

METALLURGICAL & MATERIAL ENGINEERING

Syllabus For UG Level

First Year First Semester

Met/Chem/T/111 CHEMISTRY-I

Atomic structure determination of charge and mass of electron, Frutherford Model, Bohr's model. Atomic number, X-ray spectra, Bohr's teory of Hydrogen atom origin of spectral lins, Quantum numbers. Electron distribution, Pauli's Exclusion principle, Hund's rule. Modern periodic arrangements (particular reference to transitional anner transitional elements), atomic and ionic radii, ionization potential, electron affinity and electronegativity.

Surface effects: Definition and concepts of surface/interfacial tensions, surface free energy, surface entropy and surface concentration. The thermodynamics of surfaces and interfaces - Gibbs Adsorption isotherm, Langmuir's isotherm, and other adsorption isotherms, curved interfaces.

Elements of environmental chemistry - pollution restriction on air, water; NO_x, SO_x, SPM, BOD, pH etc. Concepts of chemical bonds, bond types; ionic and covalent bonds. Born Haber cycle, Fajan's rule, metallic bonds, hydrogen bond and hybridisation.

Theories of acids and bases - Arhenius theory, Bronsted Lowry theory and Teqs theory.

Theory of inorganic qualitative analysis; solubility product and application in analysis, hydrolysis, ionic product of water, pH, buffer, common ion effect and their application.

Redox systems: Redox potentials and their role in chemistry uses of potassium permanganate and potassium dichromate in quantitative analysis.

Met/CSE/T/112 COMPUTER PROGRAMMING

Writing flow chart, Fortran language, details of format , do loops subprogrammes, sub-routines , order of Fortan statement , etc, C-Programmes ,details of programmes , I/O files, C-Processor.

Met/Math/T/113 MATHEMATICS-IN

Real numbers, Functions of a single variable: Concept of limit, successive differentiation, Rolle's theorem, Mean value theorem, Taylor's series, Maclaurin's series, Maxima and minima.

Functions of several variables: Limit, continuity, Partial derivatives. Different partial derivatives of a composite function. Euler's theorem, Total derivatives and directional derivatives.

Properties of definite integrals. Fundamental theorem of integral calculus. Improper integrals. Beta and Gamma functions multiple integrals. Applications: Arc length and areas of plane curves. Volumes and surface areas of solids of revolution, Sequence and infinite series, Convergence and divergence of infinite series. Comparison test.

D'Alembert's ratio test and Cauchy's root test.

AM/ME/T/1A ENGINEERING MECHANICS

Statics:

Introduction. Idealizations of Mechanics. Fundamentals of Vector Alæbra. Application

of Vectors in Mechanics, Equiv System, Equilibrium, FBD Concept, Fundamentals of Friction, Properties of surface, Centroid, Moment of Inertia

Dynamics:

Intro to vector calculus, Definition of vectors in Dynamics, Rectilinear Motion, Curvilinear motion of particle and description of different coordinate systems, Kinetics, Newton's Law and D' Alembert's principle and application to rectilinear and curvilinear motion, constrained motion, Energy and Momentum methods.

Ph/T/1A PHYSICS-IA

1. Use of vectors in particle mechanics, Unit vectors in spherical and cylindrical polar coordinates, Conservative vector fields and their potential functions - gravitational and electrostatic examples, Gradient of a scalar field, Equipotentials, States of equilibrium, Work and Energy, Conservation of energy, Motion in a central field and conservation of angular momentum.
2. Angular momentum of a system of particles, Torque, Moment of inertia, Parallel and Perpendicular axes theorem, Calculation of moment of inertia for (i) thin rod, (ii) disc, (iii) cylinder and (iv) sphere. Rotational dynamics of rigid body (simple cases).
3. Motion of fluids, Bernoulli's equation and its applications, motion of viscous fluids - Poiseuille's equation.
4. Simple harmonic motion, Composition of simple harmonic motion, Forced vibration and resonance, Wave equation in one dimension and travelling wave solution, Standing waves, Wave velocity and group velocity.
5. Assumption for the kinetic theory of gases, Expression for pressure, Significance of temperature, Deduction of gas laws, Qualitative idea of (i) Maxwell's velocity distribution. (ii) degrees of freedom and equipartition of energy, Specific heat of gases at constant volume and constant pressure.
6. Equation of state of a gas, Andrew's experiment, Qualitative discussion on van der Waal's equation of state, Critical constants, Law of corresponding states.
7. Macroscopic and microscopic description, Thermal equilibrium, Zeroth law of thermodynamics, Concept of international practical temperature scale, Heat and Work, First law of thermodynamics and some applications, Reversible and irreversible processes, Carnot cycle, Second law of thermodynamics, Concept of entropy, Thermodynamic relations.

Ph/S/1 PHYSICS LABORATORY-I

(Selected Experiments from the following)

1. Determination of Galvanometer resistance by half - deflection method.
2. Determination of Galvanometer resistance by Thomson's method.
3. To find high resistance by Galvanometer deflection method.
4. To measure mechanical equivalent of heat, J by electrical method (Joule's) using copper calorimeter (radiation correction to be done).
5. To compare to low resistance by drop of potential method.
6. To determine resistance per unit length of wire by using Carey Foster bridge.

7. To estimate strength of a current by using copper voltmeter.
8. a) To compare the EMF's of two cells by using a potentiometer
b) To measure current by using a potentiometer
9. To measure the horizontal components of earth's magnetic field intensity using deflection and vibrating magnetometers.
10. Determination of coefficient of linear expansion by optical lever method.
11. Determination thermal conductivity of metal by Searle's method.
12. To determine coefficient of viscosity by Capillary flow method.
13. Determination of Young's modulus by Flexure method.
14. To draw mutual and anode characteristics of triode and hence to find R_p , μ , and g_m
15. To draw the transistor characteristics (NPN/PNP) in the given configuration and hence to find h_{ie} , h_{fe}
16. Determination of refractive index of the material of the glass prism by prism spectrometer (for at least two λ 's)
17. Study of collisions in one dimension using a linear air track
18. Use of an air track for obtaining potential energy curves for magnetic interactions.
19. Study of oscillations under potential wells of various shapes using an air track.
20. Experiments on diffraction in single slit, double slit and plane grating using He-Ne laser
a) To find the wavelength of a monochromatic light by single slit.
b) To find slit separation of a double slit.
c) To find number of rulings per cm of a plane grating
21. To find the wavelength of a monochromatic light by Newton rings.
22. Fabry-Perot interferometry: To find out separation of wavelength of sodium D1 & D2 lines.

BED/ME/T/1

BED/ME/S/1 BASIC ENGINEERING DRAWING

Drawing primitives: instruments, letters, lines, title block, geometric curves & shapes, scale and dimension.

Projection: orthographic and isometric, sectional views.

WS/ME/S/9 WORKSHOP PRACTICE-IX (Pattern Making and Moulding)

Introduction to different phenomena arising out of shrinkage of castings and pattern maker's rule; making of wooden patterns from supplied drawings and samples of patterns; making of core boxes.

Introduction to moulding practice- preparation of moulding sand and use of moulder's tools; making of moulds by using selected pattern's; introduction to melting and pouring practice; experiments sand testing like permeability, moisture content, shutter index, mould strength, grain fineness number etc.; demonstration of injection moulding machine.

Met/Chem/S/114 QUALITATIVE ANALYSIS

As per the theory subject Met/Chem/T/111.

First Year Second Semester

Met/Chem/T/121 CHEMISTRY-II

Complexes. Perfect and imperfect, Werner's theory of coordination compounds, chelates, stereochemistry, studies on complexes, nature of linkages in coordination compounds, nomenclature.

Kinetic theory of gases, deduction of gas laws, equation of state, Vanderwaal's equation, Critical constants, Andrews and Amagats, Curve, liquefaction of gases, specific heats, vapour density, limiting density, determination of molecular weight.

Catalysis: Homogeneous and heterogeneous types of catalysts, catalyst poisons, promoter and mechanism of catalysis.

Thermochemistry: Mass Law, Heat of formation, heat of combustion heat of solution and dilution, heat of ionisation and conversion with regard to its measurements, variation of the heat of reaction with temperature.

Properties of dilute solution - Osmosis and osmotic pressure, lowering of vapour pressure, elevation of boiling point and depression of freezing point-experimental methods of their determination, Laws on colligative properties. Determination of Molecular Weight of substances in dilute solution and their limitation.

Viscosity with determination of viscosity.

Chemical equilibrium: Law of mass action, Lechatelier's reaction principle and its applications, sums. Chemical Kinetics: Order of reaction (1st & 2nd order).

Met/Math/T/122 MATHEMATICS-IIN

Determinants and Matrices: Definition and properties. Product of two determinants. Solution of system of linear equations by Cramer's rule. Addition and multiplication of matrices. Adjoint and inverse of matrix. Hermitian and unitary matrices. Eigenvalues and eigen vectors.

Vectors: Vectors, position vectors, Addition of vectors, Multiplication of a vector by a scalar. Scalar and vector product of two vectors. Differentiation of a vector function, gradient, divergence and curl, Physical interpretation. Vector identities. Line and surface integrals. Green's, Gauss' and Stokes' theorems.

Tensors: Definition, covariant and contravariant, properties, Christoffel symbols, Cartesian tensors.

AM/ME/T/3 STRENGTH OF MATERIALS

Uniaxial stress field, Thin pressure vessels, Torsion (inclusive of Helical spring), shear force and Bending moment, Bending and shear stress in beams, Deflection beams, Energy methods in Strength of Materials, Problem of Plane stress and strain, Theories of failure, Buckling of columns.

Met/ME/T/124 HEAT ENGINEERING

Heat, absolute temperature, units of heat and work, laws of thermodynamics, mechanical equivalent of heat, laws of perfect gases and their characteristics equation, Gas constants, specific heats, internal energy, expansion and compression of gases in general, Carnot cycle, simple reciprocating air-compressor, properties of saturated and superheated steam, use of steam tables and charts.

Boilers and their types, orifice and nozzles, impulse and reaction turbines, types of condensers, gas and oil engines, petrol engines working cycles, indicated and brake horse power, mechanical and thermal efficiency.

Refrigeration, COP of refrigeration cycle, Vapour compression refrigeration system, refrigerants.

Ph/T/2A PHYSICS-IIA

1. Electric potential and intensity, Flux of electric field, Gauss's law and its application to problems with spherical and cylindrical symmetry, Capacitance- parallel plate and spherical condensers, Energy of a capacitor, Energy density of an electric field, Potential and field due to a dipole, Dielectric polarisation, Electric displacement vector, dielectric susceptibility.

2. Biot-Savart law and Ampere's law in magnetostatics, Calculation of magnetic field in simple situations like (i) straight wire (ii) circular wire (at a point on the symmetry axis) and (iii) Solenoid.

3. Time-varying fields, Faraday's law of electromagnetic induction, Self and mutual inductance, Resonance and oscillation in electrical circuits.

4. Nature of light waves, Interference of light waves, Young's experiment, Spatial and temporal coherence, Fresnel bi-prism, Interference in thin film, Newton's rings, Measurement of film thickness and wavelength, Diffraction of light waves, Huygen's construction, Fresnel and Fraunhofer diffraction, Fraunhofer diffraction due to single slit and plane diffraction grating, Approximate rectilinear propagation of light, Zone plate, Polarisation of light waves, Polarisation by reflection, Brewster's law, Double refraction- ordinary extraordinary rays, Polaroid, Optical activity.

5. Energy levels of the hydrogen atom and the Bohr atom model, X-ray spectra, X-ray diffraction, Bragg's law, Compton effect. De-Broglie waves, Particle diffraction, Uncertainty principle and its application.

Ph/S/2 PHYSICS LABORATORY-II

(Selected Experiments from the following)

1. Determination of Galvanometer resistance by half - deflection method.
2. Determination of Galvanometer resistance by Thomson's method.
3. To find high resistance by Galvanometer deflection method.
4. To measure mechanical equivalent of heat, J by electrical method (Joule's) using copper calorimeter (radiation correction to be done).
5. To compare to low resistance by drop of potential method.
6. To determine resistance per unit length of wire by using Carey Foster bridge.

7. To estimate strength of a current by using copper voltmeter.
8. a) To compare the EMF's of two cells by using a potentiometer
b) To measure current by using a potentiometer
9. To measure the horizontal components of earth's magnetic field intensity using deflection and vibrating magnetometers.
10. Determination of co efficient of linear expansion by optical lever method.
11. Determination thermal conductivity of metal by Searle's method.
12. To determine co-efficient of viscosity by Capillary flow method.
13. Determination of Young's modulus by Flexure method.
14. To draw mutual and anode characteristics of triode and hence too fine R_p , μ , and gm
15. To draw the transistor characteristics (NPN/PNP) in the given configuration and hence to find h_i , h_f
16. Determination of refractive index of the material of the glass prism by prism spectrometer (for at least two λ 's)
17. Study of collisions in one dimension using a linear air track
18. Use of an air track for obtaining potential energy curves for magnetic interactions.
19. Study of oscillations under potential wells of various shapes using an air track.
20. Experiments on diffraction in single slit, double slit and plane grating using He- Ne laser
a) To find the wavelength of a monochromatic light by single slit.
b) To find slit separation of a double slit.
c) To find number of rulings per cm of a plane grating
21. To find the wavelength of a monochromatic light by Newton rings.
22. Fabry-Perot interferometry: To find out separation of wavelength of sodium D1 & D2 lines.

AED/ME/T/1

AED/ME/S/1 ADVANCED ENGINEERING DRAWING

True length, development of surface of simple objects. Threaded joint & riveted joints, cotter/knuckle joint. Pulley, shaft coupling.

WS/ME/S/11 WORKSHOP PRACTICE-XI (Fitter Shop and Machine Shop)

Introduction to fitter's tools, gauges, measuring instruments etc.; marking of jobs; fitter's job involving chipping, filing, sawing, drilling; use of taps and dies; pipe fittings and plumbing.

Introduction to machine tools - lathes, drilling machines, shaping machines, planing machines, slotting machines, milling machines, grinding machines; machine shop work involving different operations by using the above mentioned machines through making of jobs.

Met/Chem/S/124 METALLURGICAL ANALYSIS

Experiments based on complete analysis of ores & concentrates, Estimation of iron in iron ore (total Fe_2O_3 amount of ferrous/ferric state)

1. Estimation of Cr, Mn, in steel
2. Estimation of Ni in stainless steel
3. Estimation of Cu & Sn in brass
4. Estimation of C & S by Strolein's apparatus.
5. Slag analysis: CaO & alumina in slag
6. Iron oxide in ore
7. Silica in clay or fireclay

Second Year First Semester

Hum/T/A HUMANITIES-A

English - 2 Pds/week - 50 Marks

Sociology - 2 Pds/week - 50 Marks

HUMANITIES

1. Basic writing skills
2. Report, Covering Letter & Curriculum-Vitae writing
3. Reading and Comprehension
4. Selected Short Stories

Text Book: ENGLISH FOR ALL

SOCIOLOGY

1. Sociology: Nature and scope of Sociology - Sociology and other Social Sciences - Sociological Perspectives and explanation of Social issues
2. Society and Technology: Impact of Technology on the Society - A case study
3. Social Stratification: Systems of Social Stratification - determinants of Social Stratification - Functionalist, Conflict and Elitist perspectives on Social Stratification
4. Work: Meaning and experience of work: Postindustrial society- Post-Fordism and the Flexible Firm
5. Development - Conceptions of and approaches to development - The Roles of State and the Market in the Development
6. Globalization: The concept of globalization - globalization and the nation state - Development and globalization in post colonial times.
7. Industrial Policy and Technological change in India - The nature and Role of the State in India
8. Technology Transfer: The Concept and Types of Technology Transfer-Dynamics of Technology Transfer
9. Technology Assessment: The Concept - Steps involved in Technology Assessment
10. Environment: Sociological Perspectives on Environment - Environmental Tradition and values in ancient India
11. The Development of Management: Scientific Management - Organic Organization - Net Work organization - Post modern Organization - Debureaucratization -

Transformation of Management

12. Technological Problems and the Modern Society: Selected Case Studies - Electric Power Crisis, Industrial and/or Environmental Disaster, or Nuclear Accident.

Met/ChE/T/212 FLUID FLOW & HEAT TRANSFER

Conduction: Fourier's law of steady state heat transfer for several bodies in series, Logmean area, use of Gurney Lurie chart.

Convection: Film concept, Dettus-Bolter equation, Overall heat transfer coefficient, Heat exchangers. Dimensionless numbers. Heat Transfer by Forced Convection. Transient Heat Flow. Radiation: Concept of black body, Kirchoff's law, Allowance for non- black and pre- radiating surfaces. Fluid Flow

Newton's Law of Viscosity, Laminar Flow. Fluid Flow. Between Two Flat parallel Plates, Fluid Flow down an Inclined Plane, Fluid Flow in a Cylindrical

Tube: Hagen- Poiseuille Equation and Flowmeters. Navier Stokes Equation. Fluid Flow over a Horizontal Flat plate, Approximate Integral Method of Obtaining Boundary Layer Thickness,

Creeping Flow past a sphere, Form Drag and Friction Drag, Stoic's Law, Turbulent Flow, Friction Factor and Turbulent Flow in Cylindrical Pipes. Flow Through Packed Beds, Ergun's Equation. Fluidized Beds. Mechanical Energy Balance, Bernouli's Equation, Friction Loss, Influence of Bends, Fitting and Changes in the Pipe Radius.

Met/Geo/T/213 GEOLOGY AND MINERALS BENEFICIATION

Introduction to Geology and its relation to metallurgy

Introduction to crystallography: definition , common morphology, symmetry elements, point crystal, classes.

Physical properties of mineral colour, lustre, hardness, specific gravity electrical conductivity and thermal conductivity , magnetic properties .

Polarised light microscopy-both transmitted and incident light types .Basic principles involved and the properties of minerals studied under microscope.

Ore textures, textural features and their interpretation.

Nature and types of ore deposits. A short discourse on the types of ore deposits with emphasis on the chemical and mineralogical compositions

Different types of rocks and their basic characteristics. Major Indian ore deposits.

Resource potential of Indian and other countries with respect to important ore types and metallurgical coal.

Minerals Beneficiation:

Laws of comminution; Crushing and Grinding machines; Classification: free and hindered settling; Dry and wet sizing, tabling - Wilfley tables, Jigging and Jigging machines, surface chemistry of minerals; Flootation principles and froth floatation; dewatering, magnetic separators. Pollution in beneficiation plants & control steps.

ETech/EE/T/A ELECTRICAL TECHNOLOGY-A

DC Circuits: Kirchhoff's Laws. Maxwell's Loop Current Methods of Analysis. Star-Delta Conversion. Superposition Theorem. Thevenin's Theorem. Maximum Power Transfer. Magnetic Circuit: MMF, Flux, Reluctance. B-H Loop. Hysteresis and Eddy current loss. Magnetic circuit analysis with air gap.

AC 1-phase: Periodic Waves and Sinusoids. Average and RMS Values, Form Factor, Peak Factor. Phasor concept of Sinusoids. Impedance and Admittance. Power, Power Factor, V A, V AR. Series R-L-C Circuit, Parallel R-L-C circuit. Resonance.

Balanced 3-phase: 3-phase AC balanced circuits. Phase-sequence. Star and Delta connections. Power, V A, V AR, Power Factor or balanced 3-phase circuits.

Power Measurement: Wattmeter circuit connection. Power Measurement by two wattmeter methods in 3-phase system.

DC Machines: Construction and general principle of operation. Generator EMF Equation. Field connection, shunt series and compound. Generator characteristics.

Motor-equation and general operation. Starting and speed control, torque-speed curve.

1-Phase Transformer: Construction. EMF equation. Phasor diagram. Equivalent circuits. Losses and Efficiency. Open circuit and Short circuit test.

3-Phase Induction Machine: Types of induction machines. Rotating magnetic field, slip, torque equation, torque-speed curve. DOL starting and reduced voltage starting.

3-Phase Synchronous Machines: Alternator, constructional features, EMF equation, synchronous reactance, power-angle characteristics.

Concept of synchronous motor.

Meters: DC and AC Ammeters and Voltmeters. Megger. Multiplier.

Books :

1. Electrical Science by Prof. S. Chowdhury, Prof. R. Chakraborty & Prof. P. K. Chatterjee.
2. Electrical Machines by Prof. P.K. Mukherjee & Prof. S. Chakravorti.

Met/Math/T/215 MATHEMATICS-IIIN

Complex numbers, De Moivre's theorem, Exponential values of sines and cosines, Hyperbolic functions, Ordinary differential equations.

Linear exact and first order equations, Second and higher order equations with constant coefficients.

Method of variation of parameters. Euler – Cauchy equation.

Laplace transform and its inverse. Solution of ordinary linear differential equations with constant coefficients. Series solution of Bessel and Legendre equations. Legendre polynomials and orthogonal properties. Fourier series. Solution of one dimensional wave and diffusion equations and two dimensional Laplace equations. Introduction to finite element methods.

Met/S/211 INSTRUMENTAL CHEMICAL ANALYSIS LABORATORY

Calorimetry, FTIR Spectrometry, UVVIS, C,H,N Analysis, AAS, Optical Spectrometry, Gas Chromatography. (Principles & applications of the techniques to be covered in the

laboratory)

Met/S/212 MINERALS BENEFICIATION LABORATORY

1. Grinding characteristic of Roll crusher, Ball mill and Jaw crusher.
2. Classification.
3. Tabling.
4. Floatation.
5. Jigging.
6. Magnetic Separation.
7. Flocculation.

Met/Geo/S/213 GEOLOGY LABORATORY

Symmetry elements, Identification of minerals and as per the theory subject
Met/Geo/T/213.

MDD/ME/T/1

MDD/ME/S/1 MACHINE DESIGN AND DRAWING

Basic idea of design, factor of safety, modes of failure, theories of failure, design under static and fatigue loading.

Design of Cotter/knuckle Joint, threaded and riveted joint, eccentric loading. Shaft coupling (rigid / flexible). Belt-pulley drive. Pressure vessel.

Second Year Second Semester

Met/CSE/T/221 NUMERICAL ANALYSIS

Solution of algebraic and transcendental equations. Simultaneous linear algebraic equations. Interpolation. Approximation, boundary value problems, Eulers, Range-Kutte etc. methods. Two dimensional problems, elliptic and parabolic equations. Finite element techniques (for one dimension).

Met/ChE/T/222 FUEL & COMBUSTION

Definition and classification of fuels:

Solid fuels:

Original formation of coal, reserves of coal , composition and classification of coal, its chemical constitution and physical properties, commercial varieties of coal, coal washing, briquettes and powdered coal, spontaneous ignition of coal on storage.

Coke and coking:

N.T.C.& L.T.C. and products of carbonisation . Special forms of coal . Domestic and metallurgical coke properties, methods of improving coking quality of coal, other minor solid fuels, fire wood, charcoal, etc, gasification of solid fuels.

Liquid fuels:

Composition and character of fuel oil, petroleum, its occurrence and composition, properties and commercial products of petroleum. System of burning fuel oil.

Gaseous fuels:

Composition, character and application, Nuclear fuels.

Energy utilisation:

Thermodynamic and economic aspect of utilisation in furnaces.

Waste heat recovery

Analysis of waste heat system and efficient methods of heat recovery. Fuel testing.

Met/T/223 PHYSICAL METALLURGY-I

Bonds, Metallic, ionic etc, coordination number, packing behaviour & calculations, crystallography, Bravais Lattice, Miller indices, Alloy phases, solid solutions, H-R rules, electron phase, SRO and LRO etc. Phase rule and phase-diagram-Binary equilibrium diagrams with eutectic, peritectic, eutectoid reactions. Construction of phase diagrams. Iron-carbon system. Introduction of ternary systems. Microscopy-Optics, objective, ocular and illuminating system. Metallographic etching techniques. Thermocouples & pyrometry. Cu-Zn, Cu-Ni, Cu-Sn, Pb-Sn, Al-Cu, binary systems.

Met/T/224 THERMODYNAMICS OF MATERIALS

Introduction. Types of System State functions and Path functions. Reversible and irreversible process.

1st Law of thermodynamics. Concept of Internal Energy and Enthalpy. Heat Capacities.

Application of 1st Law in Constant Volume, Constant Pressure, Isothermal and Adiabatic process with ideal gas system. Kirchoff's equation. H.-T diagrams.

2nd Law of thermodynamics: Carnot cycle, Entropy, Concept of equilibrium.

3rd Law of thermodynamics.

Gibbs and Helmholtz Free Energies Chemical Potential and different forms of criterion of equilibrium. Gibbs-Helmholtz equation. Maxwell relations and their applications.

Fugacity, Activity and Equilibrium Constant. Reactions involving gases. Reactions involving pure condensed phases. Variation of Standard Free Energy and Equilibrium Constant with temperature. Ellingham diagrams and relative stability of oxides.

Phase equilibrium. Clausius Clapeyron equation.

Solution: Ideal and Nonideal solutions, Mixing functions and Excess functions, Relationship between Integral Molar properties and Partial Molar properties, Gibbs Duhem equation and its integration, Regular solutions, Reactions involving components in condensed solution, Quasi-chemical approach to solutions. Problems.

Met/ET/T/225 APPLIED ELECTRONICS AND INSTRUMENTATION

Circuits: Response of resistance, inductance and capacitance to D.C. and A.C, voltage sources.

Series and parallel resonance of LRC circuits:

Maximum power transfer theorem. Thevenin's and Norton's theorem.
Semiconductors : P and N type semiconductors, P.N. diodes- its operation and characteristics. P-N-P and N-P-N transistors and their operations & characteristics.
Semiconductors, diodes and transistor circuits: Single phase, half wave rectifier, full wave rectifier, bridge rectifiers and different types of filters. Transistor biasing and stabilisation. Hybrid equivalent circuit of for transistor. Transistor as an amplifier. Common emitter amplifier with a emitter resistance, the emitter follower. Cascaded resistance, capacitance- coupled amplifier.
Concept of feedback- Gain with feedback-positive and negative feedback, Negative feedback amplifier with its various advantages. The operational amplifier (TC). Use of operation of amplifier as inverter. Adder, Integrator, Differentiator. Brief idea of Electronic analog computer. Simulation of a second order differential equation. A Wien bridge oscillator using I.C. Operational amplifier.

The Cathode ray oscilloscope.
Instrumentation : Few transducers like strain gauge, LVDT etc. used in electronic instrumentation . Electronic instrumentation for the measurement of different physical parameters.

Met/Math/T/226 MATHEMATICS - IVN

Probability and Statistics : Elements of mathematical logic, Set theory, Functions and mappings.

Probability, Sample theorems, Conditional probability. Bayes theorem, Random variables, Probability distribution expectations. Binominal , Normal and Poisson's distributions.

Frequency distributions . Mean, Standard deviation, Skewness and Kurtois. Sampling Statistical estimation. Test of Hypothesis and significance (t, chisquare and f-tests).

Curve fitting by the method of least squares. Bivariate distribution, Correlation and regression.

Met/ChE/S/221 FUEL LABORATORY

Fuel testing and experiments based on course Met/ChE/T/222.

Met/EE/S/222 ELECTRICAL TECHNOLOGY LABORATORY

Experiments in tune with the course on "Electrical Technology-A".

Met/S/223 PHYSICAL METALLURGY LABORATORY-I

1. Study and use of metallurgical microscope.
2. Metallographic specimen preparation, mechanical polishing, mounting, and etching.
3. Microstructure of annealed pure metals-iron, copper, lead, zinc alluminium and use of specific etchants.
4. Macro etching and sulphur printing.
5. Electro polishing.

6. Calibration of thermocouple.
7. Optical pyrometry

Met/CSE/S/224 NUMERICAL ANALYSIS LABORATORY

Experiments in tune with the course on "Electrical Technology" (Met/CSE/T/221).

Third Year First Semester

Met/T/311 MECHANICAL METALLURGY

Elastic and plastic deformation of single crystals and polycrystalline aggregates. Cold working, recover, recrystallisation and grain growth. Annealing, orange peel effect; stretcher strain, yield point phenomenon. Aging quench aging, strain aging, strain age hardening. Dislocations & dislocation mechanisms. Strengthening of metals and alloys. Deformation of metals and alloys. Fracture behaviour of metallic materials, fracture toughness etc. Ductile and brittle fracture.

Met/T/312 PHYSICAL METALLURGY-II

Fe-C system, steel and iron microstructures with phase relations, Free energy-composition diagrams. Ideal and non-ideal behaviour of alloy systems. Diffusion: Diffusion laws, Kirkendall effect, activation energy etc. Transformation in metals and alloys – solidification and solid-state transformation. Nucleation and growth reactions: Homogeneous & Heterogeneous nucleation. Dendritic solidification: Divorced eutectic, Super cooling, Interface calculation etc. Kinetics of solid-state transformation, C-curve etc. Segregation precipitation reaction. Phase Transformation processes - Diffusional phase transformation process: Short range diffusional and long range diffusional process like polymorphic transformation, massive transformation, recrystallisation, precipitation transformation, order disorder, eutectoid and spinoidal transformations.

Met/T/313 IRON MAKING

World production of Iron and steel, occurrence and distribution of iron, coal and limestone in India. Agglomeration techniques. Blast furnace operation- Thermodynamic principles, refractories. Temperature profile, aerodynamics, different factors, Irregularities etc. Blast furnace reactions. Thermodynamics of slag-metal reactions, composition of pig iron, high top pressure, oxygen enrichment, injection of steam oil etc. Blast furnace design- furnace productivity, improving the coke rate etc. Alternative pig iron production, direct reduction process like gas-base and solid-base processes. Thermodynamic principles of carbothermic, metallothermic reduction of oxides. Role of ferro alloys in iron and steel industries. Advances in iron making.

Met/T/314 CHEMICAL KINETICS & MASS TRANSFER

Chemical Kinetics:

Introduction. Homogeneous and Heterogeneous chemical reactions. Molecularity and Order. Elementary and Nonelementary reactions. Reversible and irreversible reactions. Reaction mechanism. Temperature dependence of rate: Absolute reaction rate theory and Collision theory. Arrhenius equation, Concept of Activation energy. Types of reactor, Interpretation of constant – volume and variable-volume batch reactor data. First-order, Second-order and Zero-order reactions. Reactions in series and in parallel. Determination of order.

Mass Transfer:

Mass transfer in fluids: Mass molar fluxes in a fluid, Equations of diffusion with convection in a binary mixture A-B, Fick's first and second law of diffusion, One-dimensional steady state diffusion through a stagnant film, Equimolar counter-diffusion, Diffusion into a falling film of liquid. Convective mass transfer, Mass transfer coefficient and Concentration boundary layer on a flat plate, approximate integral method, Mass transfer correlations.

Mass transfer in solids: One-dimensional non-steady-state diffusion in a solid. Gas-solid reactions with moving interface. Spherical, cylindrical and rectangular and different rate-controlling mechanisms, reduced time plots, analysis.

Met/T/315 ELECTRO-CHEMISTRY, CORROSION

Principles of Electro-Chemistry, Nernst's equation, Half-cell reaction, Cathodic and Anodic over voltage, Tafel equation, potentiometric and conductometric titration.

Theories of Corrosion: different forms, passivity, protection, control, Pourbaix diagram. Corrosion of iron and steel.

Laws of oxidation, Oxides and their characteristics. Kinetics of oxidation of iron and its alloys.

Met/Gen/T/316 ENGINEERING ECONOMICS

Engineering economics and its importance, Want-Activity, Laissez Faire Factor of production, Elasticity of demand etc, Industrial costs, Money, Inflation and deflation. Role of commercial Banks, Source of finance. Industrial record keeping, profit and loss account. Balance sheet. Industrial costs and their classifications. Depreciation, overhead cost etc.

Accounting concepts. Pricing of issue of materials, Pricing inventory. Labor cost - different wages and bonus schemes. Determination of costs - cost sheet: marginal costing, cost versus profit relationship, breakdown point, margin of safety. Budgeting, budgetary control, flexible budgetary. Project feasibility, IRR, NPV, payback, accounting relations.

Met/S/311 VIVA-VOCE I

Based on Third year first semester theory and sessional subjects.

Met/S/312 PHYSICAL METALLURGY LABORATORY-II

1. Comparative study of microstructure of annealed steel (Hypo eutectoid, Eutectoid, Hyper eutectoid) and variation of hardness.
2. Micro hardness testing of Ferrite and pearlite in annealed 0.4% C Steel.
3. Microstructure of Cast Iron (Gray, White, Nodular).
4. Microstructure of eutectic alloys Al-Si, Pb-Sn, and Pb-Sb.
5. Microstructure of wrought and annealed single-phase alpha brass & Aluminium.
6. Recovery, Recrystallisation and Grain growth of cold worked copper.

Met/S/313 ELECTROCHEMISTRY CORROSION LABORATORY

1. Calibration of pH meter.
2. Conductometric titration.
3. Potentiometric titration.
4. Electroplating.
5. Verification of Reversibility of Electrochemical cells.
6. Galvanostatic polarization.
7. Potentiostatic Polarization.
8. Oxidation kinetics.
9. Rates of corrosion under different conditions.
10. Stress corrosion behaviour of metals & alloys.

Met/S/314 MECHANICAL TESTING LABORATORY

1. Hardness testing of common metal and alloys & their correlation with tensile properties.
2. Stress-strain diagram for common metals and alloys.
3. Compression testing.
4. Impact testing by Izod and Charpy method including transition temperature determination.
5. Erickson Cupping test, Bend test.
6. Fatigue testing.
7. Fracture toughness testing.
8. Hot torsion testing.

Third Year Second Semester

Met/T/321 STEEL MAKING

Introduction to steel making. Thermodynamic principle of steel making. Applications of alternative standard states and interaction coefficients in steel making problems. Slag

theories.

Conventional steel making process: Bessemer, Open Hearth, Electric, Arc, and modified conventional process Basic oxygen Furnace Process: LD, Kaldo and Rotor, LDAC, OBM and Combined Blowing /Bath Agitated, Other recent processes.

Secondary steel making: deoxidation, desulfurization and degassing. Solidification of steel-Ingot defects (inclusions, blowholes, segregations etc.) and remedies. Continuous casting.

Met/T/322 FOUNDRY METALLURGY

Introduction to Foundries. Types of foundries. Layout of foundries. Introduction to casting production. Sand casting and non sand casting processes. General sand casting processes – green, dry, skin, loam, pit, shell, CO₂, chemical bonding. Special casting processes – Die, gravity die, investment, ceramic, plaster full mold, centrifugal. Sand molding materials – sands, binders and additives. Their properties, selection and measurement. Mechachanization of molding – jolting, squeezing and slinging. Flask less molding. Core blowers. Patterns – types and related design including allowances. Bonding and bond mechanisms – electro static, hydraulic and chemical bonds. Selection of clays.

Solidification of cast metals – Dendritic solidification, segregation and the cast structure. Hot tears. Inclusions and porosities. Long freezing range and short freezing alloys – examples of steel and brass. Riser design – Modulus method, Chovorinov rule, Ruddle model, placement of riser. Feometry and types. Gating design – laws of continuity, Bernoulli's equation, and Reynolds number. Types and aspiration correction. Design of a plate casting gating.

Cast Irons – types and nomenclatures. Fe-C diagram (C.I. portion). Cast iron production – Cupola and its operation, Malleablising etc., Nodular iron. Melting furnaces – electric arc, Induction etc. Non-ferrous alloys – brass, bronze and silumin alloys. Phase diagrams and grain fineness. Fettling and cleaning. Casting defects. Casting design rules.

Met/T/323 HYDRO & ELECTRO METALLURGICAL EXTRACTION PROCESSES

Unit processes in Extractive Metallurgy- special reference of Oxide. Sulphide, Chloride ores. Physical and chemical aspects of leaching, types of leaching equipments etc. Enrichment techniques, solvent extraction, ion exchange, etc. Recovery of metals- electrolytic precipitation, cementation& others. Application of principle to Zn, Al, Cu, U, Ni,Cr, etc.

Electrode processes in aqueous, non-aqueous and fused salt systems and their different factors. Electro-deposition technique, plating, forming etc. Electro-winning of Cr, Mn, Co, Cu, Zn, etc.

Met/T/324 PHYSICAL METALLURGY – III

Iron – Carbon equilibrium diagram- transformation in steel, kinetics of transformation, TTT & CCT curves. pearlitic transformation with different factors. characteristic of

bainitic transformation, characteristics of martensitic transformation with stabilization and micro associated phenomena, effects of alloying elements on micro structure. Hardenability. Different heat treatments- Annealing, Normalizing, Hardening, Tempering surface treatment etc. Thermo mechanical treatments. Different heating atmospheres and salt baths. Carburizing, nitriding and its varieties, and induction hardening. Moralizing processes.

Met/T/325 TESTING OF MATERIALS & QUALITY CONTROL

Purpose, interpretation of testing methods, sampling.

Destructive testing – Hardness Tests: Brinnell, DPH, Rockwell etc.; Tensile testing with associated parameters; Impact Testing; Creep testing; fatigue testing; Torsion testing etc. Fracture toughness testing (K_{Ic} , CTOD, J-integral etc.)

Non-destructive testing: Magnetic, ultrasonic, radiographic etc. Inspection methods. Introduction to SQC techniques.

Met/T/326 PHYSICS OF METALS

Crystals, symmetry elements, symmetry groups, atomic packing, crystal structure, planes of a zone, stereographic projection, calculations. Structure of metals and alloys.

Free electron theory, density of states, Fermilevel, electrical conductivity of metals, zone theory, Brillouin zones, conductors, semiconductors and insulators.

Magnetic properties, dia- magnetism, para-magnetism and ferro-magnetism etc. Bohr magnaton, Domain theory, magnet materials, B-H curves. Superconductor.

Met/S/321 VIVE-VOCE II

Based on Third year second semester theory and sessional subjects.

Met/S/322 FOUNDRY METALLURGY LABORATORY

1. Grading of sands for selection in foundry purpose.
2. Determination of mechanical strength like GCS, DCS etc. of molding sand mixtures.
3. Determination of permeability of molding and mixtures.
4. Sand molding practice for production of moulds (two patterns)
5. Core making practice.

Theories for experiments 1 to 5 to be covered in the laboratory.

6. Study of different types of patterns.
7. Production of casting using sand moulds, metal moulds.
8. Melting practice of metal & alloys.
9. Gating design and calculations of gating parameters in sand moulds
10. Modulus method of risering in sand castings.
11. Determination of moisture content in molding sand.
12. Casting of metals in non-sand practice and cast metal structures.
13. Identification of casting defects.

Met/S/323 PHYSICAL METALLURGY LABORATORY-III

1. Effect of carbon and cooling rate of annealing normalizing, oil quenching, water quenching on microstructure and hardness of steel.
2. Hardenability
3. Tempering of hardened steel.
4. Overheated, burnt, Widmanstatten structures in steel.
5. Microstructure of heat-treated brasses. Stainless steel, High Speed steel.
6. Heat treatment practice of carbon tool steel.
7. Age hardening of Aluminium.
8. Quantitative Metallography.

Met/S/324 COMPUTER APPLICATION FOR METALLURGICAL SOLUTIONS LABORATORY

1. Draw an electric furnace by CAD: given outer and inner dimensions – 3 lab days.
2. Draw a layout of an H.T.shop/Foundry shop by CAD. – 3 lab days.
3. Develop a small project to determine materials output (Metal, slag, gasses etc.) from given materials input (Ore, coke, fluxes, air etc.) by writing a computer programme. – 3 lab days.
4. Develop a small project to determine heat output (Metal, slag, gasses etc.) from given heat input (Ore, coke, fluxes, air etc.) by writing a computer programme. – 3 lab days.
5. Develop a software to find the reaction mechanism of a solid-gas/solid-liquid/liquid-gas metallurgical reaction from the given data input of fraction reacted at different temperature and time by reduced time plots(TC). – 3 lab days.
6. Calculate d-values and lattice parameter from given data. 3 lab days.
7. Calculate intensity of diffraction lines from the given data. 3 lab days.

Fourth Year First Semester

Met/T/411 PYROMETALLURGICAL EXTRACTION OF NON-FERROUS METALS

Introduction to non-ferrous metals processing. Classification of processes on the basis of unit operation and unit processes. Physico chemical aspect of gas-solid reaction system: roasting, calcinations. Classification and design aspects of roasting process and equipments. Thermodynamics of reaction – consideration of Ellingham diagram, predominance area diagram etc.

Liquid-liquid reaction system like – conventional reduction smelting, matte smelting, oxidizing smelting & metallothermic smelting.

Refining techniques: Liquation zone, distillation, oxidizing refining, chlorination, sulphidizing, carbonyl refining, intermetallic compound forming, electrolytic refining etc.

Extraction of Pb from sulphide ore, Blast furnace smelting, Modern development in lead smelting. Flash smelting, direct smelting, TBRC smelting. Refining of Pb bullion and recovery of precious metals from lead bullion.

Extraction of Zn from sulphide: Retort reduction, Imperial smelting process, refining of Zn. Extraction of Ni from sulphide: INCO process, Mond Carbonyl process.
Extraction of Cu from sulphide, Matte smelting, flash smelting, converting, Continuous copper making: WORCRA, Normandy Mitsubishi process and refining of Cu.
Extraction of Sn from oxide, reduction smelting, electro-thermic smelting and refining.
Extraction by halide metallurgy: Ti, Zr, U.
Special reduction smelting: Mg, Nb etc.
Extraction of refractory metals from ores & concentrates – Ti, W, V, Mo etc.

Met/T/412 METAL WORKING PROCESSES

Concepts of stress & plastic state of deformation – principal stress, normal stress, hydrostatic stress, shear stress etc., Yield Criteria – Von Mises & Tresca.
Elements of metal deformation processes – Rolling: hot rolling & cold rolling; Forging: open die forging, closed die forging & press forging; Extrusion: direct, indirect & Aluminium extrusion; Wire drawing; Sheet metal working; Stretch forming for foils.
Deformation load calculations. Defects & limitations, Comparison of metal working & shaping processes.

Met/T/413 MATERIAL SCIENCE

Refractories: Classification, properties, testing of refractory. Structure of solids - NaCl type, Zinc blende, corundum, Spinel, Perovskite, CsCl type and fluorite type. Types of refractories; silica, aluminosilicate, high alumina, magnesite, dolomite and pure oxide refractories. Application of refractory materials in metallurgical processes in steel plants etc. Special ceramics - ferroelectrics and ferrites.
Non-crystalline solids: glass-ceramics, non-oxide ceramics, Introduction to polymeric materials and nanostructured materials.

Met/T/414 TECHNOLOGY OF ALLOY STEELS

Alloy steel making processes-special reference to stainless steels, high speed steel, manganese steel and other special steels. Thermodynamics and kinetics of alloys steel making. Defects and remedies. Post solidification treatments, Secondary alloy steel making techniques.
Role of alloying elements in Steel-Equilibrium diagrams etc. Structure and properties. Alloy classification and families- Stainless steel, High speed steel etc. Heat treatment of different alloy steels, special heat treatment processes, atmospheres etc. Tool steels, bearing steels.

Met/T/415 ELECTIVE – I

1. HEAT TREATMENT TECHNOLOGY

2. ELECTRONIC MATERIALS

3. POLYMERIC MATERIALS

Met/T/415A HEAT TREATMENT TECHNOLOGY

Importance of atmosphere: exothermic, endothermic, hydrogen, inert, salt bath, vacuum, Protection against oxidation against oxidation and decarburization. Heat treating furnaces and associated atmosphere control equipment, heat sources and conveyorised operations, cleaning and quenching equipments, temperature control, hardening quenching media and cooling rates in steel, alloy steel, and non ferrous alloys. Austenite grain size and its control. Failures and defects associated with heat treatment.

Met/T/415B ELECTRONIC MATERIALS

Introduction of FE Theory & Bond theory of Solids, Conductivity from FE theory. Development of structure- property relationships for ceramic and other materials used in a wide variety of electronic devices, dielectric relaxation and ferro-electrics with phenomenological approach; electrical and magnetic properties as related to device performance; the materials aspects of hybrid microelectronics. Insulator materials, capacitor materials, electro-optic materials, ferrites, sensor materials, varistors etc.

Met/T/415C POLYMERIC MATERIALS

Introduction; Basic structure of polymers – classification: Schemes, Bonding & networking Physical states & Transitions; Polymer formation; polymerization process; molecular wt. of polymers; viscous flow & mechanical properties of small deformation; ultimate properties, Design criteria- compounding, hardness, density, thermal & electrical properties; degradation & stabilization of polymer systems ; fabrication process; carbon chain polymers; hetrochain polymers; analysis and identification of polymers; polymer based composites.

Met/S/411 VIVA-VOCE III

Based on fourth year first semester theory and sessional subjects.

Met/S/412 MATERIALS LABORATORY

1. Dilatometric analysis of phase transformation.
2. Electrical property measurements of materials in Thirus Cryostat.
3. Refractory testing (PCE, RUI)
4. Sol-Gel processing for the material preparation.
5. True & apparent porosity measurements of bricks.
6. Magnetic properties of materials.

Met/S/413 SEMINAR

Based on topic assigned by the department.

Met/S/414 PROJECT & REPORT

On the basis of project topic assigned by the department and work by the student(s) as directed by teacher/supervisor.

Fourth Year Second Semester

MNG/ME/T/1 INDUSTRIAL MANAGEMENT

Growth of Industries, Management thoughts and scientific management, Taylorism; Factory system of production, Introduction to management problems, Types of manufacture, Planning analysis and control aspects in industries.

Types of business ownership, means of finance and business combinations, organization structures, committee organization, authority and responsibility, duty and span of control. Plant location, factory buildings and physical facilities, plant layout, tools and techniques of plant layout, materials - handling arrangements. Product development, standardization, simplification and diversification.

Functions of production, planning and control, production forecasting, production scheduling and network techniques, Gantt chart, CPM, PERT etc.

Work study, job evaluation and merit rating; purchase system and inventory control.

Inspection and quality control of systems, statistical quality control, maintenance and replacement policies for machine and equipments; decision making theories, breakeven analysis cost benefit analysis, evaluation of financial and managerial efficiencies.

Introduction to operational research techniques. Application of fuzzy logic in modern management concepts. Human relations in industry and labour compensation. Personnel management, provision of industrial legislations in India. Wage and salary administrations. Welfare and safety provisions, trade union acts. Study of environmental impacts and environmental laws.

Text Book:

Production and operations management: S.N.Chari

Reference books:

1. " Industrial Management" by: Basu & Majmundar (Birla Pub., Newdelhi)
2. " Quantitative techniques in management" by: N.D.Vohra (Tata Mcgraw Hill)
3. "Production systems analysis and control" by : Riggs
4. "Works organization and management by: Basu, Sahoo & Dutta.
5. Fuzzy logic with Engineering applications: Timothy J. Ross (Mcgraw Hill)

Met/T/422 X-RAY & ELECTRON MICROSCOPY

Stereographic projection. Reciprocal lattice concepts. Generation of X-Ray. Continuous and characteristic spectrum of X-ray. Filters. Coherent scattering and diffraction under nonideal conditions. Intensity of diffracted beams, Laue & Powder method. Indexing of cubic and non-cubic crvstals. Application: precise Lattice parameter determination.

solvus determination, chemical analysis, preferred orientation and texture determination, particle size determination. Electron microscopy principles, thin film and replication techniques, nature of contrast from dislocations stacking faults and second phase particles.

Met/T/423 METAL JOINING & POWDER METALLURGY

Powder metallurgy – Powder production methods, powder characterization, compaction, sintering and relevant theories, application of powder metallurgy, a few typical powder-metallurgy products.

Joining of metals and alloys by differing joining methods, physics of welding, metallurgy of welding, brazing soldering etc. Defects of welding and testing of weldments. Fracture mechanics of welded structures, concepts of weldability.

Treatment of metal finishing and repairing techniques e.g galvanizing, phosphating and protective coating, hard facing etc.

Met/T/424 ELECTIVE II

1. PRODUCTION OF FERROALLOYS

2. THEORY OF METALLURGICAL PROCESSES

3. NANOPHASE MATERIALS

Met/T/424A PRODUCTION OF FERROALLOYS

Basics of ferroalloys production – concepts, thermodynamic principles & techniques. Existing production processes of important ferroalloys. Fe-Cr, Fe-Mn, Fe-Si, Recent advances in ferro-alloy technology. Fe-W, Fe-Mo, Fe-V, Fe-Nb, Fe-Ti, Fe-B, Ca-Si etc.

Met/T/424B THEORY OF METALLURGICAL PROCESSES

Review of previous study of thermodynamics.

Behaviour of solutions-Different models.

Activity coefficients and interaction coefficients in multi component metallurgical system, Alternative standard states. Gibbs Phase rule & its applications in multicomponent and multiphase metallurgical systems. Construction of stability diagrams.

Arrhenius equation, absolute reaction rate theory, concept of activation energy.

Introduction about heterogeneous kinetics.

Generalized diffusion equation, Fick's first and second law, Steady state diffusion through flat plate, hollow cylinder and spherical shells. Pseudo steady state, diffusion through flat and spherical shapes, unsteady state diffusion.

Convective mass transfer, concept of mass transfer coefficient.

Mass transfer between two fluids.

Identification of rate controlling mechanism in a heterogeneous chemical reaction.

Problems.

Met/T/424C NANOPHASE MATERIALS

Introduction; Preparation of Nanophase materials – Sol-gel, electro-deposition, plasma assisted deposition, molecular beam epitaxy; polymers in advanced nano composites; ultra thin film preparation of metal oxide.

Role of reduced site and dimension of materials properties, Nano- physics.

Material characterization & synthesis – XRD, TEM, SAD. Auger & X –ray photoelectron Spectroscopy.

Met/T/425 MATERIAL ENGINEERING

Detailed description and metallurgy of following metals and their alloys-specifications, properties and applications - Cu, Al, Ti, Mg and super alloys. Metallics for special applications: Bearing, cryogenic, aerospace, nuclear, cutting tools, etc.

Materials for electrical contact, heating element, thermocouples, antifriction, magnetic materials, reactor, heat resistance, cryogenic purpose.

Met/T/426 GENERAL VIVA VOCE

Based on the theory and sessional subjects covered under B. Met. E. Programme.

Met/S/421 EXTRACTIVE METALLURGY LABORATORY

1. Determination of the standard Free Energy changes of decomposition of carbonates and oxides.
2. Determination of the standard free energy change of the reaction $\text{CO}_2 + \text{C} = 2\text{CO}$.
3. Kinetics of oxidation of sulfides.
4. Extraction of copper by carbothermic reduction of copper oxide.
5. Preparation of sponge iron by reduction of Ferric oxide pellets with $\text{CO} - \text{CO}_2$ mixtures.
6. Calibration of capillary flowmeters with the help of a rotameter.
7. Determination of thermodynamic properties (Partial molar enthalpies and entropies) of metallic solutions by calorimetric methods.
8. Extraction of Zinc by hydrometallurgical and electrometallurgical routes.

Met/S/422 X-RAY & ELECTRON MICROSCOPY LABORATORY

1. Problems in stereographic projection.
2. Indexing and lattice parameter determination by Debye Scherrer method.
3. Quantitative analysis by diffractometry.
4. Problem on orientation determination using stereographic projection and Laue technique.
5. Specimen preparation for TEM: replica & thin film.
6. Study of SEM.

7. Fractography study by SEM.

Met/S/423 MATERIALS PROCESSING LABORATORY

1. Macrostructure of weldment and finding out of the bead profile, percentage dilution and width of heat affected zone (HAZ).
2. Effect of various welding parameters such as welding current, welding speed etc, on bead height, bead width, penetration and width of HAZ.
3. Effect of welding heat- input on microstructure and hardness of weld metal and HAZ.
4. Inspection of various welding defects by NDT.
5. Weldability test.
6. Effect of compacting pressure on grain density of metal powders.
7. Characteristics features of sintering of metal powder compacts.
8. Metal powder characteristics like bulk density, true density etc.

Met/S/424 PROJECT & VIVA-VOCE

On the basis of project topic assigned by like department and the work done by the student(s) as directed by teacher- supervisor.