Paper III: Industrial Chemistry

Group -A Theory- Full Marks : 75

Unit I : Materials Science *(Marks 10)*

- Concepts of Materials Science, Introduction to Engineering Materials, Introductory idea of Crystal structure & Crystal imperfections. Concept of amorphous, single and polycrystalline structures and their effect on properties of materials.

- Structure, properties, preparation and uses of alumina, silica, silicates, clays, mica, carbon, zeolities. Mechanical properties of materials and change with respect to temperature. Important materials and alloys of iron, copper, aluminium, nickel, titanium. Introductory idea on nanomaterials.

Unit II : Ceramic Technology 1

(Marks 15)

- ***Cement:***

  Portland cement and its manufacture: Historical development, types of Portland cement and its derivatives, Cement compounds and their contributions, methods of manufacture, dry process, wet process and semi-dry process, sequence of operations-winning of raw materials, size reduction, storage of crushed materials, grinding of raw mix, burning the ground mix to clinker, cooling of hot clinker, grinding the clinker mixed with gypsum, setting mechanism and testing of cement. Blended fly ash and BF slag cement. High alumina cement, Cement industries in India.

- ***Glass:***

  Historical development, structure of glass, nature and types of glass-fused silica, sodalime, boro-silicate, lead special and optical glasses. Raw materials and their properties, glass melting in tank and pot furnace, sequence of operations and major engineering problems, shaping container ware, flat-glass, glass tubes, fibre glass, glass-lined steel , properties of

glass. FRP, tempered glass, laminated glass. Glass Batch Calculations, Testing of glass, Glass industries in India.

Unit II : Ceramic Technology 2 (Marks 15)

- ***Ceramics:***

  Historical development, Raw materials-their composition, occurrence and properties. Manufacture of white ware, Fabrication methods-soft mud and stiff mud process, slip casting, drying and firing of ceramic products. Ceramic products-whiteware, earthenware, porcelain, sanitaryware, chemical stoneware, glazes and its calculations, advanced polymer based ceramic products, ceramic coating, testing of ceramic products. Ceramic industries in India.

- ***Refractories :***

  Classifications of refractories, raw materials- their composition, occurrence and properties; manufacture-preliminary treatment of raw materials, blending, forming, drying firing, quality control. Nomenclature of refractory products-acid, basic, neutral, special, insulating, monolithic. Testing of refractories. Applications in industry. Refractory industries in India.

Unit III : Metallurgy (Marks 20)

- Basic divisions: Pyrometallurgy, hydrometallurgy and electrometallurgy, basic metallurgical operations -Pulverisation , Calcination, Roasting , Refining, Smelting.

- Meatllurical thermodynamics: Application of thermodynamics in metallurgy. Ellingham and kellog diagram. Gibb's phase rule, Iron Carbon equilibrium diagram for eutectoid and pro-eutectoid phases. Lever rule. Nature of cooling curves for Fe-C system.

- Physico-chemical principles & details of extraction as per Indian context of the following metals; Copper, Lead, Silver, Aluminium, Zinc.

- Production of Iron in blast furnace-Raw materials, charging and sequence of operations, casting , operation of pig casting machine.

- Production of semi-killed and killed steel in steel melting shop (LD process)- mixing of raw materials, charging sequences, operation in converter, blowing, tapping and testing process, timing in pit side, holding and stripping operations.

- Continuous casting of semi-finished steel products.

Unit V : Fuels & Furnaces *(Marks 15)*

- ***Fuels: Solid fuels***-Wood, Charcoal, Origin of Coal and its types, Formation of peat, lignite, bituminous, anthracite. Properties and Grading of Coal. Destructive distillation processes / pyrolysis & carbonisation- coke and by products, coal tar.

- ***Gaseous fuels****:* Natural gas, LPG and other fuel gases-water gas, producer gas, coke oven gas, combustion calculations.

- ***Furnaces:*** Fuel, Fired and Electric; uses in different industry, control of Furnace and waste heat utilisation, waste heat boiler. Heat balance computation.

Group B : Laboratory Practical & Sessional Full Marks 25

Unit I- Experiments on Physical & Organic chemistry *(Marks 20)*

- Lab techniques, Preparation of standard solution, Determination of Refractive Index, Partition Coefficient ,Surface tension and viscosity .

- Determination of melting point of an organic compound, Determination of functional groups e.g. NO_2, NH_2, COOH, CHO, >CO, OH (Phenolic).

Unit II - Water Analysis *(Marks 5)*

- Hardness, TDS, BOD, COD, Dissolved Oxygen .

Recomended Books:

Materials Science :

1. Principles of Materials Science & Engineering-William F. Smith, Mc-Graw-Hill Inc. N.Y.New Delhi, Singapore etc.

2. Materials Science & Engineering : An Introduction ,6th edition - William D. Callister, Jr

3.Materials Science & Engineering, A First Course,- V. Raghaban, Prentice Hall of India Pvt. Ltd., New Delhi-110001

Ceramic Technology:

1. Elements of Ceramics- F.H. Norton, MC-Graw -Hill Books Co., New York, London

2. The Chemistry of Cement and Concrete- F.M. Lea, Edward Arnold (Publishers) Ltd.

3. Introduction to Glass Science & Technology- James E. Shelly, The Royal society of Chemistry, Turpin Distribution Services Ltd., Blackhorse Road, Letchworth , Herts, 1HN.

4. Refractories- F. H. Norton, Mc-Graw-Hill Book Company, New York, London.

5. Industrial Chemistry- B.K.Sharma, Geol Publishing house, Meerut-250001,U.P.

Metallurgy:

1. Extraction of Nonferrous Metals- H.S.Ray, R. Sridhar, K.P. Abraham, Affiliated East-West Press Pvt. Ltd., New Delhi.

2. Principles of Extractive Metallurgy- H.S. roy and A. Ghosh - New Age International (P) Ltd., Publishers, New Delhi.

3. Engineering Chemistry- P.C. Jain & Moni Jain, Dhanpat Rai Publishning Co.P. Ltd., New Delhi.

4. Industrial Chemistry- B.K.Sharma, Geol Publishing house, Meerut-25001,U.P.

Fules & Furnace

1. Fuels & Combustion -Samir Sarkar, Orient Longman Ltd., Hyderabadad 500029, A.P.

2. Engineering Chemistry- P.C. Jain & Moni Jain, Dhanpat Rai Publishning Co.P. Ltd., New Delhi.

3. Industrial Chemistry- B.K.Sharma, Geol Publishing house, Meerut-25001,U.P.

Paper IV: Industrial Chemistry

Theory- Full Marks : 75

Group-A

Unit I : Chemical Engineering -I SPG (Marks 20)

Units and dimensions, Process calculations (materials balance and energy balance, phase equilibria)

Unit II : Chemical Engineering -II (Transport Process and unit operations)

SPG (Marks 35)

- ***(1) Fluid mechanics :***

Concepts and definitions, Nature of fluid statics, differential manometer, viscosity, Reynold's no., Laminer flow, Turbulant flow, Hagen Poiseulle equation, Bernoulli equation, Fanning's equation. Fluid friction, Resistance to immersed bodies, Friction in flow through packed bed. Flow measurements, Orifice meter, Venturi meter, Pitot tube , Rotameter. Transporation of fluids, Pumps , valves and Pipe fittings (Basic and qualitative ideas).

- ***(2) Heat Transfer :***

(a) Basic Laws(For e.g. Fourier's law), Definitions (Thermal conductivity and thermal diffusivity) . Heat transfer in solids and fluids. Heat transfer co-efficient, Driving force, Radiative heat transfer: Basic laws and definitions.

(b) Simple heat exchangers: Double pipe heat exchanger.

(c) Equilibrium limited separation process and rate limited separation process

(d) Basic ideas on (Physical description only) different types of heat transfer situation like natural convection , boiling and condensation.

- ***(3) Mass Transfer and separation process:***

(a) Basic laws(Fick's law) , Concepts of mass transfer co-efficients, interface mass transfer.

(b) Brief physical / qualitative description of different separation processes and equipments.

- ***(4) Mechanical Operations:***

(a) Solids: Size separation, reduction, handling.

(b) Mechanical separation- Filtration, settling.

- ***(5) Reaction engineering:***

CSTR, Plug flow reactors, packed bed reactor, fluisied bed reactors(definition and physical ideas only)

Group-B

Polymer Science and Technology SS (Marks 20)

- ***Chemistry of high polymers*** **:** Monomer , functionality , degree of polymerisation, classification of polymers, Polymerization methods: addition and condensation , cationic and anionic polymerisation, copolymerisation , monomer reactivity ratios and its significance , Polymerisation techniques: bulk , solution, suspension, emulsion.

- ***Brief introduction to the following polymers with respect to synthesis, properties and applications****:*

  Thermosetting Polymers: Phenol-formaldehyde resin, Urea-formaldehyde and Melamine-formaldehyde resins , Epoxy resin.

  Commodity and general purpose thermoplastics: Polyethylene, Polypropylene, Polystyrene, Polyvinyl Chloride, Polyesters, Acrylic, PU polymers .

  Engineering Plastics**:** Nylon , Polycarbonate, Polyphenylene oxide.

  Natural and synthetic rubbers**:** Recovery of NR hydrocarbon from latex, Styrene -Butadiene rubber, Polychloroprene rubber, Nitrile rubber, Butyl rubber, Ethylene-propylene-Diene Terpolymer, Silicone, Thermoplastic Elastomer.

- ***Polymer processing:*** Compression moulding, Extrusion, Injection moulding, Casting, Thermoforming, Vulcanization of elastomers. Polymer industry in India.

Group c : Laboratory Practical & Sessional **Full Marks 25**

Unit I : *(Marks 15)*

- ***Quantitative Chemical Analysis of Ores, Alloys and some industrial products***

  Ores - Limestone, Dolomite, Bauxite, Haematite, Pyrolusite.

  Alloys - Cu-Ni alloys, Brass.

  Products - Cement, Acid value & Saponification value of oil.

Unit II : Materials Testing and characterization *(Marks 10)*

- Hardness and compressive testing of materials, Specific surface area of powders by Blains apparatus. Ultraviolet, Visible and Infrared spectroscopy study to characterize materials, Thermal property study of materials through TGA /DTA and DSC.

Recomended Books:

Chemical Engineering

1. Principles of Unit Opreations- Allan S. Foust, Wenzel and Others, John Wiley & sons, Londong 1980

2. Unit Operations- George Granger Brown- C.B.S Publishers and Distributors, New Delhi, 1995

3. Heat Transfer-B.K. Dutta, PHI Pvt. Ltd

4. Mass Transfer- do- , New Delhi

5. Industrial Chemistry- B.K.Sharma, Geol Publishing house, Meerut-25001,U.P.

Polymer Science and Technology

1. Polymer Science & Technology- Premamoy Ghosh, The Mc-Graw-Hill Publishing Co. Ltd., New Delhi

2. Industrial Chemistry- B.K.Sharma, Geol Publishing house, Meerut-25001,U.P.