First Year First Semester

Met/Chem/T/111   CHEMISTRY-I

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; NOx, SOx, 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.

Met/CSE/T/112   COMPUTER PROGRAMMING

Writing flow chart, Fortran language, details of format, do loops subprogrammes, subroutines, 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.

AM/ME/T/1A    ENGINEERING MECHANICS

Statics:
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.
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.
12. To determine co-efficient of viscosity by Capillary flow method.
14. To draw mutual and anode characteristics of triode and hence too fine Rp, μ, and gm
15. To draw the transistor characteristics (NPN/PNP) in the given configuration and
hence to find hi, hfe
16. Determination of refractive index of the material of the glass prism by prism
    spectrometer (for at least two ?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.
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 dillution, 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 pint and depression of freezing point-experimental methods of their determination, Laws on coligative properties . Determination of Molecular Weight of substances in dilute solution and their limitation.
Viscosity with determination of viscosity.

**Met/Math/T/122  MATHEMATICS-IIN**

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 break 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.

**Ph/S/2  PHYSICS LABORATORY-II**

(Selected Experiments from the following)

1. Determination of Galvanometer resistance by half - deflection 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 Carev 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.
12. To determine co-efficient of viscosity by Capillary flow method.
14. To draw mutual and anode characteristics of triode and hence too fine Rp, μ, and gm
15. To draw the transistor characteristics (NPN/PNP) in the given configuration and
    hence to find hi, hf
16. Determination of refractive index of the material of the glass prism by prism
    spectrometer (for at least two ?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, planning
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 Fe2O3 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
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
5. Development - Conceptions of and approaches to development - The Roles of State and the Market in the Development
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, Log mean area, use of Gurney Lurie chart.

**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.
Polarized 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; Floatation principles and froth flotation; dewatering, magnetic separators. Pollution in beneficiation plants & control steps.

**ETech/EE/T/A ELECTRICAL TECHNOLOGY-A**

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-I IIN


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
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.
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.

Second Year Second Semester

Met/CSE/T/221 NUMERICAL ANALYSIS


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, caol washing, briquetes 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 systems and efficient methods of heat recovery. Fuel testing.

**Met/T/223  PHYSICAL METALLURGY-I**


**Met/T/224  THERMODYNAMICS OF MATERIALS**

Introduction. Types of System State functions and Path functions. Reversible and irreversible process.
2nd Law of thermodynamics: Carnot cycle, Entropy, Concept of equilibrium.
3rd Law of thermodynamics.

**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.


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.

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.
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.
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**


**Met/T/312 PHYSICAL METALLURGY-II**


**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:


Mass Transfer:


**Met/T/315 ELECTRO-CHEMISTRY, CORROSION**


**Met/Gen/T/316 ENGINEERING ECONOMICS**

**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.
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.
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
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**


**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

**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 ($K_{1c}$, CTOD, J-integral etc.)
Non-destructive testing: Magnetic, ultrasonic, radiographic etc. Inspection methods. Introduction to SQC techniques.

**Met/T/326 PHYSICS OF METALS**


**Met/S/321 VIVE-VOCE II**

Based on Third year second semester theory and sessional subjects.

**Met/S/322 FOUNDRY METALLURGY LABORATORY**

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.
9. Gating design and calculations of gating parameters in sand moulds
11. Determination of moisture content in molding sand.
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.
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 sold-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.

**Met/T/412 METAL WORKING 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**


**Met/T/415 ELECTIVE – I**

1. **HEAT TREATMENT TECHNOLOGY**
2. **ELECTRONIC MATERIALS**
3. **POLYMERIC MATERIALS**
**Met/T/415A  HEAT TREATMENT TECHNOLOGY**


**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, ferities, 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.

**Met/S/413  SEMINAR**

Based on topic assigned by the department.
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.


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
5. Fuzzy logic with Engineering applications: Timothy J. Ross (Mcgraw Hill)

Met/T/422    X-RAY & ELECTRON MICROSCOPY

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.

Arrhenious 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**


**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 \( \text{CO}_2 + \text{C} = 2\text{CO} \).
4. Extraction of copper by carbothermic reduction of copper oxide.
5. Preparation of sponge iron by reduction of Ferric oxide pellets with CO – 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.
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.