

# DEPARTMENT OF METALLURGICAL ENGINEERING

## Term Wise Syllabus of Batch 2009-2010 and all Previous Batches

### MY-201: METALLURGICAL THERMODYNAMICS AND KINETICS

#### Fundamentals of Thermodynamics:

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

#### 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:

Origin and Formation of Coal and Crude Petroleum, Sizing and Cleaning of Coals, Classification, preparation, storage, handling and transportation of coal. Combustion of Fuels. Physical Processing of Crude Petroleum, Light and heavy oils, furnace oil. Gaseous fuels, producer gas, water gas, coke oven gas and LPG. Natural gas and its viscosity, calorific intensity, octane number and Cetane number of fuel, analysis of fuel and fuel economy. Liquefied Petroleum Gases.

#### Secondary Fuels:

Cracking and Reforming Process for Distillation Products of Crude Petroleum, Carbonization and Gasification.

#### 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:

Introduction, Types of furnaces, electric, oil, gas, coal, thermal efficiency, methods of heat recovery, recuperation and regeneration. Melting furnaces-construction, design and operation of blast, cupola, rotary furnace, electric arc, resistance and induction furnaces. Heat treatment furnaces, Batch type and

continuous types, vacuum furnaces and controlled atmosphere furnaces. Pyrometry. Fuel-Fired Furnaces, Refractories for melting and heat treatment furnaces. Applications of Computers in Fuels and Furnaces design, construction and operation.

### **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, Comminution 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:**

Heavy fluid separation, liquids and suspension, principles of jigging. Hydraulic and pneumatic jigs, flowing film concentration and tabling. Flotation and dispersion. Magnetic separation and magnetic properties of substances. Processes of separation depending on colour and general appearance, heat properties, electrical properties, differential hardness, amalgamation. Separation of solids from fluids by thickening process, filtration, dust elimination and drying. Theory and techniques of concentrates, palletizing, nodulizing and briquetting. Flow sheets and circuit diagrams of typical mills treating ore.

### **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 cermets. 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:**

Historical and Modern Iron Making Processes. Iron and Steel Manufacture in Pakistan. Raw Materials for Iron Making, Iron Ores and Their Occurrence, Classification, Geological / Geographic Aspect, Valuation of Iron Ores.

### **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:**

Blast Furnace Structure, Auxiliaries, Refractories, Principles of BF Design, BF Operations, Erosion of refractories during Blast furnace operation, Irregularities in BF Operations, BF Modernization, BF Chemistry, Physical Chemistry of Iron making, Ellingham Diagram, Mechanism of BF Reactions (Combustion, Reduction, Slag Formation) Blast Furnace Products, Pig Iron, Grades and Classification, Ultimate Uses. Blast Furnace Calculations Analytical Charge Calculations, Reducibility, Slags, Design Parameters, Material and Energy Balances etc. Applications of Computers in design and operation of blast furnace.

### **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, Twinning.

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 and properties of steel and Cast Iron, pearlitic, bainitic, massive and order-disorder transformations, precipitation. Elementary treatment of martensitic transformation, iron-carbon system, and heat-treatment of steels.

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;

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 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 interval 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**

## موضوعات

١- عقاب

الف- توحيد

١. لو كان فيهما الهة.....عما يصفون ه  
الانبياء: ٢٢
٢. والهكم اله واحد.....الرحمن الرحيم ه  
البقرة: ١٢٣
٣. ان في خلق.....لثوم يعقلون ه  
البقرة: ١٢٤

ب- رسالت

١. ما كان ليثراً.....كنتم تدرسون ه  
آل عمران: ٤٩
٢. وما اتكم الرسول.....العقاب ه  
الحشر: ٤
٣. اليوم اكملت لكم دينكم.....دينا ه  
المائدة: ٣

ج- آخرت

١. يا ايها الناس.....كل زوج بهيج ه  
الحج: ٥
٢. واتقوا يوم ما.....ربكم عظيم ه  
البقرة: ٢٤

١- احاديث -

١. عن عمر بن الخطاب قال قال رسول الله ﷺ حين سئل عن الايمان اتق من الله وملا نكته وكتبه ورسله واليوم وتؤ من بالقدر خيره وشره. (متفق عليه)
٢. عن العباس بن عبدالمطلب قال قال رسول الله ﷺ ذاق طعم الايمان من رضى بالله ربا وبالا سلام ديناً وحمد رسولاً (مسلم)

٢- آيات

١. سورة المؤمنون كي دياره آيات
٢. قد افلح المؤمنون.....هم فيها يخلدون ه

١- احاديث

١. عن ابن عمر رضى الله عنهما قال قال رسول الله ﷺ:  
نبي الاسلام على خمس شهادة ان لا اله الا الله وان محمداً عبده ورسوله واقام الصلوة وايتاء الزكاة والحج وصوم رمضان  
(متفق عليه)
٢. وفي حديث جبريل قال رسول الله ﷺ: الاسلام ان تشهد ان لا اله الا الله وان محمداً رسول الله وتقيم الصلوة وتؤتي الزكاة وتصوم رمضان وتحج البيت ان استطعت اليه سبيلاً (متفق عليه)

٢. امر بالمعروف ونهى عن المنكر

ادعت دينك خروجه

١. كنتم خيرامة اخرجت للناس .....الفسفون ه آل عمران: ١١٠

### ب- طريق زوت

١. ادع النى سبيل ربك ..... يا لهتدين ه النحل: ١٢٥

٢. ولتكن منكم امة يدعون ..... المفلحون ه آل عمران: ١٠٢

### ا- طارح

١. عن ابى سعيد الخدرى عن رسول الله ﷺ قال من رأى منكم منكراً فليغيره بيده فان لم يستطع فبلسا نه فان لم يستطع فبقلبه و ذلك اضعف الايمان (رواه مسلم)
٢. عن عبد الله بن عمر قال قال رسول الله ﷺ الاكلكم راع وكلكم مسنول عن رعته فالأمام الذى على الناس راع وهو مسنول عن رعته والرجل راع على اهل بيته وهو مسنول عن رعته والمرأة راعية على بيت زوجها وولده وهى مسؤلة عنهم وعبد الرجل راع على مال سيده وهو مسنول عنه الا فكلكم راع وكلكم مسنول عن رعته (متفق عليه)

### ٣- اجازات

١. واعتصموا بهجبل الله جميعا.....لعلكم تهتدون ه آل عمران: ١٠٢

٢. انما المذمومون اخوة..... ترحمون ه الحجرات: ١٠

٣. قل يا اهل الكتاب ..... مسلمون ه آل عمران: ٢٢

٤. ولا تسبوا الذين..... يعملون ه الانعام: ١٠٨

### ا- طارح

١. عن انس قال قال رسول الله ﷺ والذى نفسى بيده لا يؤمن عبد حتى يحب لا خيه ما يحب لنفسه (متفق عليه)
٢. عن النعمان بن بشير قال قال رسول الله ﷺ ترى المومنين فى تراحمهم وتراحمهم وتقا طقمهم كمثل الجسد اذا اشتكى عضو تداهى له سائر الجسد بالسهر والحمى . (متفق عليه)

### ك- سلال

١. فكلوا من طيب ..... فقد هوى ه طه: ٨١

قل من حرم ..... تعلمون ه الاعراف: ٣٢، ٣٢

يا ايها الذين امنوا الا ناكلوا ..... تعلمون ه البقرة: ١٨٨

### ا- طارح

١. عن النعمان بن بشير قال قال رسول الله ﷺ الحلال بين والحرام بين وبينهما مشتبهات لا يعلمهن كثير من الناس فمن اتقى الشبهات استطر الدينه وعرضه ومن وقع فى الشبهات وقع فى الحرام كالراعى يرعى حول الحمى يوشك ان يرتع فيه الا وان لكل ملك حمى الا وان حمى الله مجارمه الا وان فى الجسد مضغة اذا صلحت صلح الجسد كله واذا فسدت فسد الجسد كله الا وهى القلب (متفق عليه)

۲. عن ابی ہریرہ قال قال رسول اللہ ﷺ ان اللہ طیب لا يقبل الا طيبا وان اللہ امر المومنين بما امر به المرسلين فقال يا ايها الرسل كلوا من الطيبات واعملوا صالحا وقال تعالى يا ايها الذين امنوا كلوا من طيبات ما رزقناكم ثم ذكر الرجل يطيل السفر الشعث اغبريمد يديه الى السماء يا رب يا رب و مطعمه حرام ومثربه حرام وملبسه حرام وغذى بالحرام فاني يمستجاب لذلك (رواه مسلم)

## حقوق العباد

### بنیادی انسانی حقوق

#### الف۔ جان کا تحفظ

من اجل ذلك ..... لمسرفون ۵ المائدہ: ۲۲

#### ب۔ کلمت کا تحفظ

يا ايها الذين ..... بكم رحيماً النساء: ۲۹

#### ج۔ عزت کا تحفظ

يا ايها الذين ..... تراب رحيمه الحجرات: ۱۲، ۱۱

#### د۔ آزادي رائے و عقيدہ

لا اكره في الدين ..... عليه ه البقرہ: ۲۵۲

#### ح۔ حق مساوات

يا ايها الناس ..... خبير ه الحجرات: ۱۳

#### خ۔ معاشی تحفظ

والذين في ..... المحروم ه المعارج: ۲۵، ۲۴

#### ل۔ المیت کی بقاء پر پورا حق کے حصول کا حق

ان اللہ يا مرکم ان ..... بصيرا ه النساء: ۵۸

#### م۔ حصول نفاق کا حق

يا ايها الذين امنو ..... تجبراه النساء: ۱۳۵

## بہ حقوق نسواں

۱۔ من عمل ..... يعملون ه النحل: ۹۷

۲۔ ان المسلمين ..... عظيماً الاحزاب: ۲۵

۳۔ للرجال نصيب ..... مفروضاً النساء: ۷

## ۸۔ غیر مسلموں سے تعلقات



۱. لاینها کم اللہ.....الظلمون ۵ الممتحنہ : ۹.۸  
 ۲. وان جذجو المسلم.....العلیم ۵ الانفال : ۲۱

احادیث

### ۹۔ خطبہ حجۃ الوداع

#### ترجمہ اور اہم نکات

نوٹ: مذکورہ بالا تمام عنوانات کی قرآنی آیات کی کثیر میں ہر عنوان کے تحت احادیث دے دی گئی ہیں۔

۲۔ اسوہ حسنہ (سیرت طیبہ)

۱۔ ولادت باسعادت

۲۔ قبل از نبوت کی زندگی

۳۔ بہشت نبوی

۴۔ دعوت و تبلیغ اور اس کی مشکلات

۵۔ ہجرت مدینہ

۶۔ موانع اور بیعتی مدینہ

۷۔ غزوات نبوی

۸۔ حجۃ الوداع

۹۔ وصال

#### ۳۔ اسلامی تہذیب

\* برصغیر پر اسلامی تہذیب کے اثرات

۱۔ اسلام سے پہلے برصغیر کی تہذیبی حالت

۲۔ اسلامی تہذیب کے عوامل و عناصر

۳۔ برصغیر پر اسلامی تہذیب کے معاشرتی، اخلاقی، سیاسی اور سماجی اثرات

#### ۱۔ اسلامی تہذیب کے عالمی اثرات

\* ۱۔ اسلام کی سلیب ٹریک کے اثرات

۲۔ فکری اثرات

۳۔ معاشرتی اور سماجی اثرات

**Note:** The English translation of the Course is available with the Department of Humanities.

## **HS-209: Ethical Behavior**

### **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. Ethical, 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

## **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 with variable coefficients. Cauchy's and 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. Heaveside's expansion formula. Simple applications.

**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:**

An outline of various methods of steel making - Physical chemistry of steel making process - Raw materials for steel making Acid open hearth and basic open hearth processes. Oxygen Enrichment of fuel Operation, control of composition and different slag practices.

**Pneumatic and Electric Steel Making:**

Acid Bessemer. Basic Bessemer. Side blown convertor. L.D.convertor. Kaldo Rotor- Bottom blown and combined blown processes of steel making Principles of operation under different slag practices for steelmaking by Electric Arc furnace and Induction furnace. Rapid steel making.

**Duplexing and Ingot Making:**

Introduction to secondary steel making. Some modern developments in steel making like ESR VOD and AOD process Pre-treatment of steels. Ingot solidification. killed, semi killed. Rimmed and capped steels. Ingot defects, their identification and remedial actions - continuous casting of steel.

**Deoxidation of Steels:**

Deoxidation by Si. Al- Mn etc., Comparison of deoxidising effects of various deoxidisers. Deoxidation by complex deoxidisers. Vacuum degassing of steels. Ladle Metallurgy. Concept of clean steel.

### **Carbon and Alloy Steels:**

Low, medium and high carbon steels. Alloy Steels, Manganese steels. Free cutting steels. Tool steels and stainless steels. Basis of designing of 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, Chromium, 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:**

Melting methods and practice and their effect upon metal quality. Melting furnaces and equipment, Gases in metal, their control and removal, Solidification, Nucleation and growth phenomenon, Microstructure of cast metal and alloys, Heat flow in solidification, Solidification of single phase systems, Solidification of multiphase systems, Structures of casting and segregation. Melting of Ferrous & Non-Ferrous Metals & Alloys.

### **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:**

Inspection & Quality Control, Casting Defects: Identification, Causes of defects and their remedies. Fettling & Processing of Castings, Patterns, Sand Moulding, Gating & Riser, Computer applications in foundry processes.

## **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:**

Introduction and concepts in welding structures and assemblies. Analytical practice of designing weldments. Welding codes and specifications. Estimation of welding costs.

### **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:**

Shaping Processes and Classification, Structure-Property-Processing Relationship, Fundamentals of Mechanical Work on Metals, Cold and Hot Working of Metals.

### **Metal Forming Processes:**

Detailed study of Rolling, Forging, Extrusion, Wire, Rod, Tube and Sheet Metal Forming Processes. Roll-Pass Design. Elements of theory of plasticity, Materials behaviour under forming conditions: Stress and strain, Macroscopic plasticity and yield criteria, Work Hardening, Plastic instability, Strain rate and temperature dependence of flow stress, Ideal work, friction, redundant work, and mechanical efficiency, Slab analysis, upper-bound analysis, Slip-line field theory, Deformation zone geometry, Formability, bending, Plastic anisotropy, Complex stamping and sheet metal properties. Flow stress, deformation resistance, workability, evolution of microstructure during metal working, Friction and surface integrity, Analysis of metal flow in metal forming processes, Analysis and modeling of 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, Thermo mechanical 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, modulus 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 steels. Secondary hardening, heat treatment of dies and tool steel, Alloy steels, HSLA steels, and stainless steels, surface hardening, carburising, 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 treatment of nonmetallic materials like polymers, plastics, rubbers and composites.

### **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: ENGINEERING ECONOMICS**

#### **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.

### **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, linear transformations, matrix of a linear transformation. Basic definitions and matrix operations, adjoint 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.

**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, McLeod 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:**

Introduction, purpose of Vacuum Coating, process of Vacuum coating, Process of PVD and CVD coatings, Characterization of vacuum coatings. Coating science and selection, Measurement of coating thickness. Case studies.

**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:**

Classification of materials according to magnetic properties. Magnetic fields, flux density and magnetization. Magnetic materials, magnetic measurements. Magnetic properties of materials, hysteresis. Technological application, soft magnetic materials for electromagnets, hard magnetic materials, permanent magnets, magnetic recording technology.

**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:**

Overview Elevated-Temperature Characteristics of Materials, Mechanical Properties at Elevated Temperatures, Corrosion at Elevated Temperatures. Processing and Properties of Superalloys. Directionally Solidifies and Single-Crystal Superalloys. Elevated-Temperature Corrosion of Superalloys. Microstructural Instabilities. Heat-Resistant Materials, Titanium Alloys, Refractory Metals and Alloys Structural Intermetallics Ceramics Carbon-Carbon Composites. Materials for Aerospace applications. Materials for nuclear applications

**Nanomaterials:**

Overview of Nanomaterials and their classification. Mechanically alloyed Nanomaterials, ODS alloys, Nanostructured materials, Fuel cell Materials, Materials for Hydrogen Storage, Ceramic and Ceramic matrix composites, Metal Matrix composites. Shape memory alloys Application of Computer in Advanced materials.

**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, L TPD, 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 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:**

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**

Theories of creep and fatigue fracture mechanism in ductile and brittle materials. Brittle and ductile fracture comparison. The theoretical cohesive strength of solids. Stress concentration at a notch and at a crack. Plane stress and plane strain fracture toughness. Fracture toughness parameters and testing.

Fractography: Micro Mechanism of crack nucleation and propagation inter crystalline brittleness. Fracture mechanics in stress corrosion. Impact testing, characteristics of fracture observed in ductile and brittle material. The crack opening displacement approach and empirical methods for assessing crack propagation in thick sections