Duties
 - Applied Ethics
 - Society as the background of moral life
 - Universalism and Altruism
 - Theories of punishment

RECOMMENDED BOOKS

(01) *An Introduction to Ethics* by Lillie W.

(02) *Philosophy : the Basic* by Warburton N.

(03) *Quranic Ethics* by Dar B. Ahmed

(04) *A Companion of Ethics* by Singer P.

EA-208 BUSINESS COMMUNICATION & EHTICS

Communication Skills (Oral)

- Definitions and Conditions, Modes; verbal, non-verbal, vocal, non-vocal, sender, receiver, encoding, decoding, noise, context, emotional, relationships, etc.
- Language and perception, Distortion of thought, interference.
- Non-verbal, body language, physical appearance, cultural differences etc.
- Barriers to Comm: ambiguity, context, closure, prediction, pseudo listening.
- Listening: effective listening, benefits and ethics for listener.
- Personal and interpersonal skills/perceptions.
- Communication dilemmas and problems.
- Public Speaking – speaking situations, persuasive speeches/ interviews

Written Communication

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

Engineering / Business Ethics

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

RECOMMENDED BOOKS

(01) *Report Writing for Business* by Lesikar and Pettit

(02) *Business & Professional Communication* by Roach, Gant, Allyn Perigo & Bacon

(03) *Engineering Ethics* by Flederman

ME-219 MECHANICS OF MACHINE

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

- **Turning-Moment Diagrams and Flywheel:** Turning Moment of Steam Engine; Turning Moment of Internal Combustion Engine; Turning Moment of Multi-cylinder Engine; Coefficient of Fluctuation of Energy; Coefficient of Fluctuation of Speed. Flywheel; Energy Stored in a Flywheel; Dimensions of the Flywheel Rim.

RECOMMENDED BOOKS

(01) *Mechanical Engineering Design* by Shigley

Third Year Fall Semester

ME-317 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.

RECOMMENDED BOOKS

(01) *DeGarmo's Materials and Processes in Manufacturing* by J. T. Black

(02) *Fundamentals of Modern Manufacturing: Materials, Processes, and Systems* by Mikell P. Groover

(03) *Manufacturing Engineering and Technology* by Serope Kalpakjian & Stephen R. Schmid

ME-321 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.

RECOMMENDED BOOKS

(01) *Powerplant Engineering* by M. M. El-wakil

ME-302 SOLID MECHANICS – II

- Combined bending and direct stresses. Shear stresses in bending, bending and shear stresses in I-section beams. Asymmetrical bending, Shear stress in thin-walled open sections and shear center, General case of bending of a thin walled open section, Bending of initially curved bars, Beams with small radius of curvature.
- Strain energy under direct stress and in pure shear, Strain energy in bending and torsion, Maximum stress due to a suddenly applied load and due to impact, Bending deflection of a beam from an impact, Shear deflection, Theorems of Castigliano and Maxwell's Reciprocal Theorem.
- Double integration method; Superposition method; Virtual work; Compatibility and equilibrium methods
- Two-directional stress systems; Mohr's stress circle, Principal stresses and planes, Combined bending and torsion, Two-directional strain analysis, Normal and shear strain in terms of coordinate and maximum shear strain, Relationship between elastic constants.
- Thick-walled cylinders, Compound cylinders, Shrink fit, Rotating disk of uniform thickness
- Maximum Principal Stress Theory, Maximum principal strain theory, Maximum shear stress theory, Total strain energy theory.
- Deflection of thin Plates, bending of circular plates with symmetrical loading, Plates with uniform loading, solid plate with different loading conditions, Axi-symmetrical thin shells, bending stresses in thin shells.

RECOMMENDED BOOKS

(01) *Mechanics of Materials* by R.C. Hibbeler

(02) *Mechanics of Engineering Materials* by Warncok. F.V, P P Benham and R.J. Crawford

(03) *Mechanics of Materials* by Ferdinand P. Beer & E. Russell Johnston, Jr & John T. Dewolf & David F. Mazurek

(04) *Strength of Materials and Structures* by Case, J.,L. Chilver and C.T.F. Ross

ME-316 FLUID MECHANICS - II

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

RECOMMENDED BOOKS

(01) *Fundamentals of Fluid Mechanics* by Munson, Young & Okiishi

(02) *Fluid Mechanics* by Frank, M White

Third Year Spring 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 tri-diagonal matrix), Rank of a matrix using row operations and special method, echelon and reduced echelon forms of a matrix, determination of consistency of a system of linear equation using rank, 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 transform 1 ations to plane figure, composition or transformations.
- **Advance Calculus:** Define a stationary point of a function of several variables, define local maximum and saddle point for a function of two variables the stationary points of a several variables, obtain higher partial derivatives of simple functions of two or more variables, iterated integrals, double and triple integrations with applications (area, centroid, moment of inertia, surface area, and volume, use multiple integrals in solutions of engineering problems.
- **Vector Calculus:** Vector differential operator, directional derivative, gradient, divergence, curl of a vector field, and Laplacian operators with applications. (Solenoid, conservative, etc.). Vector Integrations; Evaluate line integrals along simple paths, apply line integrals to calculate work done, apply Green's theorem in the plane to simple examples, evaluate surface integrals over simple surface, use the Jacobean to transform a problem a new co-ordinate system, apply Gauss' divergence theorem to simple problems, apply Stokes theorem to simple examples.

RECOMMENDED BOOKS

- (01) *Elementary Linear Algebra* by Howard Anton
(02) *Calculus and Analytical Geometry* by Howard Anton
(03) *Advance Engineering Mathematics* by Erwin Kreyszig
(04) *Elementary Linear Algebra* by Bernaid Kolman

EL-305 INSTRUMENTATION AND CONTROL

- Introduction, instrumentation and control system terminologies.
- Open loop and closed loop system.
- Mathematical models of physical systems, transfer function, interaction and non-interactive system, development block diagrams tachometers and signal conditioning activator.
- Transient response of first and second order system, steady state analysis, Transportation lag, dynamic response of a gas absorber and heat exchange.
- Controller design, P control, I control, PID control, stability criteria, root locus method, frequency response of control system, D control (bode diagram, Nyquist diagram).
- Introduction to nonlinear system.
- Simulation of control system.

RECOMMENDED BOOKS

- (01) *Linear Control System Analysis & Design with MATLAB* by D'Azzo
(02) *Control System Engineering* by Norman Nise

ME-323 MACHINE DESIGN

- **Design of Machine Elements:**
 - **Shafts and Columns:** Shaft Types and Materials; Design of Shafts under Normal and Combined Loading; Static, Cyclic and Shock Loads; Torsional stiffness; Critical speeds; Shaft Materials Introduction to Flexible Shafting;Column; Types of End Conditions; Euler's Column Theory; Connecting Rods and Crank Shafts.
 - **Bearing:** Bearing types and Materials, Friction and Wear, Theory and Application of Lubrication and its Methods; Details design of Journal bearing and Thrust bearings, Rolling Contact Bearings, Bearing life, Bearing Load, Bearing

Survival, The Reliability Goal, Selection of Ball and Straight Roller Bearings, Spherical and Tapered roller bearings; Selection of Tapered Roller Bearing.

- **Plates and Shells:** Introduction to the Design of Pressure Vessels, Thin and Thick Pressure vessels, Stresses in Thin and Thick Pressure Vessel, Compound Cylinders, Stresses in Compound Cylinders, Design of Plates, ASME Codes, Petro-Chemical piping systems; Design of rings and wheels.
- **Gear Design:** General gear theory; Design of the Spur gear; The Lewis formula, the AGMA Stress Formula, The AGMA Strength Formula, Design of any one of the following types of gears; Helical, Worm, Bevel, gear; Gear Trains.
- **Application of Industrial Codes:** Introduction to Industrial Design Codes. Application of at least one Design standards i.e. ASME, BS, ANSI, JIS, DIN, and ISO in the design of Machine Elements and Assemblies.
- **Elements of Micro Electro-Mechanical System (MEMS):** MEMS manufacturing; Lithography, Etching, Micromachining; MEMS Devices; Sensors; Actuators; Springs and Fluid Flow devices.

RECOMMENDED BOOKS

(01) *Mechanical Engineering Design* by Shigley

ME-318 HEAT & MASS TRANSFER

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

RECOMMENDED BOOKS

(01) *Fundamentals of Heat & Mass Transfer* by Theodore L. Bergman, Adrienne S. Lavine, Frank P. Incropera and David P. Dewitt

ME-319 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 and Air Conditioning Systems Components:** Compressor, Condenser, Evaporator, Expansion devices, Humidifier, Dehumidifier, Fan, Pump, Blower, grills and registers, cooling tower, Automatic temperature and humidity control systems, Pneumatic, electric and hydraulic systems.
- **Refrigerants:** Desirable properties of a refrigerant, Classification of refrigerants and their comparison, designation systems, secondary refrigerants (brine), Defrosting air circulation systems.
- **Application of Refrigeration:** Domestic refrigerators, Water cooler, Cold storage, Ice making plants, Heat pump and Dairy industries applications

RECOMMENDED BOOKS

(01) *Refrigeration and Air Conditioning* by W. F. Stoecker & J. W. Jones

(02) *ASHRAE HANDBOOK -Fundamentals, HVAC Applications, Refrigeration & HVAC Systems & Equipment*

Final Year Fall 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. Break-even 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 and 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, VIP and TIP ratios.
- **Linear Programming:** Mathematical statement of linear programming problems graphic solution. Simplex method and duality problems.

RECOMMENDED BOOKS

- (01) Engineering Economics by William G. Sullivan & James A. Bontadelli
(02) Operational Research: An Introduction by Hamdy A. Taha

ME-436 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 electro-mechanical systems and analogies.

RECOMMENDED BOOKS

- (01) *Mechanical Vibrations: Theory and Applications* by W. T. Thomson
(02) *Elements of Vibration Analysis* by L. Meirovitch
(03) *Engineering Vibrations* by D.J. Inman

ME 419 STRESS ANALYSIS

- 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.
- Hyperelasticity; isotropic hyperelasticity; material and spatial description of hyperelastic deformation; compressible Neo-Hookean material.
- Yielding of ductile isotropic 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.
- 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.

- 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.

RECOMMENDED BOOKS

- (01) *Experimental Stress Analysis* by James W. Dally & William F. Riley
 (02) *Advanced Mechanics of Materials* by Arthur Boresi
 (03) *Continuum mechanics* by G.Thomas Mase and George E. Mase
 (04) *Finite Element Analysis: Theory and Application with Ansys* by Saeed Moaveni

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

RECOMMENDED BOOKS

- (01) *Introduction to Entrepreneurship* by Donald F. Kuratko
 (02) *The Entrepreneurial Mindset* by McGrath R. G. & McMillan I.

MT-441 ADVANCE MATHEMATICAL TECHNIQUES

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

RECOMMENDED BOOKS

- (01) *Complex Analysis for Mathematics and Engineering* by John H. Mathews
 (02) *Advance Engineering Mathematics* by Erwin Kreyszig
 (03) *Applied Numerical Analysis* by Gerald
 (04) *Calculus & Analytical Geometry* Howard Anton

ME-417 COMPRESSIBLE FLOW AND PROPULSION SYSTEMS

- Governing equations for compressible fluid flow: conservation of mass, momentum and energy.
- 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.

- 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.
- 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.
- 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.
- Fannoline, friction parameter for a constant area duct, limiting conditions, isothermal flow in long ducts.
- Flow in ducts with heating or cooling, thermal choking due to heating, correlation with shocks.
- 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.

RECOMMENDED BOOKS

(01) *Gas Dynamics* by M.H. Aksel, O.C. Eralp

(02) *Fundamentals of Gas Dynamics* by R.D. Zucker & O. Biblarz

ME-435 OPERATIONS MANAGEMENT

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

RECOMMENDED BOOKS

(01) *Operations Management* by Jay Heizer & Barry Render

Final Year Elective Courses

ME-421 GAS TURBINE

- 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.
- Turboprop, Turbofan and turbojet engines, Influence of altitude and flight speed on performance.
- Principle of operation, Work done and pressure rise, Compressibility effects, Non-dimensional quantities for plotting compressor characteristics.
- Elementary theory, Degree of reaction, Simple design method, Blade design, Calculation of stage performance, Overall performance, compressibility effect.
- Form of combustion system, Some important factors effecting combustion chamber designing, combustion process, Combustion chamber performance.
- Elementary theory, Vortex theory, Choice of blade profile, pitch and cord, Estimation of stage performance, Overall turbine performance.
- 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 of Gas Turbine, compressor and turbine efficiencies, and specific fuel consumption will be conducted in the lab.

RECOMMENDED BOOKS

(01) *Mechanics & Thermodynamics of Propulsion* by Hill & Peterson

ME 422 NUCLEAR POWER

- 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.
- 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.
- Nuclear chain reactors, Criticality, The four factor formula, One group critical equation, The critical size, Non-leakage probability, Neutron life cycle.
- Excess reactivity and reactor-period, Xenon poisoning.
- 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).
- Introduction, Nuclear Reactions, Conversion and breeding, Liquid metal fast breeder reactor (LMFBR) Plant arrangements, LMFBR, Gas cooled Fast breeder reactor (GCFBR).
- Choice of a moderator, The fuel, The coolant, Nuclear fuels.
- Nuclear power economics, Fuel reprocessing, Health hazard due to reactions, Shielding, Nuclear applications for peaceful purposes.

RECOMMENDED BOOKS

(01) *“Particle and Nuclei”* by B. Povh, K. Rith, C. Scholtz, F. Zetsche

(02) *Nuclear Physics* by Green

(03) *Radiation Detection and Measurement* by Glenn F. Knoll

ME-423 COMPUTER AIDED DESIGN / COMPUTER AIDED MANUFACTURING

- Introduction, The design process, Application of computers for design, Creating the manufacturing data base, Benefits of CAD.
- The design workstation, Graphics terminal, Operator input devices, Plotters and other output devices, The central processing unit, Secondary storage.
- The software configuration of a graphics system, functions of a graphic package, Constructing the geometry, Data base structure and content, Wire-frame versus solid modeling, other CAD features and CAD/CAM integration.
- Two dimensional transformations, Translation, Scaling and rotation, Concatenation, Various techniques for design optimization, finite element analysis / modeling.

COMPUTER AIDED MANUFACTURING (CAM)

- Introduction, basic components of an NC system, The NC procedure, NC coordinate systems, NC motion control systems, Applications of numerical control, Economics and justification
- Punched tape in NC, tape coding and format, manual part programming, computer assisted part programming, The APT language, NC programming with interactive graphics, Voice NC programming, manual data input, APT word definitions.
- Problems with conventional NC, NC controller technology, Computer numerical control, Direct numerical control, Adaptive control machining systems, Trends and new developments in NC.
- Robot anatomy, Accuracy and repeatability, Robot specifications, End effectors, Characteristics of robot applications, Robot cell design, Types of Robot applications

RECOMMENDED BOOKS

(01) *Computer Aided Design & Manufacturing* by Groover, Zimmers

ME-424 CLEAN ENERGY TECHNOLOGY

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

- Conservation of energy, energy conservation opportunities and management.
- Introduction to renewable energy sources: Solar, Wind, Ocean, Geothermal, Biomass including biofuels, Hydrogen coupled with other renewable sources, Hydro power, Thermoelectricity.
- Nature of solar radiation, insolation, architecture and types of solar collectors, Solar Plant configurations, Introduction to Photovoltaic systems, Application software.
- History, availability, data collection, wind turbine configurations and characteristics, principles of aerodynamics, wind turbine analysis and performance calculations, Application software.
- 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).
- Composition of biomass, biomass as fuel, Photosynthesis and renewable energy; production and use of biodiesel and ethanol; Merits and demerits.
- The resource, Types of hydroelectric plants, Applications, Small scale hydroelectricity, Environmental considerations.
- 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.
- 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.

RECOMMENDED BOOKS

- (01) *Renewable & Efficient Electric Power Systems* by Gilbert M. Masters ,Publisher: Wiley
 (02) *Renewable Energy Systems (Advance conversion technologies)* by Fang ling Luo Hong YE
 (03) *Geothermal Energy* by William E. Glassley

ME-425 FINITE ELEMENT ANALYSIS

- Introduction to general Numerical Techniques; Basic concepts regarding finite element analysis; Matrix stiffness method; Minimum potential energy formulation; Recent developments.
- Finite element modeling, element division and numbering scheme; Basic steps in FEA (Pre-processing, solution, post processing); Finite element Analysis of Bar element; Finite element Analysis of Truss; Finite element Analysis of Beam; Finite element Analysis of Frame.
- Governing Differential Equations; Transformation of Differential equation into FE equations; Treatment of boundary conditions (Elimination approach, penalty approach); Variational Formulation of boundary value problem; Methods of weighted residuals (Galerkin, Collocation, least square, sub-domain); Rayleigh Ritz Method.
- Interpolation techniques (Triangular, Rectangular); shape functions; Lagrange interpolation function; Analysis of one dimensional problems (Linear, Quadratic, Cubic elements); Analysis of two dimensional elements; Integration on master scale, modeling, mesh generation; Gaussian Quadrature formulae, One point form, two point form.
- Convergence of solution; Various measures of errors; FEA application to Heat Transfer problems; FEA application to Fluid Mechanics problems; FEA application to Solid Mechanics problems.
- Assumptions of plane elasticity; Basic equations; Formulation of Plane stress problems; Explicit expression for Constant strain triangular element stiffness matrix; Finite element solution of a Plane stress problem.

RECOMMENDED BOOKS

- (01) *Finite Element Analysis: Theory and Application with Ansys* by Saeed Moaveni
 (02) *A First Course in finite element method* by Daryl L.Logan
 (03) *Finite Element Modeling for Stress Analysis* by Robert D. Cook
 (04) *Fundamentals of Finite Element Analysis* by David V. Hutton

ME-426 PLANT MAINTENANCE

- 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 categories (Breakdown, Preventive, Predictive), Merits and de-merits of Preventive maintenance and Predictive maintenance, maintenance schedules, RCM (Reliability Centred Maintenance), analysis
- Condition monitoring, Economics of condition monitoring, Design of a Predictive Maintenance Program, Total Plant predictive program, Methods and instruments for Predictive Maintenance (pertaining to Vibration analysis, thermography and relevant techniques).
- 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.

- 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, run-out measurement and misalignment in shafts, vibration amplitude, gears, ultrasonic detection

RECOMMENDED BOOKS

- (01) *Maintenance Fundamentals* by Keith Mobley
 (02) *Maintenance Engineering Handbook* by R. K Mobley, L. R. Higgins, D. J. Wikoff, McGraw-Hill
 (03) *Maintenance Engineering & Management* by R.C. Mishra, K. Pathak, Prentice Hall of India
 (04) *Engineering Maintenance A Modern Approach* by B. S. Dhillon, CRC Press London
 (05) *Managing maintenance resources* by Kelly, Anthony
 (06) *Mechanical fault diagnosis* by Collacott, R.A.Chapman and Hall
 (07) *Handbook of maintenance management* by Levitt Joel
 (08) *Asset maintenance management* by Wilson Alan
 (09) *Developing performance indicators for maintenance* by Tery Wireman
 (10) *Handbook of Maintenance Management and Engineering* by Mohamed Ben-Daya, Salih O. Duffuaa Abdul Raouf, Jezdimir Knezevic

ME-429 WATER TREATMENT AND DESALINATION

- Water quality criteria for potable water, Composition and constituents of water and wastewater, physical and chemical characteristics, microbiological characteristics, water impurities.
- Coagulation and Flocculation, types of mixers, Zeta potential, chemical reactions of alum and ferrous and ferric ion, jar test for pH adjustments.
- Softening processes, chemical dosages based on stoichiometry, ion exchange processes, operation and maintenance of ion exchange systems.
- Sedimentation, Basin design, Factors affecting sedimentation, Carbon adsorption, activation techniques, adsorption characteristics, Relative velocities and head losses, Granular Filtration, Filter media characteristics Disinfection methods, Ultraviolet, Ozonation and Chlorination.
- Membrane Filtration: Reverse Osmosis, Nanofiltration and Ultrafiltration, Membrane fouling, Electrodialysis
- Wastewater pretreatment, biological principles for treatment of wastewater, suspended growth bio-systems, Wastewater microbiology, primary, secondary and tertiary treatment processes for sludges.
- Thermal desalination such as Single Vapor compression systems, Multi-stage flash, Multi-effect systems

RECOMMENDED BOOKS

- (01) *Desalination Engineering Planning and Design* by N. Voutchkov
 (02) *Membrane Technologies for Water Treatment* by Alberto Figoli, Jan Hoinkis, Jochen Bundschuh

ME-430 MECHATRONICS

- **Introduction to Mechatronic Systems:** Historical perspective of Mechatronic systems, key components of a mechatronic system; design considerations and specifications.
- **Mechanisms for motion transmission:** Introduction; Rotary to Rotary Motion Transmission Mechanisms: Hydraulics and Pneumatics, Gears; Belt and Pulley. Rotary to Translational Motion Transmission Mechanisms: Lead-Screw and Ball-Screw Mechanisms; Rack and Pinion Mechanism. Cyclic Motion Transmission Mechanisms: Linkages; Cams.
- **Electronic components for Mechatronics:** Basics of Linear Circuits; Equivalent Electrical Circuit Methods; Semiconductor Electronic Devices; Operational Amplifiers; Basic Op-Amp; Common Op-Amp Circuits; Digital Electronic Devices; Logic ; Decoders ; Multiplexer; Flip-Flops; Digital and Analog I/O; D/A and A/D Converters; Microcontroller and Microprocessor.
- **Sensors and Actuators:** Sensor types or classifications, principles of operation, selection criteria, signal conditioning and calibration, electrical and optical sensors; sensors for measuring displacement, strain, force, pressure, temperature, flow and motion. Actuator types or classifications, principles of operation, selection criteria. Electro-mechanical actuators: permanent magnet DC motors, stepper motors, servo motors; pneumatic and hydraulic actuators, characteristics of sensors & actuators.
- **System Interfacing using Microcontrollers** Data acquisition; Interfacing, Ports, Input/Output, Analog to Digital converter, sampling theory, Digital to Analog converter. Sample and hold, multiplexer, Interfacing switches, LEDs, stepper motors and DC motors to microcontrollers.
- **Industrial Applications of Mechatronic Systems:** Applications in manufacturing, robotics, process control.

RECOMMENDED BOOKS

(01) Sergey Edward Lyshevski, *Mechatronics and Control of Electromechanical Systems*, CRC Press, 1st Edition, 2017.
(02) Robert H. Bishop, "Mechatronics: An Introduction" CRC Taylor & Francis 2006

ME-431 TRIBOLOGY

- **Course Overview:** Introduction to tribology, Surface topography physico-chemical aspects of solid surfaces, Surface interactions.
- **Mechanics of Solid Contacts:** Elastic contacts, elastoplastic contacts, fracture.
- **Friction:** Laws of friction, Mechanisms of friction, friction space, stiction, stick slip, surface temperature.
- **Wear:** Adhesive wear, delamination wear, fretting wear, abrasive wear, erosive wear, corrosive wear, Mild and severe oxidation wear, Melt wear, Wear Mechanism Maps.
- **Lubrication:** Boundary lubrication, solid-film lubrication, Mixed lubrication, Hydrodynamic lubrication, hydrostatic lubrication.
- **Nanoscale Tribology:** Interatomic interactions, atomic force microscope (AFM), challenges of tribological testing at small scales.
- **Tribological Testing:** Common geometries, instrumentation and Methods used for testing, influence of Test parameters.
- **Application and Case Studies:** Sliding contacts, rolling contacts, bearing design, coating selection, Engine Tribology, Marine tribology.

RECOMMENDED BOOKS

(01) Ian Hutchings Philip Shipway, *Tribology, 2nd Ed. Butterworth Heinnemann, 2017*
(02) Shizhu Wen Ping Huang, *Principles of Tribology, Tsinghua University Press, 2018.*

ME-432 HEALTH, SAFETY AND ENVIRONMENT

SAFETY MANAGEMENT & HAZARD COMMUNICATION

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

ACCIDENT PREVENTION & CONTROL

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

BUILDING & FACILITIES

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

ERGONOMICS & SAFETY

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

HEALTH, TOXIC & ENVIRONMENT

Toxic substances, measures of exposure, detecting contaminants, ventilation, noise and radiation, flammable and explosive materials

PERSONAL PROTECTIVE EQUIPMENT & FIRST AID

Protection need assessment, PPE Training; hearing, eye and face respiratory protection, confined spaces, first aid.

PROCESS SAFETY

Material handling and storage, machine guarding, welding, electrical hazards, construction hazards

OPERATIONS OCCUPATIONAL SAFETY

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

ME-433 LAW FOR ENGINEERS

Introduction to legal studies, concepts and sources of law, Industrialization and role of Law, Development and role of contract legislative intervention

Intellectual property, Designs, Trademark, Patents, Copyright in Engineering, Enforcing rights to intellectual property

Engineering Contracts, Rights & Obligations, Legal documentation, Tendering and sub-contracting, Claims Concept of negligence Dispute Resolution in Domestic and International dealings

Liability for defective products, Role of Insurance

International Aspects of Laws, Law of Agency, Law of property

Taxation, Service Tax, Income Tax, VAT, Excise Duty
Aspects of employment law, Labour laws

Environmental Law for Engineers, Need for a Environmental Protection Policy, Environmental Policy Act, Air and Water Pollution Acts, ISO 14000

Public Procurement Rules, Procurement planning, pre-qualification, bidding documents, evaluation criteria, Re-bidding

ME-434 TOTAL QUALITY 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, EOQ, MS Project, Queueing with Poisson arrivals and exponential service times.

ME 438 AI and Internet of Things

Fundamental Elements: Artificial Intelligence (AI), Internet of Things (IoT), Data Analysis, Fourth Industrial Revolution (Industry 4.0), Foreseeable Industrial Revolution through AI. Real world interaction devices and linkage to mechanical engineering

Mathematical Tools: Statistics, Probability, Regression, Confidence Bounds, Decision making criterion, Matrix Structures (Matrix Operations, Array addressing, Multidimensional arrays), Forecasting (Moving average, Weighted Moving Average, Smoothing).

Programming Languages and Structures: Development Environments/Integrated Development Environments, Structure, types of data, compiling.

Machine Learning (ML) Algorithms: Supervised/Unsupervised/Hybrid learning methods, ML by linear regression, Nearest neighbor methods, neural networks, Decision tree analysis.

Microcontroller / Microcomputer Boards and Interfacing: Single board computers (Arduino, ESP etc.), Microcontrollers vs Microprocessors, interfacing with Arduino IDE, feedback control, result oriented programming. Raspberry Pi, Python foundation, Python IDEs, data/plot library.

Server Maintenance, Data Harvesting and Visualization: Data Collection and storage on platforms, primary servers and handling (PHP, TXT, CSV), recall and storage routines. Open access libraries, deployment tools. Data visualization by Python Processing IDE

Industrial Controls and Automation: PLCs, remote monitoring and process disruption.

EA-219 PROFESSIONAL ETHICS

Introduction to Professional & Engineering Ethics:

- Definitions: Ethics, professional Ethics, Engineering Ethics, Business Ethics
- Ethics & Professionalism Need and scope of Engineering and professional Ethics through Case Studies
- Development of Engineering Ethics & Major issues in Engineering & Professional Ethics

Moral Reasoning & Ethical Frameworks Ethical Dilemma:

- Resolving Ethical dilemmas and making Moral Choices Codes of Ethics (of local and international professional bodies)
- Moral Theories: Utilitarianism, Rights Ethics and Duty Ethics, Virtue Ethics Self- Realization & Self Interest
- Ethical Problem Solving Techniques: Line drawing, flow Charting, Conflict Problems. Case Studies and applications

Contemporary Professional Ethics:

- Professional Responsibilities
- Risk and Safety as an Ethical Concern for Engineers
- Workplace Responsibilities and Ethics: Teamwork, confidentiality and conflicts of interest, Whistleblowing, Bribe and gift, risk and cost-benefit analyses, gender discrimination and sexual harassment
- Environmental Ethics Computer Ethics & the Internet Honesty: Truthfulness, trustworthiness, academic and research integrity

EA-228 SOCIOLOGY & DEVELOPMENT

1. Introduction to Sociology

- a. Foundations of OB: Management functions, roles, and skills
- b. Definition, nature, scope, and importance of Sociology
- c. Study of social life; exploring the global village
- d. Sociology as a science; relationship with other social sciences
- e. The sociological imagination; development of Sociology, pioneers of Sociology
- f. The sociological imagination; development of Sociology, pioneers of Sociology
- g. Brief historical development of Sociology
- h. Society and community, Social interaction processes

2. Social groups & Social Institutions

- a. Definition, functions and types of social groups
- b. Structure and function of social institutions
- c. Inter-relationships among various social institutions

3. Culture and Related Concepts

- a. Definition, types and elements of culture
- b. Role of culture in organization
- c. Socialization and personality

4. Social Stratification

- a. Factors of Social Stratification
- b. Approach to study social stratification
- c. Power, Prestige, and Authority
- d. Social Mobility; Migration

5. Social and cultural change

- a. Definition of social change
- b. Dynamics of social change
- c. Impact of globalization on society and culture
- d. Resistance to change

6. Sociology & Development

- a. Significant sociological questions
- b. Measures of inequality and development
- c. Modernisation theory and explanation of underdevelopment
- d. Education, industrialization & development

EA-229 ANTHROPOLOGY

1. Introduction to Anthropology

- i. Significance of Anthropology
- j. Fields of Anthropology; Anthropological Theories
- k. Anthropology and its relationship with other disciplines

2. Culture & Culture Change

- d. Definition, Properties and Taxonomy
- e. Evolution of Growth and Culture
- f. Evolution of Man and Evolution of Culture
- g. Culture and Personality
- h. Process of Cultural Change
- i. Cultural Change in the Modern World
- j. Cultural Change in Pakistani society
- k. Language and Culture

3. Economic System

- d. Global Economic System
- e. The Allocation and conversion of Resources
- f. Poverty and Inequality

4. Political Organization

- e. Political Sociology
- f. Origin of Political Organization and Organizational System
- g. Types of Political Organizations
- h. Power Politics and Factionalism in Pakistan
- i. Resolution of Conflict

5. Applications of Anthropology

- e. *(Anthropology and Engineering and other disciplines)*

EA-230 ORGANIZATIONAL BEHAVIOUR

1. Introduction to Organizational Behavior

- l. Foundations of OB: Management functions, roles, and skills
- m. Effective versus successful managerial activities
- n. Replacing intuition with systematic study
- o. Exploring OB challenges and opportunities facing globalization
- p. OB Model

2. Foundations of Individual Behavior

- l. Biographical traits and ability
- m. Note taking in different forms paragraphs (points, figures, processes, tables, graphs etc.)
- n. Personality
- o. Perceptions and individual decision making
- p. Values, attitudes and job satisfaction
- q. Motivation - basic concepts and applications
- r. Work stress

3. Foundations of Group Behavior

- g. Group in OB: Defining and classifying groups
- h. Stages of group development, work group behaviour
- i. Dynamics of groups
- j. Understanding work teams
- k. Leadership: basic approaches and contemporary issues
- l. Conflict & negotiation

4. Foundations of Organizational Structure

- j. Organizational structure and design
- k. Organizational culture
- l. Organization change and development