

DEPARTMENT OF MATERIALS ENGINEERING

Course Outline

MM-102: INTRODUCTION TO ENGINEERING MATERIALS

Introduction to engineering materials, their scope and role in industrial development, raw materials for engineering materials: their availability and demand, fundamentals of engineering materials: atomic bonding, crystal structures of metals, introduction to polymers, ceramic, composite and semiconductor materials. Processing, properties and applications of metallic, polymeric, ceramic, composite and semiconductor materials. An introduction to new breeds of engineering materials e.g., shape memory materials, smart materials, electrical, magnetic and optical materials. Materials of aerospace and transportation industries. Laboratory activities

ME-101: ENGINEERING MECHANICS

Statics of Particles: Forces in a plane; Newton's First Law, Freebody diagram; Forces in space (rectangular components); Equilibrium of a particle in space.

Kinematics of Particles:

Rectilinear and curvilinear motion of particles; Components of velocity and acceleration; Motion relative to a frame in translation.

Kinetics of Particles:

Newton's Second Law; Dynamic equilibrium; Rectilinear and curvilinear motion; Work and energy; Kinetic energy of particle; Principle of Work and Energy; Conservation of energy; Impulse and momentum; Impulsive forces and conservation of momentum; Impact, direct and oblique; Conservation of angular momentum.

Rigid Bodies:

Equivalent systems of forces; Principle of transmissibility; Moment of a force; Couple; Varignon's Theorem. Centre of gravity of a three-dimensional body and centroid of a volume. Moments of inertia, radius of gyration, parallel axis theorem.

Equilibrium of Rigid Bodies:

Free-body diagram; Equilibrium in two and three dimensions; Reaction of supports and connections; Equilibrium of two-force and three-force bodies.

Kinematics of Rigid Bodies:

General Plane motions; Absolute and relative velocity and acceleration.

Plane Motion of Rigid Bodies:

Forces and acceleration; Energy & momentum; Conservation of linear and angular momentum.

Friction:

Laws of dry friction; Angles of friction; Wedges; Square-threaded screws; Journal & thrust bearings; Belt friction.

Analysis of Structures:

Internal forces & Newton's Third Law; Simple & space trusses; Joints & sections; Frames & machines. Forces in cables.

PH-122: APPLIED PHYSICS

Introduction:

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

Vectors:

Review of vectors, Vector derivatives. Line & 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, Paramagnetism and Ferromagnetism.

Semiconductor Physics:

Energy levels in a semiconductor. Hole concept. Intrinsic and Extrinsic regions. Law of Mass Action. P-N junction. Transistor. Simple circuits.

Waves and Oscillations:

Free oscillation of systems with one and more degrees of freedom Solution for Modes. Classical wave equation. Transverse modes for continuous string. Standing waves. Dispersion relation for waves. LC network and coupled pendulums. Plasma oscillations.

Optics and Lasers:

Harmonic traveling waves in one dimension .Near and far fields. Two-slit interference. Huygens Principle. Single-slit diffraction. Resolving power of optical instruments. Diffraction Grating. Lasers. Population inversion. Resonant cavities. Quantum efficiency. He-Ne, Ruby and 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 atom, Atomic spectra, Reduce mass, De-Broglie hypothesis Braggs Law, Electron microscope, Uncertainty relations Modern atomic model, .Zeeman effect, Atomic nucleus, Mass-energy relation, Binding energy, Nuclear forces and fundamental forces, Exponential decay and half-life. Radioactive equilibrium in a chain, Secular equilibrium, Nuclear stability, Radiation detection instruments, Alpha decay, Beta decay, Gamma decay attenuation Nuclear radiation hazards and safety, Medical uses of Nuclear Radiation. Fission, Energy release. Nuclear Reactors. Breeder Reactor. Nuclear Fusion.

ME-104: WORKSHOP PRACTICE

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

HS-104: FUNCTIONAL ENGLISH

Listening: Types of Listening, Problems in listening and coping strategies, Listening skills, Sub skills, Practice in Listening. **Note taking:** Techniques for taking notes, Note taking in different forms paragraphs (points, figures, processes, tables, graphs etc.). **Vocabulary development:** Enhancing current vocabulary to reflect a better usage of words in spoken and written language, Tips / strategies in vocabulary enhancement, Practice in vocabulary development. **Reading:** Reading skills, Sub skills, reading comprehension levels, reading

strategies, Reading practice through variety of reading texts and comprehension exercises, Beyond reading [outline, précis, speech and presentation]. **Writing:** Process of Writing, Informal Writing strategies. **Writing Correctly:** Sentence structure and punctuation, Error correction. **Paragraphs:** Structure, Types, Topic and the topic sentence, Unity, Adequate development and coherence in paragraphs. **Essays:** Types, Five paragraphs, long essays, Structure (thesis statement and the paragraphs). **Short Reports:** Structure, Format and types (informational and analytical). **Letters:** Elements, Styles, Formatting (digital letter writing), Organization and structure of the letter, Types (Routine requests and intimation, invitation, thank you and condolence letters etc.)

EE-118: BASIC ELECTRICITY & ELECTRONICS

DC Analysis:

Series and Parallel electric circuit: kirshhoffs voltage low (ICVL) and kirshhoffs current low (KCL), voltage divider and current divider rules; series parallel circuit; Y-Delta conversion; methods of circuits analysis: mesh analysis and nodal analysis; network theorem; superposition. Theremean's Norton and Magzimum power transfer; magnetic circuits; magnetic fields, flux density, permeability, reluctance, magnetizing force, hysteresis, and ampere's circuital low; capacitor and inductors; electric field and dielectric strength; charging and discharging face of! Capacitor; capacitor types; Faraday's low of electromagnetic induction; Lent's low; charging and discharging face of an inductor.

AC Analysis Poly Phase Systems:

General format sinusoidal voltage and current, phase relation: average power and power factor, frequency response of basic elenients (R, L,C) rectangular and polar form conversions: series-parallel circuits with phase or diagram; mesh analysis and nodal analysis; network theorems; passive filters: law pass, high pass, pass band, stop band filters, resonance: series resonant and parallel resonate circuits, poly phase systems.

Electrical Machines:

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

Basic Electronics:

Introduction to electronics engineering; P-N Junction: Semiconductor theory, doping and energy bands, diode models, diode data sheet understanding, diode applications (half wave, full wave and bridge rectifier, clipper and clamper); BJT and FET construction, operation and characteristic curves, introduction to Digital electronics; Comparison with Analogue electronics.

AU-102 ENGINEERING DRAWING AND COMPUTER GRAPHICS

Engineering Drawing: Drawing equipment and the use of instruments; basic drafting techniques and standards; freehand sketching of machine and engine components; geometrical curves including plane curves: cycloid, hypocycloid, and the involutes. Intersections and development of surfaces of geometrical bodies such as prism, pyramids, cylinders and cones. Concept of working drawing of component parts of machines and engines: size, description, dimensions, and specification; limit dimensioning and geometric tolerances; limits; fits and tolerances; conventional symbols. Computer Aided Graphics: Introduction, application of computers in drafting and designing, methods for creating drawing entities, common editing

features, dimensioning with variable setting, printing and plotting. The Software configuration of a graphics system; functions of a graphics package; constructing the geometry; Introduction to wire framing and solid modelling.

CY-109: APPLIED CHEMISTRY

Gases:

Gas Laws, Kinetic Gas Equation, Van der Waal's Equation, critical phenomenon, liquification of gases, specific heat (molar heat capacity).

Properties of Solution & Liquids:

Surface Tension, Viscosity, Osmosis, Osmotic Pressure, pH-Buffer Solution, Spectrophotometer, Basic concepts of Colloidal Chemistry, classification purification (dialysis).

Thermochemistry:

Chemical Thermodynamics, Hess' Law, Heat of reaction, Relation between H and U measurement of heat reaction, Bomb Calorimeter.

Electrochemistry:

Laws of Electrolysis, E.M.F. series, corrosion (Theories, inhibition & protection).

Water and Sewage:

Sources of water, impurities, hardness, water softening, purification of water for potable and industrial purposes, electro dialysis. Introduction to environmental pollution; main sources and effects. Sewage treatment.

Fuels: Types of fuels, classification of fossil fuels.

Metals & 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, Glass. Organic Engineering Materials: Polymers, Rubbers, Plastics, and Paints. Semiconductors and Dielectric materials.

MT-114: CALCULUS

Set and Functions:

Define rational, irrational and real numbers; rounding off a numerical value to specified number of decimal places or significant figures; solving quadratic, and rational in equalities in involving modulus with graphical representation; definition of set: set operations, venn diagrams, De-Morgan's laws, Cartesian product, relation, function and their types (Absolute value, greatest integer and combining functions). Graph of some well-known functions. Limit of Function and continuous and discontinuous functions with graphical representation.

Propositional Logic:

Definition of proposition, statement and argument, logical operators, simple and compound proposition various types of connectives, truth table, tautology, contradiction, contingency & logical equivalence.

Boolean Algebra: Definition, Boolean function, quality, some basic theorems & proofs, to evaluate Boolean algebra, truth functions, Canonical sum of product form, Digital logic Gates & Switching circuit designs.

Complex Number: Argand diagram, De Moivre formula, root of polynomial equations, curve & regions in the complex plan, slandered functions & their inverses exponential, circular & hyperbolic function.)

Differential Calculus: Differentiation & Successes differentiation & its application; Leibnitz theorem. Taylor & Maclaurin theorem with remainders in Cauchy & Lagrange form, power series, Taylor & Maclaurin series, L. Hospital rule, extreme values of a function of one variable using first & second derivative test, asymptotes of a function, curvature & radius of curvature of a curve, partial differentiation, exact differential & its applications in computing errors,

extreme values of a function of two variables with an without constant. Solution of non-linear equation, using Newton Raphson Methods.

Integral Calculus: Indefinite integral & their computational techniques, reduction formulae, define integral & their convergence. Beta α * Gamma functions & their indefinites, applications of integration. Centre of pressure and depth of center of pressure.

Solid Geometry: Coordinate Systems in three dimensions. Direction cosines & ratios, vector equation of a straight line, plane & sphere, curve tracing of a function of two & three variables.

HS-105: PAKISTAN STUDIES

An Outline of Emergence of Pakistan: A brief historical survey of Muslim community in the sub-continent. War of Independent 1857 and After match. Sir Syed Ahmed Khan, Development of Two Nation Theory. Formation of Muslim League. Lucknow Pact. Khilafat & Non-Cooperation Movement. Political Events from 1924 to 1937. Pakistan Resolution - Struggle for Pakistan from 1940 to 1947. Emergence of Pakistan.

Land of Pakistan: Geophysical conditions, Territorial situation and its importance, Natural Resources-Mineral and Water

Constitutional Process: Early effects to make constitution - Problems and issues. Constitution of 1956 and its abrogation. The constitution of 1962 and its annulment. Constitutional and Political Crisis of 1971; The constitution of 1973. Recent constitutional developments.

Post-Independence Development: Education in Pakistan; Planning & Development in the Field of Education. Development of Science and Technology with special reference to Engineering and Architecture.

Brief survey of Pakistan Economy: Industrial and Agricultural Development. Internal and external trade. Economic planning and prospects.

Cultural Development in Pakistan: Definition, Contents & Contributing factors in culture, Development of Art, Philosophy and literature.

Foreign Policy: Relations with neighbors, Super powers & the Muslim World.

HS-127: PAKISTAN STUDIES (FOR FOREIGNERS)

Land of Pakistan: Land & People –Strategic importance – Important beautiful sights – Natural resources (some portion of economics of Pakistan)

A brief Historical Background: A brief historical survey of Muslim community in the sub-continent – British rule & its impacts – Indian reaction Two nation theory Origin & development Factors leading towards the demand of a separate Muslim state Creation of Pakistan.

Government & Political Development in Pakistan: Constitution of Pakistan – A brief outline Governmental structure Federal and Provincial – Local Government Institutions – Political History a brief account.

Pakistan & the Muslim World: Elations with the Muslim countries.

Language and Culture: Origins of Urdu Language - Influence of Arabic & Persian on Urdu Language & Literature - A short history of Urdu literature - Dominant Culture features.

MM-201: PHYSICAL METALLURGY

Basic principles of chemistry & physics applied to structure of materials, especially metals & alloys. Crystal structure of materials, Space lattice, Crystal system, Unit cell, Packing density, Coordination number, Allotropy, Rotational & Reflection Symmetries, Crystal planes & direction, Crystalline defects, Twinning, Phase transformations in metals, glasses and organic materials. Elementary physical chemistry of phases, phase diagrams & phase rule application, Binary system, Ternary system, Solid Solution, Interstitial solid solution & Substitutional solid solution, Factor affecting the limit of solubility, Ordered and Disordered solutions, diffusion in solids, structure of interfaces, nucleation and growth, Crystallization, solidification, Grain boundaries, Grain size, Cast structure, Segregation, Shrinkage defects, Solid state

transformations, Iron -Carbon Diagram, Microstructure & properties of steel and Cast Iron, pearlitic, bainitic, massive and order-disorder transformations, precipitation. Elementary treatment of martensitic transformation, iron-carbon system, & heat-treatment of steels. Microstructure of Copper based and Aluminum based alloys and their relationship to the properties, Metallurgical Microscope, Objectives lenses and their shortcomings, Polarized light microscopy. Microstructure of plastics, polymers, rubbers and composites.

MM-204: ENGINEERING CERAMICS AND REFRACTORY MATERIALS

Types and classification of engineering ceramics. Traditional ceramics, brick and tile, refractory and insulating materials, china, porcelain, enamels, abrasives, cements, coordination number, interstitial sites, solid solutions, types of transformations, silica and silicate structures, mullite and spinels, glass and glass processing, glass ceramics, Advanced structural ceramics, oxide ceramics, nitride ceramics, fracture toughness, micro crack formation, high temperature application of ceramics, processing of ceramics, shaping and binding, molding, firing, sintering. Refractories: Raw materials for refractories such as fire clay, china clay, silica materials, alumina, magnesite, dolomite, chromite, graphite, carbon materials, Zirconia, classification of refractories. Manufacturing, testing, and use of basic, neutral, acid, and specialty refractories. Relationship between physical properties of various refractories. Selection and use of refractories in materials and metallurgical industry. Application and selection methods, manufacturing of refractories for ferrous and nonferrous industrial furnaces.

MM-205: MECHANICS OF MATERIALS

Review mechanics of materials. Deformation; strain; elastic stress-strain behavior of materials; Introduction to stress-strain diagram, working stresses, unit design, Introduction to elastic and nonlinear continua. Poisson's ratio; Determination of forces in frames; Simple bending theory; general case of bending; Shear force and bending moment diagrams; Relationship between loading, shear force and bending moment. Stress; Skew (antisymmetric) bending Direct, shear, hydrostatic and complementary shear stresses; Bar and strut or column; Theory of buckling instability, Thin ring, Elementary thermal stress and strain; General stress-method. Theory of elasticity, Analytical solution of elasticity problems brittle fracture. strain energy in tension and compression. Analysis of bi-axial stresses, principal planes, principal stress-strain, stresses in thin walled pressure vessels. Mohr's circles of bi-axial stress. Torsion of circular shafts, coiled helical spring, strain energy in shear and torsion of thin walled tubes, torsion of non-circular sections. Shear centre and shear flow for open sections, General case of plane stresses, principal stress in shear stresses due to combined bending and torsion plane strain. Composite materials, Volume dilatation, Theories of Yielding, Thin Plates and Shells Stress Concentration

MT-215: DIFFERENTIAL EQUATIONS AND COMPLEX VARIABLES

Infinite Series: Applications of simple convergence tests such as comparison, root, ratio, Raabe's and Gauss' tests on the behavior of series.

Ordinary Differential Equations: Definitions, formation & solution. Boundary conditions. Homogeneous and Non-homogeneous linear differential equations with constant coefficients, linear equations with variable coefficients. Cauchy's & Legendre's equations. Equations of second order. System of simultaneous linear equations with constant coefficients. Numerical approximation to solutions. Solution in Series. Simple applications in Engineering. Orthogonal trajectories.

Partial Differential Equations: Formation of partial differential equations. Solution of first order linear and special types of second and higher order differential equations used in Engineering problems. Various standard forms.

Laplace Transformations: Elementary transformations. Shifting Theorems.

Heaviside's expansion formula. Simple applications.
Complex Variables: Limit, continuity, zeros & poles, Cauchy - Reimann Equations, conformal transformations, contour integration.

MY-211: METALLURGICAL THERMODYNAMICS AND KINETICS

Fundamentals of Thermodynamics: State functions, First law of thermodynamics, Enthalpy, Heat capacities, Second law of thermodynamics, Entropy, Gibbs and Helmholtz energies, Equilibrium conditions, Chemical potential, Maxwells relationships, Third law of thermodynamics, Enthalpy & entropy calculations, activity, Gibbs-Hemholt equation, Gibbs-Duhem equation, Measurement of heat reactions, Phase equilibria in single & multi- component systems. Behaviour of solutions, non-ideal solutions, thermodynamics of phase diagrams.

Experimental Methods: Evaluating thermodynamic functions, estimation & calculation of the values of thermodynamic functions, free energy of formation, free energy diagrams.

Kinetics: The Arrhenius equation, the activated complex theory, collision theory, calculation of reaction rates. Heterogeneous reactions, gas-solid reactions, liquid-solid reactions, liquid-liquid reactions at slag-metal interface, gas-liquid reactions. Kinetics of phase transformations under non-equilibrium conditions.

Application: Application of the laws of thermodynamics to metallurgical processes, electrochemistry, interfacial phenomena, extraction and refining of metals, corrosion, and electrodeposition. Computational thermodynamics.

MM-202: PRODUCTION AND REFINING OF MATERIALS

Ferrous Materials: Principles related to iron & steel making from ores, New trends in iron & steel making, Blast furnace chemistry, operations & productivity, Wrought Iron & sponge Iron. Direct reduction processes of iron making, Description of steel making processes, chemistry of steel making, Bessemer & electric steel making operations & productivity, Secondary steel making process, e.g., AOD, VOD, ESR, VAR. Non-conventional techniques of iron & steel making.

Non-Ferrous Materials: Overview of the production and refining processes of non-ferrous materials. Extraction of Cu, Ni, Al, Zn, Mg, Pb and Sn from ores. Pyro- and hydro-metallurgical process of refining. Special methods used for Rare earth materials. Introduction to synthesis and production processes for rubbers, plastics and composites materials.

MM-208: FUNDAMENTALS OF MODERN MANUFACTURING AND FOUNDRY

Scope and importance of manufacturing processes; Introduction to melting and casting Practice, pattern making, Tooling, equipment, machines and types of furnaces used in melting of materials, Re-melting furnaces. Selection and control of melting processes control of chemical compositions and charge calculations. Casting and fettling operations, Casting Defects, inspection and quality assurance. Classification of mechanical working processes, basic concept plastic deformation, Hot working processes: forging and its types, Extrusion and its methods, Hot spinning; Pipe welding, & piercing. Cold working processes; Squeezing, Bending, Shearing, & Drawing processes, Riveting, Coining, Peening, Angle bending, Blanking, Bar & tube drawing, Wire drawing, Embossing & Stretch forming, sheet metal forming process, rolling principles. Introduction to Non-conventional manufacturing processes. Introduction to CAD (Computer-aided design)/ CAM (Computer-aided manufacturing) technology. Secondary manufacturing process. Prototypes and experimentation. Applications of computers in manufacturing processes. Manufacturing defects causes and remedies, Cost/Volume/Profit analysis.

MM-307: JOINING OF MATERIALS

Survey of joining processes for materials. Basis of selections and use of joining processes. Introduction to welding and joining, weld defects, selection of appropriate welding process, effect of heat on metals, pre heating, stress, strain, weldability, type of joints, types of welds, filler metals, welding problems, producing good weld. Gas welding and equipments, fluxes, torch gases hoses and hose connection, torches, mixers, welding tips, regulators clamps outfits. Arc welding, power sources, DC and AC power sources, cables, electrodes, current and circuit polarity, electrode selection, weld deposit. TIG & MIG welding; Introduction, principles, non-consumable tungsten electrodes, gas supply and equipment, and TIG joint preparation, spot welding, electrode wire, gas supply, spray metal transfer method, CO₂ – MIG welding, MIG spot welding. Submerged arc and other shielded methods, equipment, current, flux, electrodes, atomic hydrogen welding, plasma arc welding electro slag welding under water shielded metals, arc welding, vapor shielded metal arc welding- CIG welding. Resistance welding, resistance spot welding, multiple spot welding, PIGME welding process, flash and upset welding, percussion welding. Thermit welding, equipment techniques, process, ignition powder removing the mold inspection. Other welding processes; laser welding, electron beam welding, pressure welding, ultrasonic welding. solders principles, Equipment, fluxes, automatic soldering systems, soldering aluminum and aluminum alloys, magnesium and magnesium alloys, brazing, equipment, copper and copper alloys, aluminum brazing, dissimilar metals joining. Methods for joining of non-metallic materials, plastic welding, adhesive bonding, bonding materials, inspection and testing of weldment Cold welding, adhesive bonding, diffusion bonding, soldering, brazing, flames, arcs, high-energy density heat sources, solidification, cracking resistance, shielding methods, and electric contacts.

IM-207: COMPUTER PROGRAMMING AND DRAFTING

Introduction: Introduction to programming concepts & languages, Compilation & Interpretation, Overview of modular programming, ASCII character set.

Building Blocks: Identifiers & keywords, Data-types, Variables & Constants, Statements & Operators, Input & Output Functions.

Branching Statements: Conditional branching & Looping (Counter & condition-controlled loops).

Subroutine: As brief overview, Defining a subroutine, Accessing a subroutine, Passing arguments, Returning values and Recursion.

Arrays & Strings: Defining an array, Referring to individual elements of an array, Processing an array, Multidimensional arrays, String handling and Manipulation, Overview of pointers.

Computer Aided Drafting: Introduction, Application of computers in drafting and designing, Methods for creating drawing entities, Common editing features, Dimensioning with variable setting, Printing and Plotting.

MM-309: CONSTRUCTION MATERIALS

Introduction to materials in construction environment, Fundamentals of soil. Cement: Introduction, Types of Cement, Manufacturing Process, Admixtures, Hydration Process, Pozzolans, High Alumina & Slag Cement, Testing of Cement, Fine & Coarse Aggregate, Properties of Aggregate. Concrete: Introduction, Types of Concrete, Properties of fresh and

harden concrete, Concrete Mix Design, Micro cracking, Stress-strain relation, Deformation of concrete, Strength and failure of concrete, Cohesion & Segregation, Effect of Temperature on Concrete, Durability of concrete. Masonry: Introduction, materials for masonry, Structural behavior. Construction Steel: Introduction, Steel Reinforcing Bars, steel for other structural sections, weathering steel. Wood: Introduction, Sustainability of wood, Lumber, wood products. Advanced Construction materials: Fiber Reinforced Concrete, High Performing Concrete, Self-Healing Concrete. Laboratory activities.

HS-205: ISLAMIC STUDIES

Thematic Study of Holy Quran.

1. Basic Islamic Beliefs

Topics i) Tauheed: Al-Ambiya-22, Al-Baqarah-163-164 ii) Prophethood: Al-Imran-79, Al-Huda-7 Al-Maidah-3 iii) Here-After: Al-Hajj-5, Al-Baqarah-48 *Two Hadith

2. Basic Islamic Practices:

Al-Mu'minin-1-11

3. Amre-Bil-Ma'roof Wa-Nahi Anil Munkar

The Concept of Good & Evil.

i) Importance & necessity of Da'Wat-e-Deen Al-Imran-110.

ii) Method of Da'Wat-e-Deen. An-Nehl-125, Al-Imran-104 *Two Hadith

4. Unity of the Ummah: Al-Imran-103, Al-Hujurat-10, Al-Imran-64, Al-An'am-108 *Two Hadith

5. Kasb-e-Halal. Taha-81, Al-A'raf-32-33, Al-Baqarah-188 *Two Hadith.

6. Huquq-ul-Ibad:

i) Protection of Life: Al-Maidah-32

ii) Right to Property: An-Nisa-29

iii) Right of Respect & Dignity: Al-Hujurat-11-12

iv) Freedom of Expression: Al-Baqarah-256

v) Right of Equality: Al-Hujurat-13

vi) Economic Security: Al-Ma'arij-24-25

vii) Employment Opportunity on Merit: An-Nisa-58

viii) Excession Right to Justices: An-Nisa-135

7. Women Rights: An-Nehl-97, Al-Ahzab-35, An-Nisa-07

8. Relations With Non-Muslims: Al-Mumtahanah-8-9, Al-Anfal-61. Last sermon of Hajj at Arafat Translation & the important points of the sermon.

9. Serat Life of the Holy Prophet: Birth, Life at Makkah. Declaration of Prophethood, preaching & its difficulties migration to Madina. Brotherhood (Mawakhat) & Madina charter. The Holy War of the prophet (Ghazwat-e-Nabawi) Hujjat-ul- Wida.

10. Islamic Civilization:

Impacts of Islamic civilization on the sub-continent. The civilization of sub-continent before Islam. The Political, Social & Moral impacts of Islamic Civilization on sub-continent. Academic, Intellectual, Social & Cultural Impacts of Islam on the World.

*N. B: As prescribed by UGC. The original Text & complete course plan may be obtained from the Department of Humanities.

HS-206: ETHICAL BEHAVIOUR Nature, Scope and methods of Ethics and religion. Ethical teachings of world religions. Basic Moral concepts, Right and wrong, Good and evil. An outline of Ethical systems in philosophy; Hedonism, Utilitarianism, Rationalism and Kant. Self-Realization Theories, Intuitionism.

Islam Moral Theory: Ethics of Quran and its philosophical basis. Ethical precepts from Quran and Hadith and promotion of moral values in Society.

MM-301: CORROSION: PROTECTION AND PREVENTION

General concepts of corrosion applied to materials, corrosive environments, atmosphere, water, chemicals, gases, general corrosion, galvanic corrosion, oxygen concentration cell, atmospheric corrosion, chemical corrosion, corrosion in gas, types of scale, mechanism of scale protection, oxide, defect structure, oxidation rates, high temperature gas reactions, localized corrosion, pit and crevice corrosion. Mechanically assisted corrosion, stress corrosion cracking, corrosion fatigue, hydrogen damage, corrosion in ceramics and plastics, atmosphere water, chemical corrosion, corrosion prevention and protection. Chemical inhibitors, environmental control, anodic and cathodic protection, mechanical protection, coatings, anodizing, painting, corrosion resistant materials, corrosion of carbon steels, stainless steel, aluminum alloys, case studies. Corrosion of metals: simple electrochemical theory, polarisation curves, activation and concentration polarisation; Evans diagrams, Passivity, pitting, localised corrosion, Common problems: galvanic corrosion, differential aeration, crevice corrosion, Corrosion Prevention: Cathodic protection, anodic protection, inhibitors, Paint; modes of protection, inhibitive and metallic pigments, Metal coatings; action, methods of application, Anodising of aluminium. Design and materials selection.

MM-303: INSPECTION AND TESTING OF MATERIALS

Introduction to inspection and testing of materials, its scope and importance. The Brinell test, the Vicker test, the Rockwell test, the Knoop test, the Scleroscope test, conversion tables for various scales of hardness. Stress and strain, load extension diagrams, modules of elasticity, elastic limit, yield stress, proof stress, work hardening, tensile testing, (equipment and specimens).

Compression testing, bend testing, torsion testing. impact testing. Toughness, brittleness and ductility, notched bar impact testing, the Charpy and Izod impact tests, brittle and ductile fractures. The fatigue test, different types of fatigue fractures, Goodman diagram, endurance limit-ultimate tensile strength. The Creep Test. Overview of the main NDT techniques of materials testing, Visual, Ultrasonic, Penetrant, Magnetic particles and x-ray, and eddy current techniques, Example in NDT of materials. Advanced techniques used for testing of plastics, rubbers, polymers and composite materials.

MM-304: HEAT TREATMENT OF MATERIALS

Introduction and scope of the heat treatment processes used for materials. Review of iron carbon phase diagram, Effect of common alloying additions on the equilibrium diagram, annealing and its types, Structures of slowly cooled steels. Specialized heat treatments including full annealing, normalizing, process annealing. Oxidation and decarburization during heat treatment, Batch and continuous annealing. Quenching, tempering and hardening of steel, quenching rates and quenching media, martensitic transformation, time temperature transformation diagrams, effects of austenizing, grain size and alloying element on the transformation diagram, continuous cooling diagrams. Hardenability and its measurement, Jominy test. austempering, martempering, retained austenite, tempering of martensitic steel. secondary hardening, heat treatment of dies and tool steel, Alloy steels, HSLA steels, and stainless steels, surface hardening, carburizing, nitriding, cyaniding, carbonitriding, induction and Flame hardening, heat treatment of cast iron heat treatment of non ferrous metal and alloys, age hardening/precipitation hardening, defects caused during heat treatment and their

remedies, subzero treatment.heat. Heat treatment of nonmetallic materials like polymers, plastics, rubbers and composites.

HS-304: BUSINESS COMMUNICATION SKILLS AND ETHICS

Part-I Communication Skills (Oral):

Definitions and Conditions. Modes:- verbal, non-verbal, vocal, non-vocal, sender, receiver, en-loding, decoding, noise, context, emotional maturity, relationships, etc. Language, perception. Non-verbal, body language, physical appearance, cultural differences etc. Personal and interpersonal skills/perceptions. Communication dilemmas and problems. Public Speaking – speaking situation, persuasion.

Part-II Written Communication:

Formal / Business letters. Memos (brief revision). Notice and minutes of meetings. Contracts and agreements (basic theoretical knowledge and comprehension). Research / scientific reports. Tenders (basic theoretical knowledge and comprehension). Participating in seminars, interviews, writing and presenting conference papers, solving IELTS type papers. (Non-examination).

Part-III Engineering / Business Ethics:

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

MT-315: MATHEMATICAL METHODS

Solid Geometry:

Rectangular Coordinate Systems in three dimension, direction cosines, plane (straight line) and sphere.

Advanced Calculus:

Taylor's Theorem for functions of two variables without proof. Maxima and minima of functions of two variables. Lagrange's method of multipliers. Double integration, change of order, conversion to polar form. Applications in finding areas, volumes, centroids, centre of pressure. Movement of inertia and principal axes. Theorems of Pappus and Guldinus. Surface area and volumes of revolution.

Vector Calculus:

Differentiation of vectors, gradient, divergence and curl. Laplacian and spherical harmonies. Vector integration. Theorems of Gauss, Green and Stokes. Simple applications.

Linear Algebra & Matrices:

Linearity, dependent and independent vectors, bases and dimension, vector spaces, fields, liner transformations, matrix of a linear transformation. Basic definitions and matrix operations, adjoin and inverse of a 3 x 3 matrix. Rank of a matrix. Cayley-Hamilton Theorem, eigen values. Applications in solving linear homogeneous and non-homogeneous equations in three unknowns. Cases of existence of solution, no solution, infinite and unique solutions.

Elements of Tensors:

Cartesian Tensors, understanding of stress tensor and deformation.

MM-305: POLYMER AND COMPOSITES MATERIALS

Survey and classification of polymeric materials. Review of polymer chemistry, introduction to polymers, classification of polymers, polymerization, co-polymerization, structure and properties of thermoplastic and thermosetting polymers, elastomers and rubber, vulcanization, additives and fillers. Manufacturing, properties and applications of polymers, polystyrene, polybutadiene, polyester, polymethyl methacrylate (PMMA), nylon 6:6, acrylonitrile-butadiene-styrene (ABS), silicon resin, epoxy resin, phenol- formaldehyde and other advanced polymers, forming processes, testing and identification of polymers, fibers, foams and adhesives, Plastics, conductive

polymers and plastics, Introduction to Composite materials, classification characteristics, mechanical behavior potential advantages, properties and applications. Composite material design, specific stiffness and strength, and recent developments such as metal matrix composite, ceramic matrix composites, carbon fiber reinforced composite, production and processing of fibres and other reinforcements, polymeric matrix composites, processing principles and design of ply and laminate structures, filament winding and pultrusion.

MM-308: MATERIALS CHARACTERISATION AND ANALYTICAL TECHNIQUES

Introduction to Characterization of Materials. Microstructure investigation: Optical microscopy, interference contrast, SEM (Scanning Electron Microscope) and TEM (Transmission Electron Microscope) principles and configuration, STEM (Scanning Transmission Electron Microscope). Defect analysis, sample preparation, EPMA (Electron Probe Micro Analyzer). Atomic force microscopy. Structural characterization: Introduction to Crystallography and XRD (X-Ray Diffraction) techniques. Overview of crystal structure of materials. Symmetry, lattice directions and planes, preferred orientation and Texture. Production of X-Rays, X-Ray diffraction, Diffraction methods, X-Ray diffractometer, Stereographic projections. Chemical analysis: WDS (Wavelength Dispersive Spectroscopy) and EDS (Energy Dispersive Spectroscopy) microanalysis Surface analysis: X-ray photoelectron spectroscopy (XPS) and ion beam techniques. Thermal analysis: TGA (Thermo Gravimetric Analysis), DTA (Differential Thermal Analysis), DSC (Differential Scanning Calorimetry) and dilatometry.

MG-481: ENTREPRENEURSHIP

Understanding the Entrepreneurship Mind-set

- The revolution impact of Entrepreneurship
- The individual Entrepreneurship Mind-set
- Corporate Entrepreneurship Mind-set
- The Social and Ethical perspectives of Entrepreneurship

Launching Entrepreneurship Ventures

- Creativity and innovations
- Methods to initiate ventures
- Legal challenges in Entrepreneurship
- The search for Entrepreneurship

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

Strategies perspectives in Entrepreneurship

- Strategies growth in Entrepreneurship
- Valuation challenges in Entrepreneurship
- Final harvest of a new venture

PF-303: APPLIED ECONOMICS FOR ENGINEERS

Introduction: Engineering economy defined; Measures of financial effectiveness; Nonmonetary factors and multiple. Objectives; principles of engineering economy.

The Economic Environment:

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

Cost Concepts Analysis:

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

Time Value of Money:

Simple interest; Compound Interest; Cash flow diagrams; Interest formulas; Nominal versus effective, interest rates; Continuous compounding.

Depreciation and Depletion:

Purpose of depreciation; Types of depreciation; Economic life. What can be depreciated?

Comparing Alternatives:

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

Production Concepts & Mathematical Models:

Manufacturing lead time, Production rate; Capacity; Utilization; Availability; Work in process; WIP and TIP ratios.

Linear Programming:

Mathematical statement of linear programming problems; Graphic solution; Simplex method; Duality problems.

Capital Financing and Budgeting:

Types of ownership; types of stock; partnership & joint stock companies; Banking & specialized credit institutions.

Industrial Relations:

Labour problems; Labour organizations; Prevention & Settlement of disputes.

MT-441: ADVANCE MATHEMATICAL TECHNIQUES

Complex Variable

Limit, continuity, zeros and poles of a complex function. Cauchy-Reimann equations, conformal transformation, contour integration.

Error Analysis

Types of errors (relative, Absolute, inherent, round off, truncation), significant digits & 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. Numerical Differentiation, Forward Difference Method, Backward Difference Method, Central Difference Method.

Interpolation & Curve Fitting

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

Numerical Integration & Differentiation

Computation of integrals using simple Trapezoidal rule, 1/3th Simpson's rule, 1/8th Simpson's rule, Composite Simpson's and Trapezoidal rules, computation of solutions of differential equations using (Euler method, Euler modified method, Runge Kutta method of order 4).

Improper Integrals

Definitions, Types of improper integral and their convergence.

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

MM-404: PHASE TRANSFORMATIONS IN MATERIALS

Phase transformation in materials. Equilibrium transformations; first order & second order, Order-disorder transitions, transformations in complex structures, Driving force for phase transformation, Free energy changes during phase transformation, Concept of Gibbs's free energy, Volume free energy, & strain free energy Critical radius. Liquid-solid transformation, Solidification, Homogeneous nucleation; surfaces & interfaces; heterogeneous nucleation; polymer crystallization; nucleation rate; planar vs. dendritic interface growth; Gibbs-Thomson effect; dendrite velocity; alloy solidification; zone-refining; constitutional supercooling; solid-solid phase transformation; Nucleation & growth, homogeneous & heterogeneous nucleation, nucleation on crystalline defects & on grain boundaries. spinodal decomposition, Transformation in the Solid-State Precipitation reactions, GP zones, Intermediate & stable precipitate, Coherency strain, Diffusion-controlled transformations. Interfacial energy-controlled transformations, e.g., transformations far from equilibrium conditions. Nano-scale particles. Diffusion less transformations. Ordered & disordered transformation, Recovery, crystallization & grain growth. Phase transformations in non-metallic materials & its effect on mechanical & physical properties. Transformations in glasses & organic materials.

MM-411: NANOMATERIALS AND NANOTECHNOLOGY

Introduction & Scope of Nanotechnology, Units of Measurement, The Significance of the Nanoscale, Advancing beneficial nanotechnology, Nanoscale in Three Dimensions, Introduction to Molecular nanotechnology and Nanorobotics. Review of structures of Materials, Effects of Materials' Properties Change at the Nanoscale, Equipment for nano studies, tools for Characterization of Nanomaterials, Present Applications of Nanotechnology, Potential applications of Nanotechnology. Introduction to Nanoparticles, Nanomaterials and nanoproducts, Processing and Synthesis Techniques for Nanoparticles, Chemo-physical processes in nanoparticle, Lithographies. Design, production and application of Nanocomposite, devices and materials. Concept of a molecular assembly, Nobel Metal nanotechnology, Natural Nanoparticles. Carbon Nanostructures, Nanowires, Nanoindentation.

MM-412: SURFACE ENGINEERING

Introduction to definition and types of surface, Introduction to the physics and chemistry underlying the deposition of surface coatings (films) for a variety of applications.

Deposition and surface modification methods: Physical vapor deposition. Chemical vapor deposition, ALD (Atomic Layer Deposition). Methods of surface modifications. Nanostructured and nanocomposite coatings: Fundamentals of nanostructured thin films. Nanostructured coatings with enhanced chemical, mechanical and tribological characteristics. Advanced methods of surface and coating characterization: X-ray diffraction and electron microscopy. Spectroscopy. Advanced methods of surface and coating testing: Methods of contact and non-contact characterization of surface topography: Roughness. Mechanical characterization of nanofilms. Special application of surface engineering for tribological applications.

MM-413: NUCLEAR MATERIALS

Overview of Nuclear Systems, Nuclear energy, nuclear reactors. Introduction to nuclear power plant operation, nuclear fission and fusion reactions, neutron absorption cross section. Nuclear fuels: uranium, thorium, plutonium; Fuel cladding materials: Aluminum alloys, stainless steels, zirconium alloys; Reflecting materials: graphite, beryllium, moderators, light water, heavy water, graphite; Control rod materials: cadmium, boron. Overview of UO₂, Irradiation hardening and embrittlement. Structural materials in nuclear power plants, overview of Materials used in nuclear power plants. Effect of radiations on properties of materials. Radiation hazards and their safety, Radiation Damage, health physics. Disposal of radioactive waste.

MM-414: TOTAL QUALITY MANAGEMENT

Introduction to Total Quality Management. Defining quality, cost of quality, quality prizes. Standardization. Continuous improvement: 5S, Kaizen, Poka-Yoke, Six sigma, PDCA/PDSA cycle, lean manufacturing. Tools of Total quality management: statistics, seven QC (Quality Control) tools, statistical process control. Introduction to probability and its distribution. Sampling. Introduction to metrology and gauging. Introduction to industrial management and administration, Functions of Management, Project Management, Maintenance Management, Financial Management, Human Resources, Facility Location and Layout.

MM-402: DESIGN AND SELECTION OF MATERIALS

Philosophy and practice of engineering selection of materials. Overview, the selection of materials, service conditions, materials and primary processes, secondary processes, welding, machining, thermal treatment, finishing operations, strength-to-density and modulus-to-density ratios, reading and using specifications, safety and reliability, quality control and quality assurance, help from the computer, prototypes and experimentation, cost analysis for a component, the recycling and reuse of materials. Selection of materials for specific applications, designing for corrosion resistant service, concept of passivity, designing for wear resistant service, designing for high temperature service and designing for high strength/weight applications. Introduction to the aluminum, copper, nickel, cobalt, stainless steel, cast irons, titanium, refractory materials, rubber, plastics, polymers and composite materials systems. Coating science and selection. Intelligent selection of materials for better design, manufacturing and performance. Case studies of real-life engineering problems and solutions.

MM-415: MATERIAL DEFORMATIONS AND FAILURES: MECHANISMS AND ANALYSIS

Introduction & overview of the deformation behaviours of materials, Review of types of defect/imperfections, Burgers Vectors, Dislocations in crystal structures, Forces on

Dislocations, Movement of Dislocation, Critical Resolved Shear Stress, Deformation by Slip & Climb, Intersection of Dislocations, Multiplication of Dislocations. Deformation by Twinning, Stacking Faults and Grain Boundaries, Yield Point Phenomenon, Bauschinger Effect, Strengthening mechanism of materials. Stress concentration at a notch and at a crack. Plane stress and plane strain fracture toughness. Fracture toughness parameters and testing. The theoretical cohesive strength of solids. Theories of creep and fatigue fracture mechanism in ductile and brittle materials. Micro Mechanism of crack nucleation and propagation. Mechanisms of deformation of materials like polymers, rubbers, plastics and composites. Characteristics of fracture observed in ductile and brittle material. The crack opening displacement approach. The approach to failure analysis of Materials. Case Studies.

MM-416: BIOMEDICAL AND FUNCTIONAL MATERIALS

Introduction to biomaterials, Basic physical and chemical properties of biomaterials. Introduction to the Protein and cell structure and their interactions with biomaterial surface. Surface chemistry and physics of biomaterial. The modification of biomaterials surfaces. The Selection of biomaterials and design of artificial organs, implants, and prostheses. Biosensors, drug delivery and tissue engineering. Introduction to Functional materials. Designing and selection of functional materials. Specific properties of functional materials. Shape memory metals, Chromogenic materials, Magnetic material, environmental sensitive polymers, Conducting thermoplastics and Smart ceramics

IM-417: HEALTH, SAFETY AND ENVIRONMENT

Safety Management:

Understanding accident and hazard, Hazard control and loss control, Company policy and management responsibilities, Direct and indirect cost, Accident causes and their control, Principles and processes of lost control, Knowledge of existing safety codes and standards.

Accident Prevention and Control:

Fire safety, Electrical Safety, Safety in boilers and unfired pressure vessels and high pressure systems, Safety in material handling and storage, Safety in production operations (hand portable power tools, Wood working machinery, welding and cutting, metal working

machinery, cold and hot forming of metals, automated lines system and processes).

Process Safety Management:

Development of facility operation and procedures, Analysis of process hazard, Permit to work systems, Hazard communication (Material safety data sheet), Chemical inventory record, Accident reporting and investigation, Ensuring mechanical integrity,

Industrial Hygiene and Workers Protection:

Understanding industrial hygiene, various hazards encountered in workplace, Types of personal protective equipment (PPE), Availability in market their design standards and selection criteria.

Environment Management:

Environment pollution, Air emission management, Waste management, Waste water treatment and control, Soil and ground water protection, Introduction to Pakistan Environment Protection Act 1997 and National Environmental Quality Standards, Key elements of ISO 14000.

machinery, cold and hot forming of metals, automated lines system and processes).

Process Safety Management:

Development of facility operation and procedures, Analysis of process hazard, Permit to work systems, Hazard communication (Material safety data sheet), Chemical inventory record, Accident reporting and investigation, Ensuring mechanical integrity,

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Understanding industrial hygiene, various hazards encountered in workplace, Types of personal protective equipment (PPE), Availability in market their design standards and

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criteria.

Environment Management:

Environment pollution, Air emission management, Waste management, Waste water treatment and control, Soil and ground water protection, Introduction to Pakistan Environment Protection Act 1997 and National Environmental Quality Standards, Key elements of ISO 14000.