DEPARTMENT OF METALLURGICAL ENGINEERING

Semester wise Syllabus of 2011 and onward

MY-101: INTRODUCTION TO METALLURGICAL ENGINEERING

**Metallurgy:**
Objectives of Metallurgy, Importance of Metallurgy, Metallurgical Engineer’s Jobs, Scope of Metallurgy in Pakistan, Branches of Metallurgy, Art of Metallurgy

**Metals and Non-Metal:**
Metals & Their Characteristics, Classification of Metals, Non-metals, Comparison between Metals and Non-metals, Sources of Metals, Differences between Rocks, Ores and Minerals, List of Important Minerals.

**Alloys:**

**Engineering Materials:**

EE-116: PRINCIPLES OF ELECTRICAL ENGINEERING

**Electric and Magnetic Circuits:**

**AC Single Phase and Poly phase Systems:**
Single Phase systems, Series, Parallel and series parallel circuits, J operator method and polar method. Resonance and measurement of power and power factor. Poly phase systems, Poly phase generation, Star and Delta connections, Voltage and current relations, measurement of power and power factor, Balanced load analysis.

**DC Machines:**
Construction and principle of DC machine, Simple lap and wave windings, Concept of armature reaction and commutation Cross and demagnetizing ampere turns, DC Generators, Types emf equation, Losses, Efficiency principle Back EMF, Speed and speed regulation. Types, Characteristics, Performance curves, Losses and efficiency, Speed and torque problems involving magnetization curve, charging and Ignition circuits of automobiles.

**AC Synchronous Machines:**
**AC Induction Machines:**

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

**Rectifiers and Applications:**
Rectification, Half Wave and Full Wave Rectifiers simple treatment, Elementary concept of amplification with transistor used as amplifier in common emitter configuration.

**HS-101: ENGLISH**
Preparation of Short Speeches for various occasions.

**Written Communications:**
Writing of formal letters and applications, Drafting of Memorandums, Contracts, Advertisements and Tender notices. Preparation of Minutes of meeting. Writing short papers on technical subjects. Notes taking.

**Oral Communication:**
Oral reporting, Conference Leading, Dictation. Interviewing, Precise Writing.
Essays on technical and non-technical subjects.

**Applied Grammar:**
General rules for writing correct English, Punctuation, Study of words, Constructions and improvement of sentences. Vocabulary learning and use of dictionary.

**HS-105: PAKISTAN STUDIES**

**An Outline of Emergence of Pakistan:**

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

**Constitutional Process:**

**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 and Contributing factors in culture, Development of Art, Philosophy and literature.

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

**HS-127: PAKISTAN STUDIES (FOR FOREIGNERS)**
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 and 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:**
Relations with the Muslim countries.

**Language and Culture:**

**ME-101: ENGINEERING MECHANICS**

**Statics of Particles:**
Forces in a plane; Newton’s First Law, Free body 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; Varignons 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 and momentum; Conservation of linear and angular momentum.

**Friction:**
Laws of dry friction; Angles of friction; Wedges; Square-threaded screws; Journal and thrust bearings; Belt friction.

**Analysis of Structures:**
Internal forces and Newton’s Third Law; Simple and space trusses; Joints and sections; Frames and machines. Forces in cables.

**ME-102: ENGINEERING DRAWING**
Drawing equipment and the use of instruments; Basic drafting techniques and standards; Geometrical curves including plane curves; Cycloid; Hypocycloid and Involute.

Intersections at various positions of geometrical bodies such as prisms, pyramids, cylinders and cones, Development of surfaces of prisms, pyramids, cylinders and cones.

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

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

Sectioning of machine and engine components; Orthographic projections and standard practices, Isometric views with particular reference to piping and ducting.

**ME-104: WORKSHOP PRACTICE**
Use of carpenter’s tools, Exercise in preparing simple joints, Bench fitting practice, Exercise in marking and fittings; Use of measuring instruments.

Smith’s forge; Exercise in bending, upsetting and swaging.

Familiarizing the students with the following processes:

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

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

**ME-108: FUNDAMENTALS OF THERMAL-FLUID ENGINEERING**
PH-121: APPLIED PHYSICS

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

Vectors:

Mechanics:

Electrostatics and Magnetism:


Semiconductor Physics:

Waves and Oscillations:

Optics and Lasers:

Modern Physics:

CY-105: APPLIED CHEMISTRY

Gases:
Gas Laws, Kinetic Gas Equation, Van der Waal's Equation, critical phenomenon, liquidification 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:**

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

**Fuels:**
Types of fuels, classification of fossil fuels.

**Metals & Alloys:**
Properties and general composition of metals and alloys such as Iron, Copper, Aluminum, Chromium, Zinc used in engineering field.

**Engineering Materials:**

**MT-111: CALCULUS**

**Set and Functions:**
Define rational, irrational and real numbers; rounding off a numerical value to specified number of decimal places or significant figures; solving quadratic and rational inequalities in involving modulus with graphical representations; Definition of set, set operations, Venn diagrams, DeMorgan’s laws,

Cartesian product, Relation, Function and their types (Absolute value, greatest integer and combining functions). Graph of some well-known functions. Limit of functions and continuous and discontinuous functions with graphical representation.

**Propositional Logic:**
Definition of Proposition, Statement and Argument, Logical Operators, Simple and Compound proposition, various types of connectives, Truth table, tautology, Contradiction, Contingency & Logical equivalence.

**Boolean Algebra:**
Definition, Boolean function, duality, some basic theorems & their proofs, two valued 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 and regions in the complex plane, standard functions and their inverses (exponential, circular and Hyperbolic functions).
**Differential Calculus:**
Differentiation and Successive differentiation and its application; Leibnitz theorem, Taylor and Maclaurin theorems with remainders in Cauchy and Lagrange form, power series. Taylor and Maclaurin series, L’Hoptals rule, extreme values of a function of one variable using first and second derivative test, asymptotes of a function, curvature and radius of curvature of a curve, partial differentiation, exact differential and its application in computing errors, extreme values of a function of two variables with and without constraints. Solution of non-linear equation, using Newton Raphson method.

**Integral Calculus:**
Indefinite integrals and their computational techniques, reduction formulae, definite integrals and their convergence, Beta and Gamma functions and their identities, applications of integration, Centre of pressure and depth of centre of pressure.

**Solid Geometry:**
Coordinate Systems in three dimensions, Direction cosines and ratios, vector equation of a straight line, plane and sphere, curve tracing of a function of two and three variables, Surfaces of revolutions, transformations (Cartesian to polar & cylindrical).

**MY-201: METALLURGICAL THERMODYNAMICS AND KINETICS**

**Fundamentals of Thermodynamics:**

**Experimental Methods:**
Evaluating thermodynamic functions, estimation and 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.

**MY-202: FUELS AND FURNACES**

**Primary Fuels:**
Secondary Fuels:

Fuel Combustion:
Combustion of Coal on Grates, Fluidized Beds and in Pulverized Form, Ignition Temperature, Limits of Inflammability and Flame Speed of Combustible Gases, Combustion of Liquid Fuels, Oil and Gas Burners and their Design Calculations on Combustions.

Furnaces:

MY-203: MINERAL PROCESSING

Introduction:
Minerals of economic importance. Mineral processing plant design. Process analysis, simulation, optimization, and control. Basic mineral processing technology, ore handling, sampling, efficiency of operation in mineral dressing plant, Communion techniques, sizing classification. Flotation: surface chemistry, reagents, on-stream analysis, process optimization, basic flotation; oxide flotation, ore concentration, gravity concentration, magnetic separation, electrostatic separation Gravity and magnetic separations. Tailings disposal, water pollution control, closed circuit operation.

Crushing and Sizing:
Theory of crushing, operation and application of jaw-, gyrator-, cone-, roll, gravity stamp- and special crushers. The theory and application of liberation techniques. Theory and attributes of comminution and use of ball, rod and tube mills. Industrial screening, types and operating characteristics screens, the movement of solids in fluids. Stoke’s, Newton-, Rettinger’s Law. Reynolds number free setting ratio and hindered setting ratio.

Separation and Concentration:

MY-204: REFRACTORIES IN METALLURGICAL INDUSTRY

Introduction:
Basics of refractories and ceramics. Requirements of good refractory - Classification - Properties and testing - Raw materials for refractories such as fire clay, china clay, silica materials, alumina, magnesite, dolomite, chromite, graphite, carbon materials, zirconia, classification of refractories, Application and selection methods of manufacturing of refractories for ferrous and non ferrous industrial furnaces.
**Manufacturing:**
Manufacturing, testing, and use of basic, neutral, acid, and specialty refractories. Processing of raw materials and production of ceramic bodies, glazes, glasses, enamels, and cermet. 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, moulding, firing, sintering.

**Application:**
Refractory materials in metallurgical construction. Relationship between physical properties of the various refractories and their uses in the metallurgical industry. Oxide phase diagrams to explain the behavior of metallurgical slags in contact with molten metals. Erosion of refractory during melting. Case studies on specific ceramic materials. Applications of Computers in Refractories.

**MY-205: METALLURGY OF IRON PRODUCTION**

**Introduction:**

**Blast Furnace:**
Principles and operation of blast furnace, BF Fuels: Coke, Coke-Oven Batteries, Coking, Natural Gas, Functions of Coke, Quality Requirements of Coke. BF Fluxes and their Classification. BF Burden Requirement and Preparation.

**Construction and Operation:**

**Cast Irons:**
Classification / Grading of Cast Irons, Manufacturing of Cast Irons, Properties and Commercial Uses of Cast Irons.

**Alternate Routes of Iron Making:**
Low Shaft Furnace, Charcoal furnace. Electrical furnace. Direct reduction- Sponge iron route - Sponge Iron production in Pakistan, Electric smelting.

**Ferro Alloys:**
Production of Fe-Si, Fe-Mn, Fe-Cr, Fe-Mo, Fe-V, Fe-Ni and Fe-W

**MM-201: PHYSICAL METALLURGY**

Basic Principles of chemistry and physics applied to structure of materials, especially metals and alloys. Crystal structure of materials, Space lattice, Crystal system, Unit cell, Packing density,
Coordination number, Allotropy, Rotational and Reflection Symmetries, Crystal planes and direction, Crystalline defects, Twining.

Phase transformations in metals, glasses and organic materials. Elementary physical chemistry of phases, phase diagrams and phase rule application, Binary system, Ternary system, Solid Solution, Interstitial solid solution and 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 of Copper based and Aluminum based alloys and their relationship to the properties, Metallurgical Microscope, Objective lenses and their short comings, Polarized light microscopy. Microstructure of plastics, polymers, rubbers and composites.

**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;


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 center 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

**EE-221: INSTRUMENTATION**

**General Theory:**
Classification, performance and characteristics. Absolute and secondary instruments, indicating, Recording and integrating instruments, Controlling balancing and damping, Static and Dynamic characteristics.

**Ammeter and Voltmeter:**
Classification, Moving iron, Moving coil, Thermal, Electrostatic and induction type Errors extension of ranges, CT's and PT's their burden and accuracy.

**Power and Energy Meters:**
Wattmeter types, Active and Reactive power measurement, Max. demand indicator, Calibration, Classification of energy meter, KWH meter and KVARH meters, P.F. meter.
**Electronic Instruments:** Electronic and digital voltmeters, Counters, Digital frequency meter, Time internal measurement, RLC meter, Power and energy meter, Oscilloscope and its use.

**Basic Concepts:** Basic concepts of measurement, Measurement of resistance, inductance and capacitance, Potentiometer and bridge methods.

**Magnetic Measurement:** Measurement of field strength flux Permeability, B-H curve and hysteresis loop, magnetic testing of materials.

**Transducers:** Variable, Resistance and inductance transducers, Linear variable differential transformer (LVDT), capacitive, photoconductive, Piezo-Electric Transducers thermo electric transducers, Thermo electric transducers, Filtering, Instrument amplifiers, A/D conversion.

**Measurement of Non-electrical Quantities:** Measurement of temperature, Pressure Flow, Strains, Thermal conductivity, Motion, Speed and Vibrations, Thermal and Nuclear Radiations.

**High Voltage Measurement:** Measurement of dielectric strength High voltage strength

The practical work will be based on the above course.

**HS-205: ISLAMIC STUDIES**
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1. اسلامیت

2. تعلیم

Note: The English translation of the Course is available with the Department of Humanities.
HS-209: **ETHICAL BEHAVIOUR**

**Introduction to Ethics:**

i) Definition of Ethics

ii) Definition between normative and positive science

iii) Problem of freewill

iv) Method of ethics

v) Uses of Ethics

1. **Ethics Theories:**

i) History of Ethics: Greek Ethics, Medieval, Modern Ethics

ii) Basic concept of right and wrong: good and evil

iii) Utilitarianism, hedonism, self-realization: egoism, intuitionism, rationalism

iv) Kant’s moral philosophy

2. **Ethics & Religion:**

i) The relation of Ethics to religion

ii) Basic ethical principles of major religions: Hinduism, Judaism, Buddhism, Zoroastrianism, Christianity, Islam

3. **Ethics, Society, and moral theory:**

i) Ethical foundation of Rights and Duties

ii) Applied Ethics

iii) Society as the background of moral life

iv) Universalism and Altruism

v) Theories of punishment

4. **Ethics, Society, and moral theory:**

vi) Ethical foundation of Rights and Duties

vii) Applied Ethics

viii) Society as the background of moral life

ix) Universalism and Altruism

x) Theories of punishment

IM-207: **COMPUTER PROGRAMMING AND DRAFTING**

**Introduction:**

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

**Building Blocks:**

Identifiers and keywords, Data-types, Variables and Constants, Statements and Operators, Input and Output Functions.

**Branching Statements:**

Conditional branching and Looping (Counter and condition controlled loops).
Subroutines:
A 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.

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 and solution. Boundary conditions. Homogeneous and Non-homogeneous linear differential equations with constant coefficients, linear equations will variable coefficients.


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:

Complex Variables:
Limit, continuity, zeros and poles, Cauchy-Reimann Equations, conformal transformations, contour integration.

MY-301: STEEL MAKING PROCESSES
Difference between iron and steel making processes.

General Principles And Open Hearth Steel Making:

Pneumatic and Electric Steel Making:

Duplexing and Ingot Making:
Deoxidation of Steels:

Carbon and Alloy Steels:
Applications of Computers in steel making processes.

MY-302: NON-FERROUS EXTRACTIVE METALLURGY

Introduction:
Non Ferrous metals and its ore deposits in Pakistan, Introduction to Non- Ferrous Extractive Metallurgy: Scope and importance in Pakistan. Principles of extractive metallurgy; The application of the principles of thermodynamics, kinetics, and heat and mass transfer to the extraction and refining of non-ferrous metals.

Aluminum and its Alloys:
Aluminum and its ores, Preparation of Alumina, Preparation of Cryolite, Production of metallic Aluminum, Thermal process of Aluminum, Alloys production, Recovery of other values from Aluminum ores, Aluminum and its alloys,

Copper and its Alloys:
Copper and its ores, Preparation of concentrate, Extraction of Copper ores by pyrometallurgical methods, Matte smelting, Pier Smith converter, Top Blown Rotary Converter, Electrolyte and fire refining of Copper, Recovery of values such as Gold and Silver from Copper ores, Copper and its alloys,

Zinc and its Alloys:
Zinc and Zinc ores, General Preparation of extraction of Zinc, Roasting of Zinc concentrate, Leaching of roasted Zinc concentrate, Electrolysis of Zinc Sulphate solution, Melting of Cathodic Zinc, Production of Zinc retort and blast furnace method, Refining of Zinc, Zinc and its alloys.

Lead and its Alloys:
Lead and its ores, Extraction of lead, Blast roasting of lead concentrate, Blast furnace smelting of lead bullion, Recovery of Cadmium and other metals from lead concentrate, Lead and its alloys.

Magnesium, Chromuim, Titanium and its Alloys:
Magnesium and its ores, Chromium and its ores, Extraction of magnesium and Chromium by Alumino-thermic and silico- thermic method, Titanium and its ores, Treatment of its ores concentrate, Production of Titanium metals by reduction with Sodium and Magnesium, Titanium and its alloys.

MY-303: FOUNDRY: PRINCIPLES, METHODS AND PRACTICES

Introduction:
Foundry Engineering and Practice, Scope and importance of the subject, Foundry plant layout, design and calculations, Tooling, equipment, machines. Advanced design techniques and calculation using personal computer,
**Pattern and Moulds:**
Types of pattern, pattern making, shrinkage and contraction allowances, Selection of suitable moulding and core materials, Properties of moulding and core materials, Analysis, testing and control of moulding and core materials requirements.

**Melting:**

**Casting Methods and Techniques:**
Casting process and procedures, Pouring & Feeding of Casting, Different casting techniques: sand casting, shell mould casting, plaster casting, investment casting, permanent mould casting, centrifugal casting, continuous casting, Gravity and pressure die casting methods, Selection of die casting alloys, Moulding materials and mould dressings, Metallurgy of die casting alloys, Shell moulding, Lost wax, Investment and Precision casting processes. Cast metal systems: non-ferrous alloys, cast irons, steels Casting techniques of Ferrous and Non- Ferrous metals.

**Defects and Quality:**

**MY-304: METALLURGY OF WELDING**

Introduction to welding and joining, Metallurgy of welding, effect of heat on metals, pre heating , stress, strain, weldability, weld defects, selection of appropriate welding process.

**Fusion Welding Processes:**
Overview of welding processes. 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. 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. Thermite welding, equipment techniques, process, ignition powder removing the mold inspection.

**Non-Fusion Joining Processes:**
Joining processes in which the base materials are not melted. Brazing, Soldering, Diffusion bonding, Explosive bonding, and Adhesive bonding processes. Resistance welding, resistance spot welding, multiple spot welding, MIG spot welding, PIGME welding process, flash and upset welding.

**Other Welding Processes:**
laser welding, electron beam welding, pressure welding, ultrasonic welding, solders principles, Equipment, fluxes

**Design of Welded Structures and Assemblies:**
**Physics of Welding:**
Introduction to arc welding physics, fluid flow in the plasma, weld pool phenomena, thermal experience during welding, Quality of weld, Applications of Computers in welding processes.

**Material’s Specific Welding:**
Aluminum and aluminum alloys, magnesium and magnesium alloys, brazing, equipment, copper and copper alloys, aluminum brazing, dissimilar metals joining, plastic welding.

**MY-305: METAL FORMING & SHAPING PROCESSES**

**Introduction:**

**Metal Forming Processes:**

**Design and Equipment:**
Fundamentals of design of metal forming equipment, An examination of the forging process for the fabrication of metal components. Techniques used to model deformation processes including slab equilibrium, slip line, upper bound and finite element methods.

**Applications:**
Application of these techniques to specific aspects of forging and metal forming processes. Extrusion, Rolling, wire drawing, Forging processes, Sheet metal forming process Metallurgical structure evolution during working. Application of FEM in metal forming processes, Thermomechanical processing of advanced steels.

**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**


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.
**PF-303: APPLIED ECONOMICS FOR ENGINEERING**

**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; 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 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.

**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
Part-III Engineering / Business Ethics:

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:

Linear Algebra & Matrices:
Linearity, dependent and independent vectors, bases and dimension, vector spaces, fields, linear transformations, matrix of a linear transformation.


Elements of Tensors:
Cartesian Tensors, understanding of stress tensor and deformation.

MY-401: VACUUM METALLURGY

Introduction:
Vacuum principles, their Importance, classification and application in the metallurgical field, Different units of measuring pressure vacuum regimes, mean free path, collision frequency.

Equipment:
Vacuum pumps: Water pumps, positive displacement pumps, rotary and roots pump, vapour ejector and vapour entrainment pumps, diffusion pump, turbo-molecular pump, ion pumps, sieve pumps, adsorption pumps. Classification and working principles of vacuum measuring devices: Manometers, McLoad gauge, Penning gauge, Pirani gauge. Valves used in vacuum technology. Calculation of vacuum systems, conductance and through put, effective pumping speed, gas flow through pipes and orifices. Sources of leakage, leakage detection and remedies.

Application:
Application of vacuum in metal processing. Vacuum induction melting, vacuum arc melting. Metal refining in vacuum, degassing in liquid state, vacuum heat treatment, vacuum sintering, vacuum
coating, use of vacuum technology in the production of strategic materials. Design of vacuum Furnaces.

**Vacuum Coatings:**

**MY-402: ADVANCED MATERIALS**

**Introduction:**
Development of new breeds of engineering materials, smart materials and functionally gradient materials, biomaterials. Semiconductors, superconductors, optical and magnetic materials.

**Magnetics Materials:**

**Biomaterials:**
Basic chemical and physical properties of biomaterials, including metals, ceramics, and polymers, as they are related to their manipulation by the engineer for incorporation into living systems. Role of microstructure properties in the choice of biomaterials and design of artificial organs, implants, and prostheses.

**High Temperature Materials:**

**Nanomaterials:**

**MY-403: METALLURGICAL PLANTS**

**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; Production control charts; Machine arrangement problems; Control for maximum profit; Scheduling techniques.
Environmental Impacts, Pollution Control and Waste management:
Type of Pollutants and their treatment, Process description, Resources, Consumption and Emissions: Overview, Environmental impacts of Iron and Steel making, Hot rolling, Forging, Cold rolling, Annealing and Tempering, Coating and Plating plants. Environmentally friendly metallurgical plants

Health and Safety:
Occupational Health and Safety Impacts of Metallurgical plants. Basic procedures and remedies.

Computer Applications:
Applications of computers for environmental and Pollution Control and Waste management in metallurgical plants

MY-404: ADVANCES IN SPECIAL STEELS

Introduction:
Microstructure and property relationships in steels, High strength low Alloy (HSLA) steels, microalloyed steels, stainless steels, duplex steels, high yield steels, super alloys, inconels, haste alloys, nickel maraging steels.

Production and Processing:
Classifications, production and processing principles, thermomechanical processing, advantages and limitations, TMT steels, dual phase steels, IF (interstitial-free) and ultra-low carbon steels for structural and automotive applications, ultra-low-carbon bainitic steels (ULCB), martensitic steels.

Special Steels:
Stainless steels, nitrogen containing fine grained steels, orthopedic steels, duplex and superduplex corrosion stainless steels, special Steels, TRIP steels, maraging steels, tool steels, die steels, special steels for low to moderate temperature applications for nuclear and thermal power plants, heat resistance steels for superheaters, tool and die steels, processing and properties. Design and processing: New concepts for engineering steels.

MY-405: INDUSTRIAL QUALITY CONTROL IN METAL INDUSTRY

Fundamentals of Probability and Statistics:
Set theory and set operations, Venn diagram, definition of probability, probability laws, conditional probability, deterministic and probabilistic data, grouping of data, measures of central tendency and dispersion, Random Variable (discrete and continuous), mathematical expectation, laws of expectation.

Probability Distributions:
Discrete probability distributions (Uniform, Binomial, Multinomial, Hypergeometric and Poisson)
Continuous probability distributions (uniform, Normal and Exponential)

Statistical Tests of Hypothesis:
Basic concept, types of errors, operating characteristic (OC) curve, testing hypothesis when sample size is fixed, testing hypothesis when sample size is not fixed, drawing conclusions, determining sample size for testing a hypothesis.

Control Charts:
Common causes and special causes of variation, Steps to start a control chart, control charts for variables (X-R chart, X-S chart) control charts for attributes (percentage nonconforming, number of nonconforming items, number of nonconformities, number of nonconformities per unit), interpretation of control charts, uses of control charts (for process improvement and process maintenance).
Acceptance Sampling:
Introduction, types of sampling, OC curve in sampling, consumer and producer risks, AQL, AOQL, LTPD, attributes sampling, variable sampling, selection of proper sampling plan.

Bulk Sampling:
Objectives of Bulk Sampling, determination of the amount of sampling, models for bulk material moving in a stream, obtaining the test-units, test of homogeneity.

Evaluation of Quality in Materials Industry:
Reliability and maintainability, process capability analysis, inspection of different types of materials and products for evaluation of quality reliability of flaw detection by nondestructive inspection, quality control applications of nondestructive inspection.

Quality Control Procedures:
Introduction to standards. Familiarization of standards for testing of materials, ASTM, BS, JIS GOST and ISO. Pakistan Standards, Quality assurance for final products, Measures for quality control.

MY-406: POWDER METALLURGY

Introduction:
General concepts of Powder Metallurgy, Techniques for Production of metallic powders: gas atomization, chemical processes, electrolysis, gaseous reduction, mechanical processes, spray deposition, powder characterization techniques, bulk, density, particle size, surface area, consolidation of powder.

Compaction:
Compaction of metallic powder, Types of presses, mechanical press, cold isostatic press, hot isostatic pressing, moulds and dies, consolidation mechanism, effect of lubricants, binders, compaction defects,

Sintering and Finishing:
Mechanism, theory of sintering, sintering defects, sintering environments, characterization of sintered components; finishing operations; structural and porous components; cutting tools.

Application:
Advantages and limitation of powder metallurgy, application of powder metallurgy, merits and demerits of powder metallurgy, applications of P/M parts. Case histories

MY-407: DESIGN, SELECTION AND CHARACTERIZATION OF ENGINEERING MATERIALS

Introduction:
Philosophy and practice of design and selection of engineering materials. Overview, the selection of materials, service conditions, materials and primary processes, secondary processes, welding, machining, thermal treatment, finishing operations, strength-to-density and modules-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:
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. Selection of Non-Ferrous materials including aluminum, copper, nickel, cobalt, stainless steel, cast irons, titanium, refractory materials, rubber, plastics,
polymers and composites materials systems. Intelligent selection of materials for better design, manufacturing and performance. Case studies of real-life engineering problems and solutions.

**Characterization:**
Overview of characterization techniques of engineering materials. Wet analysis, Microscopic characterisation, Optical microscopy, interference contrast, quantitative analysis. Image analysis, SEM and TEM principles and configuration, elastic and inelastic scattering. SE, BSE, imaging, WDS and EDS microanalysis, BSCP, TEM BF and DF contrast, diffraction patterns, STEM. Defect analysis, sample preparation, EPMA, field ion microscopy (AP-FIM) and concentration profiling. Scanning tunneling, acoustic and atomic force microscopy, DTA, DSC and dilatometry, AES and SIMS, molecular spectroscopy, Electron microprobe analysis, Gas analysis by mass spectrometry. Application and limitation of characterization techniques-case studies.

**MY-408: METALLURGICAL ENGINEERING PROJECT**

Selected problems from the industry and current materials research issues regarding selection processing, designing, manufacturing and development. Fabrication of prototype/models and laboratory experimentation shall be assigned to individual students. Grading shall be the reports produced by individual students and their evaluation through an oral examination.

**MM-403: FRACTURE MECHANICS AND FAILURE ANALYSIS**


**CH-407: Industrial Organization and Management**


**IM-414: INDUSTRIAL SAFETY & 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.