

## **1. Assistant Manager (Printing)**

**1. Introduction to Printing Process :** Basics of Print Media & Printing Technique, Digital Printing Technology, Technology of offset printing, Flexography Printing, Principle and Technology of Gravure & Screen Printing, Printing & Technology of offset Printing (Dry-Wet), Principle & technology of Intaglio Printing

**2. Basic Principles of Imaging Techniques:** Pre-Press → DTP, Camera Processing, Conversion to film output- negative, CTP, technology, surface preparation for letterpress, lithography, dry-wet offset, screen, gravure & flexography; Basic concept of printing designs- Layout style, art work, Typography, Symbol & logos, layout and colour etc; Presses → Configuration of machine part and accessories, Dry-Wet offset, flexography, gravure, intaglio, digital and screen printing machines.

**3. Technology Security Printing:** Introduction of security printing, Requirement of security printing, Counterfeiting creation graphics, Types of security product, Overt & Covert features

**4. Security Printing Inks:** Type of Security Printing Inks, Migrating Heat reactive Ink, Erasable & Fugitive Inks, Copy protection & Thermo chromic Ink, Penetrating Ink, OVI & UV Curing Ink, IR Ink, Monochromic Ink, Water Resistant & Invisible Phosphorescent Ink tec

**5. Security Substrates:** Security Fibers, Planchettes, Fluorescent Hi-Lites, Iridescent coating, Security threads, Holographic foil, Colour Centered paper, Chemically Void, Toner fused Paper, Visible security fibers, Invisible fluorescent fibers and Other security papers.

**6. Print Processes used in Security Printing :** Printing Processes such as Gravure, Offset, Intaglio, Flexo, Letterpress, Screen, Variable Data Printing, Software and Digital printing equipment used for variable data printing, Recent trends and developments in security printing, Process of Gravure, offset, Intaglio, Flexo Image Carrier, Inking, Drying and Impression system of offset, Intaglio, Flexo etc.

**7. Printing Electronics :** Materials in Printed Electronics, Basic Electronic components, Printing Process used for printing electronics, Impact Printing Processes: Offset, Screen, Gravure, Flexography, Non-impact printing processes-Inkjet Drop on demand for production of PE, scope and limitations, Printed Electronics Applications, Advances and Future Trends.

**8. Maintenance Management of Printing Machines:** Printing machine technology in sheetfed & Webfed Offset Printing Machines, Flexography Digital Printing Machine, Maintenance Management, Preventive Maintenance, Corrective Maintenance, Quality and Safety in Maintenance, Predictive Maintenance Techniques, Breakdown Maintenance and Reconditioning and Replacement Theory

**9. Management information System and Cost:** Basics concepts of Management, Basics of MIS, Requirement & Types of MIS, Enterprise Management Systems, Costing & Estimation, Print Production Planning and Control

**10. Knowledge of computer system Microsoft Office, Excel etc.**

**11. Industrial Management.**

**12. Pollution from printing, CNC M/Cs in printing, Tooling**

**13. Others -** • ISO standards • Quality Management 7QC tools. SPC/SQC Techniques • Calibration, Gauging, Digital Measurements • Safety Guidelines, Factory Act, • Environment Aspects , Discharge and their control • Industry 4.0 • Engineering Mathematics + Engineering Drawing • Material handling • BS Standards for materials & Material testing

## **2. Assistant Manager (Electrical)**

**1. Electronic Machine & Drives:** Line-Commutated and Active PWM Rectifiers, Electrical Drives, Electrical and Hybrid Vehicles, Electrical Machine Design, Power System Protection, HVdc Transmission Systems, Power Quality and FACTS, High Voltage Engineering, Electrical Energy Conservation and Auditing, Industrial Electrical Systems, Power System Dynamics and Control, Digital Control Systems, Digital Signal Processing, Computer Architecture, Electromagnetic Waves, Computational electromagnetics, Control Systems Design, Advanced Electric Drives

**2. Electric Circuits and Electromagnetic Fields:** Electrical Circuit Analysis, Analog Electronic Circuits, Electrical Machines, Electromagnetic Fields, Digital Electronics, Power Electronics, Signals and Systems, Power Systems, Control Systems, Microprocessors, Electric and Electronic Measurements, Analog and Digital Electronics

**3. Mathematics:** Linear Algebra, Calculus, Differential Equations, Complex Variables, Probability and Statistics, Engineering Mathematics

**4. Knowledge of Computer System Microsoft Office, Excel etc.**

**5. Industrial Management**

**6. Power factor Control, PLC, SCADA, Substation & Maintenance, Switchgears & Transformers, Mechatronics.**

**7. Others:** ISO standards • Quality Management 7QC tools. SPC/SQC Techniques • Calibration, Gauging, Digital Measurements • Safety Guidelines, Factory Act, • Environment Aspects, Discharge and their control • Industry 4.0 • Engineering Drawing • Material handling • BS Standards for materials & Material testing

## **3. Assistant Manager (Electronics)**

**1. Electronic devices and Digital System Design:** Electronic Devices, Digital System Design, Signal and System, Network Theory, Analog and Digital Communication, Analog and Digital Communication Laboratory, Analog circuits, Microcontrollers, Electromagnetic Waves, Computer Architecture, Control Systems, Computer Network

**2. Electronics:** Microwave Theory and Techniques, Fibre Optic communication, Information Theory and Coding, Speech and Audio processing, Introduction to MEMS, Adaptive Signal Processing, Antennas and Propagation, Bio-Medical Electronics, Mobile Communication and Networks, Digital Image & Video processing, Mixed Signal Design, Wireless Sensor networks, CMOS Design, Power Electronics, Satellite Communication, High Speed Electronics, Wavelets, Embedded Systems, Nano Electronics, Error Correcting Codes

**3. Mathematics:** Linear Algebra, Calculus, Differential Equations, Complex Variables, Probability and Statistics, Vector Analysis, Engineering Mathematics

**4. Knowledge of computer system Microsoft Office, Excel etc.**

**5. Industrial Management**

**6. Mechatronics, VLSI, Cyber Security, Biometric Systems**

**7. Others:** ISO standards • Quality Management 7QC tools. SPC/SQC Techniques • Calibration, Gauging, Digital Measurements • Safety Guidelines, Factory Act, • Environment Aspects, Discharge and their control • Industry 4.0 • Engineering Drawing • Material handling • BS Standards for materials & Material testing

## **4. Assistant Manager (Mechanical)**

**1. Engineering Mathematics:** Linear Algebra, Calculus, Differential Equations, Complex Variables, Probability and Statistics, Numerical Methods

**2. Manufacturing Technology:** Tooling for conventional and non-conventional machining processes, Mould and die design, Press tools, Cutting tools; Holding tools: Jigs and fixtures, Principles, applications and design; press tools-configuration, design of die and punch, Principles of forging die design, Metrology: Dimensions, forms and surface measurements, Limits, Fit and tolerances; linear and angular measurements; comparators; gauge design; interferometry, Alignment and testing methods; tolerance analysis in manufacturing and assembly, Assembly practices: Manufacturing and assembly; Process planning, selective assembly, Material handling and devices

**3. Kinematics and Theory of Machines:** Classification of mechanisms-Basic kinematics concepts and definition-Degree of freedom, mobility; Grashof's law, Kinematic inversions of four bar chain and slider crank chains-Limit positions; Mechanical advantage-Transmission angle- Description of some common mechanisms; Quick return mechanism, straight line generators-Universal Joint-Rocker mechanisms; Displacement, velocity and acceleration analysis of simple mechanisms; Graphical velocity analysis using instantaneous centers; Velocity and acceleration analysis using loop closure equations; Kinematic analysis of simple mechanisms-slider crank mechanism dynamics- Coincident points; Classification of cams and followers; Involute and cycloidal gear profiles, gear parameters; Fundamental law of gearing and conjugate action, spur gear contact ratio; Interference/undercutting-helical, bevel, worm, rack & pinion gears, epicyclic and regular gear train kinematics

**4. Manufacturing Processes:** Casting and moulding, Introduction to bulk and sheet metal forming, Plastic deformation and yield criteria, Fundamentals of hot and cold working processes, Load estimation for bulk forming (forging, rolling, extrusion, drawing) and sheet forming, (shearing, deep drawing, bending) principles of powder metallurgy, Metal cutting: Single and multi-point cutting; Orthogonal cutting, various force components: Chip formation, Tools wear and tool life, Surface finish and integrity, Machinability, Cutting tools materials, Cutting fluids, Coating; Turning, Drilling, Milling and finishing processes, Introduction to CNC machining, Joining/fastening processes: Physics of welding, brazing and soldering; design considerations in welding, Solid and liquid state joining processes; Adhesive bonding; Unconventional Machining Processes: Abrasive Jet Machining, Water Jet Machining, Abrasive Water Jet Machining, Ultrasonic Machining, principles and process parameters; Electricals Discharge Machining, principle and processes parameters, MRR, surface finish, tool wear, dielectric, power and control circuits, wire EDM; Electro—chemical machining (ECM), etchant & maskant, process parameters, MRR and surface finish; Laser Beam Machining (LBM), Plasma Arc Machining (PAM) and Electron Beam Machining

**5. Design of Machine Elements:** Limits, fits and standardization, Review of failure theories for static and dynamic loading; (including fatigue failure); Design of shafts under static and fatigue loadings; Analysis and design of sliding and rolling contact bearings, Design of transmission elements: spur, helical, bevel and worm gears; belt and chain drives, design of springing: helical compression, tension, torsional and leaf springs; Design of joints; threaded fasteners, pre-loaded bolts and welded joints; Analysis and applications of power screws and couplings, Analysis of clutches and brakes

**6. Automation in Manufacturing:** Why automation, Current trends, CAD, CAM, CIM; Rigid automation: Part handling, Machine tools, Flexible automation: Computer control of Machine Tools and Machining Centers, Computer Aided Design: Fundamentals of CAD- Hardware in CAD-Computer Graphics, Software and Data Base, Geometric modeling for downstream applications and analysis methods; Computer Aided Manufacturing: CNC technology, PLC, Micro-controllers, CNC- Adaptive Control; Low cost automation: Mechanical & Electro mechanical Systems, Pneumatics and Hydraulics; Introduction to Modeling and Simulation: Product design, process route modeling, Optimization techniques, Case studies & industrial applications; Sensors and transducers: classification, Development in Transducer technology,

Optoelectronics-Shaft encoders, CD Sensors, Vision System, etc.; Drives and Actuators: Hydraulic and Pneumatic drives, Electrical Actuators such as servomotor and Stepper motor, Drive circuits, open and closed loop control; Embedded Systems; Hardware Structure, Software Design and Communication, Programmable Logic Devices, Automatic Control and Real Time Control Systems; Smart materials: Shape Memory Alloy, Piezoelectric and Magnetostrictive Actuators: Materials, Static and dynamic characteristics; Micromechatronic systems: Microsensors, Microactuators ; Micro-fabrication techniques; LIGA Process: Lithography, etching, Micro-joining etc. Examples thereof.

**7. Microprocessors in Automation:** Number Systems, codes, digital electronics: Logic Gates, combinational circuits design, Flip-flops; Sequential logic circuits design: Counters, Shift registers; Introduction to 8085 Functional Block Diagram, Registers; ALU, Bus systems, Timing and control signals; Machine cycles, instruction cycle and timing states, instruction timing diagrams, Memory interfacing; Assembly Language Programming: Addressing modes, Instruction set, simple programs in 8085; Concept of Interrupt, Need for Interrupts, Interrupt structure, Multiple Interrupt request and their handling; Interfacing Analog to Digital Converter & Digital to Analog converter; Multiplexed seven segments LED display systems, Stepper Motor Control; Introduction to Digital Control: sampling theorem, Signal conversion and Processing, Z-Transform, Digital Filters, Implementation of Digital Algorithm.

**8. Composite Materials:** Definition and applications of composite materials, Fibers-glass, carbon, ceramic and aramid fibres; Matrices- polymer, graphite, ceramic and metal matrices; Characteristics of fibers and matrices; Manufacturing of composite materials, bag moulding, compression moulding, pultrusion, filament welding, other manufacturing processes; Basic assumptions of laminated anisotropic plates, symmetric laminates, angle plylaminates, cross ply laminates, laminate structural moduli, evaluation of lamina properties, determination of lamina stresses;

**9. Core Topics:** Fluid Mechanics and Fluid Machines, Instrumentation and Control, Heat Transfer, Solid Mechanics, Kinematic and Theory of Machines, Internal Combustion Engines, Mechatronic systems, Microprocessors in Automation, Composite Materials, Computer Aided Design, Refrigeration and Air Conditioning, Finite Element analysis, Power Plant Engineering, Gas Dynamics and Jet Propulsion, Process Planning and cost Estimation, Principles of Management, Automobile Engineering, Design of Transmission Systems, Total Quality Management, Energy Conservation and Management, Hoists Lifts , Lifting tackles Testing ,Alloys & Machining, Forming

**10. Knowledge of Computer System Microsoft Office, Excel etc.**

**11. Industrial Management**

**12. Others:** ISO standards • Quality Management 7QC tools. SPC/SQC Techniques • Calibration, Gauging, Digital Measurements • Safety Guidelines, Factory Act, • Environment Aspects, Discharge and their control • Industry 4.0 • Engineering Drawing • Material handling • BS Standards for materials & Material testing

## **5. Assistant Manager (Metallurgy)**

**1. Introduction to Materials Engineering:** Design, synthesis & processing, characterization, applications of materials; Failure analysis & forensics of different types of materials starting from common metals and alloys to exotic materials;

**2. Mechanical properties of Materials:** Strength of materials - Mohr's circle representation, elements of elasticity and plasticity, yield criteria; Deformation of ideal crystal, crystal defects, dislocation theory, dislocations in FCC, BCC, and HCP structures, stress fields and energies of dislocations, forces on and between dislocations, reactions and interaction of dislocations, dislocation-precipitate interactions;

Plastic deformation of single crystals and polycrystals. Strain hardening, cold work, recovery and recrystallization; Effect of grain boundaries, yield point phenomenon, strain ageing, dynamic strain ageing. Tensile flow properties, effects of strain rate and temperature, ductile/brittle transition; Introduction to creep, fatigue and fracture mechanics

**3. Physical Metallurgy:** Phase diagrams — binary and ternary, principles of alloying, Hume-Rothery rules. Strengthening mechanisms — solid solution, work hardening, precipitation hardening, dispersion strengthening; Iron carbon diagram, isothermal and continuous cooling transformation diagrams; influence of alloying elements on transformation characteristics; Heat treatment - annealing, normalizing, hardening and tempering of steels, hardenability; Introduction to important ferrous alloys (stainless and special steels, cast irons), aluminum alloys titanium alloys, copper base alloys; Superalloys, shape memory alloys-classifications, heat treatment, properties and applications.

**4. Materials Chemistry and Characterization:** Chemical analysis to identify and quantify different elements in ferrous and non-ferrous alloys by wet chemistry routes; Chemical analysis to identify and quantify different elements in ferrous and non-ferrous alloys by instrumental methods; Application of chemical analysis to experiments involving mass transfer; Application of chemical analysis to experiments involving extractive metallurgy & corrosion; Application of chemical analysis to experiments involving fluid property measurements; Specimen preparation for scanning electron microscopy, transmission electron microscopy; Control of composition and quality of steel using slags- ferrous slags, physical chemistry of slag metal reactions.

**5. Materials Processing:** Principles of plasticity related to metal forming, cold warm, and hot working, dynamic recovery and recrystallization. Basic metal forming processing such as Rolling, Forging, Extrusion, Wire Drawing, Sheet metal working; Welding versus other joining processes, Welding processes, welding processes, welding metallurgy, TTT and CCT diagrams, carbon equivalent, welding of ferrous and non-ferrous alloys, joining of dissimilar metals

**6. Nanomaterials:** History of nano-materials, Feynman talk -There is plenty of room at the bottom, Synthesis routes for nano and ultra fine grained materials: bottom up and top down approaches; Specific synthesis routes such as vapor deposition, sol-gel, rapid solidification processing, high energy ball milling, cryo rolling, and equal channel angular extrusion; Thermodynamics of nanomaterials; Mechanical property aspects of nanomaterials, inverse Hall-Petch relationship; Specific nano materials and their applications such as: Carbon nanostructures (Nanotubes, nanohoms, graphene, buckyballs etc), Semiconducting nanomaterials - Quantum confinement, Quantum wells, quantum wires and quantum dots, Magnetic nanomaterials - super paramagnetism; Ferroelectric, nano ceramics, Superplasticity, Nanocomposites, Characterization techniques from the perspective of nanomaterials.

**7. Surface Engineering:** Need for engineered surface, definition and principles, Conventional surface hardening methods, Methods involving no change in the chemical composition of the surface, Methods involving change in chemical composition of the surface, Application of advanced techniques such as ion and electron beam towards creating new engineered surface, Controlled high quality surface modification by techniques such as CVD, PVD. Plasma, laser, ion bombardment, Effect of process variables and structure -property correlations, Thermo - chemical, thermo - mechanical and thermal processes, Treatments for industrial components

**8. Powder Metallurgy & Foundry Technology:** Powder production, Powder characterization, Powder treatment, Powder compaction, Pressureless powder shaping, Sintering theory, sintering kinetics, sintering technology, consolidation; Defects in P/M route and their control, treatment of powder metallurgy components, Pattern making, moulding and core making, Metal mould casting, gating and risering, melting; Casting defects and quality control, Heat treatment of castings, Use of CAD CAM in foundries

**9. Phase Transformations:** Definition and types of Phase transformations, Diffusion: Fick's laws of diffusion, solution of Fick's second law and its applications, atomic model of diffusion and role of crystal defects, temperature dependence of diffusion coefficient; Kirkendall effect. Diffusional transformation in solids and diffusionless transformation in solids; Nucleation and growth - energy considerations; homogeneous nucleation, heterogeneous nucleation, growth kinetics, overall transformation rates; Crystal interfaces and microstructure; Microstructure evolution including recrystallization and grain growth; Precipitation from solid solution: Homogeneous and heterogeneous nucleation of precipitates, the aging curve, mechanisms of age hardening, examples from AlCu and other alloy systems; Martensitic Transformations: General characteristics of martensitic reactions, similarity to deformation twinning, bain distortion, crystallography and kinetics of martensitic transformations, examples from ferrous and non-ferrous alloy systems; Order-disorder Transformation Examples of ordered structures, long and short range order, detection of super lattices, influence of ordering on properties; Spinodal decomposition; Machining, Forming Tools, Dies, Punches, Moulds, Inserts, Collets, Heat treatment

**10. Engineering Mathematics:** Linear Algebra, Calculus, Differential Equations, Complex Variables, Probability and Statistics, Numerical Methods

**11. Knowledge of Computer System Microsoft Office, Excel etc.**

**12. Industrial Management.**

**13. Others:** ISO standards • Quality Management 7QC tools. SPC/SQC Techniques • Calibration, Gauging, Digital Measurements • Safety Guidelines, Factory Act, • Environment Aspects, Discharge and their control • Industry 4.0 • Engineering Drawing • Material handling • BS Standards for materials & Material testing

## 6. Assistant Manager (Quality Assurance-Paper):

**1.0 Pulp and Manufacturing** - Introduction , Fibrous Raw Material for paper Making, Raw material structure, chemistry and preparation of fibrous materials, pulping (Kraft and Soda) and Recovery, Paper making; Pulping Mill operations, Pulping of Non-woods, Semi-chemical and Chemimechanical Pulping, Washing, Bleaching , Fundamentals(ECF and TCF), Deinking.

**2.0 Paper-making Process** – Introduction, Refining, Sizing , Strength Additives, Fillers and Dyes, Control Chemicals at the wet end and Approach Flow System, sheet structure, wet end of Paper Machine, stock and white water systems, Paper Machines corrosions, vibrations and safety.

**3.0 Paper Properties** – Introduction, Physical Properties, mechanical properties, Optical Properties, Resistance Properties, and Interrelation between Properties; chemical properties-Kraft and soda Recovery Cycles, Black Liquor- characterization, oxidation, Desalination.

**4.0 Printing and packing papers** – Printing processes, letterpress, flexography, gravure, lithography, and screen printing; Printing presses; Printing inks; Ink transfer; Halftone printing; color reproduction; Plate making and printing operation; Paper and paperboard properties required for printing; Reprography. Packing – Element of packaging technology, approaches to package development; Recruitment of paper and paperboard for different types packages: sacks, cartons and aseptic packing.

**5.0 Heat and Mass Transfer:** Modes of Heat Transfer, Conduction, Convection, Radiation, Heat Exchanges, Condensation, Boiling, Evaporator, Crystallization, Diffusion, Interphase Mass Transfer, Distillation, Solid-Liquid Extraction, Liquid-Liquid Extraction, Absorption, Adsorption, Humidification and Dehumidification, Drying , Membrane separation

### **6.0 Some Basic Concepts of Chemistry**

**General Introduction:** Importance and scope of chemistry. Historical approach to particulate nature of matter, laws of chemical combination, *Dalton's atomic theory*: concept of elements, atoms and molecules. Atomic and molecular masses. Mole concept and molar mass; percentage composition and empirical and molecular formula; chemical reactions, stoichiometry and calculations based on stoichiometry.

**States of Matter: Gases and Liquids:** Three states of matter, intermolecular interactions, types of bonding, melting and boiling points, role of gas laws in elucidating the concept of the molecule, Boyle's law, Charles's law, Gay Lussac's law, Avogadro's law, ideal behaviour, empirical derivation of gas equation, Avogadro number, ideal gas equation. Kinetic energy and molecular speeds (elementary idea), deviation from ideal behaviour, liquefaction of gases, critical temperature. Liquid State - Vapour pressure, viscosity and surface tension (qualitative idea only, no mathematical derivations).

**Thermodynamics:** Concept of system, types of system, surroundings, work, heat energy, extensive and intensive properties and state function. First law of thermodynamics - internal energy and enthalpy, heat capacity and specific heat, measurement of  $\Delta U$  and  $\Delta H$ , Hess's law of constant heat summation, enthalpy of: bond dissociation, combustion, formation, atomization, sublimation, phase transition, ionization, solution and dilution.

Introduction of entropy as a state function, second law of thermodynamics, Gibbs energy change for spontaneous and non-spontaneous process, criteria for equilibrium. Third law of thermodynamics-Brief introduction.

**Equilibrium:** Equilibrium in physical and chemical processes, dynamic nature of equilibrium, law of mass action, equilibrium constant, factors affecting equilibrium-Le Chatelier's principle; ionic equilibrium-ionization of acids and bases, strong and weak electrolytes, degree of ionization, ionization of polybasic acids, acid strength, concept of pH., Hydrolysis of salts (elementary idea), buffer solutions, Henderson equation, solubility product, common ion effect (with illustrative examples).

**Redox Reactions:** Concept of oxidation and reduction, redox reactions, oxidation number, balancing redox reactions in terms of loss and gain of electron and change in oxidation numbers, applications of redox reactions.

**s-Block Elements (Alkali and Alkaline earth metals):**

*Group 1 and Group 2 elements:* General introduction, electronic configuration, occurrence, anomalous properties of the first element of each group, diagonal relationship, trends in the variation of properties (such as ionization enthalpy, atomic and ionic radii), trends in chemical reactivity with oxygen, water, hydrogen and halogens; uses. Preparation and Properties of Some Important Compounds: Sodium carbonate, sodium chloride, sodium hydroxide and sodium hydrogencarbonate, biological importance of sodium and potassium. CaO, CaCO<sub>3</sub> and industrial use of lime and limestone, biological importance of Mg and Ca.

**Some p-Block Elements:** General Introduction to p-Block Elements. Important compounds of silicon and a few uses: silicon tetrachloride, silicones, silicates and zeolites, their uses.

**Organic Chemistry - Some Basic Principles and Techniques**

General introduction, methods of purification, qualitative and quantitative analysis, classification and IUPAC nomenclature of organic compounds. Electronic displacements in a covalent bond: inductive effect, electrometric effect, resonance and hyper conjugation. Homolytic and heterolytic fission of a covalent bond: free radicals, carbocations, carbanions; electrophiles and nucleophiles, types of organic reactions.

**Environmental Chemistry:** Environmental pollution-Air, water and soil pollution, chemical reactions in atmosphere, smogs, major atmospheric pollutants; acid rain, ozone and its reactions, effects of depletion of ozone layer. Greenhouse effect and global warming-pollution due to industrial wastes; green chemistry as an alternative tool for reducing pollution, strategy for control of environmental pollution.

**Study of pH change by common-ion effect in case of weak acids and weak bases.**

## Basics of Quantitative Estimation

### Qualitative Analysis:

a) Determination of one anion and cation in a given salt.

Cations-  $\text{Pb}^{2+}$ ,  $\text{Cu}^{2+}$ ,  $\text{As}^{3+}$ ,  $\text{Al}^{3+}$ ,  $\text{Fe}^{3+}$ ,  $\text{Mn}^{2+}$ ,  $\text{Ni}^{2+}$ ,  $\text{Zn}^{2+}$ ,  $\text{Co}^{2+}$ ,  $\text{Ca}^{2+}$ ,  $\text{Sr}^{2+}$ ,  $\text{Ba}^{2+}$ ,  $\text{Mg}^{2+}$ ,  $\text{NH}_4^+$

Anions-  $\text{CO}_3^{2-}$ ,  $\text{S}^{2-}$ ,  $\text{SO}_3^{2-}$ ,  $\text{SO}_4^{2-}$ ,  $\text{NO}_2^-$ ,  $\text{NO}_3^-$ ,  $\text{Cl}^-$ ,  $\text{Br}^-$ ,  $\text{I}^-$ ,  $\text{PO}_4^{3-}$ ,  $\text{C}_2\text{O}_4^{2-}$ ,  $\text{CH}_3\text{COO}^-$

Detection of nitrogen, Sulphur, Chlorine, in organic compounds

**Solutions:** Types of solutions, expression of concentration of solutions of solids in liquids, solubility of gases in liquids, solid solutions, colligative properties-relative lowering of vapour pressure, Raoult's law, elevation of B.P., depression of freezing point, osmotic pressure, determination of molecular masses using colligative properties, abnormal molecular mass, Vant Hoff factor.

**Electrochemistry:** Redox reactions, conductance in electrolytic solutions, specific and molar conductivity variations of conductivity with concentration, Kohlrausch's Law, electrolysis and laws of electrolysis (elementary idea), dry cell-electrolytic cells and Galvanic cells; lead accumulator, EMF of a cell, standard electrode potential, Nernst equation and its application to chemical cells. Relation between Gibbs energy change and EMF of a cell, fuel cells, corrosion

**Chemical Kinetics:** Rate of a reaction (average and instantaneous), factors affecting rates of reaction: concentration, temperature, catalyst, order and molecularity of a reaction; rate law and specific rate constant, integrated rate equations and half life (only for zero and first order reactions); concept of collision theory (elementary idea, no mathematical treatment). Activation energy, Arrhenius equation.

**Surface Chemistry:** Adsorption-physorption and chemisorption, factors affecting adsorption of gases on solids, catalysis homogenous and heterogeneous, activity and selectivity: enzyme catalysis; colloidal state: distinction between true solutions, colloids and suspensions, lyophilic, lyophobic multimolecular and macromolecular colloids, properties of colloids, Tyndall effect, Brownian movement, electrophoresis, coagulation, emulsions-types of emulsions.

**d and f/Block Elements:** General introduction, electronic configuration, occurrence and characteristics of transition metals. general trends in properties of the first row transition metals-metallic character, ionization enthalpy. oxidation states, ionic radii, colour, catalytic property, magnetic properties, interstitial compounds, alloy formation. Preparation and properties of  $\text{K}_2\text{Cr}_2\text{O}_7$ , and  $\text{KMnO}_4$

Lanthanides-electronic configuration, oxidation states, chemical reactivity and lanthanide contraction and its consequences. Actinides-Electronic configuration, oxidation states and comparison with lanthanides.

**Coordination compounds:** Coordination compounds Introduction, ligands, coordination number, colour, magnetic properties and shapes, IUPAC nomenclature of mononuclear coordination compounds, bonding, Werner's theory VBT.CFT, isomerism (structural and stereo)importance of coordination compounds (in qualitative analysis, extraction of metals and biological systems).

**Alcohols, Phenols and Ethers:** *Alcohols:* Nomenclature, methods of preparation, physical and chemical properties (of primary alcohols only); identification of primary, secondary and tertiary alcohols; mechanism of dehydration, uses, with special reference to methanol and ethanol. *Phenols:* Nomenclature, methods of preparation, physical and chemical properties, acidic nature of phenol, electrophilic substitution reactions, uses of phenols. *Ethers:* Nomenclature, methods of preparation, physical and chemical properties, uses.

**Aldehydes, Ketones and Carboxylic Acids:** *Aldehydes and Ketones:* Nomenclature, nature of carbonyl group, methods of preparation, physical and chemical properties, and mechanism of nucleophilic addition, reactivity of alpha hydrogen in aldehydes; uses. *Carboxylic Acids:* Nomenclature, acidic nature, methods of preparation, physical and chemical properties; uses.

**Biomolecules:** Carbohydrates-Classification (aldoses and ketoses), monosaccharide (glucose and fructose), D-L configuration, oligosaccharides (sucrose, lactose, maltose), polysaccharides (starch, cellulose, glycogen): importance. Proteins-Elementary idea of  $\alpha$ -amino acids, peptide bond, polypeptides, proteins, primary structure, secondary structure, tertiary structure and quaternary structure (qualitative idea only), denaturation of proteins, enzymes.

**Hormones- Elementary idea (excluding structure):** Vitamins- Classification and functions. Nucleic Acids: DNA and RNA

**Chemistry in Everyday Life:** Chemicals in medicines-analgesics, tranquilizers, antiseptics, disinfectants, antimicrobials, antifertility drugs, antibiotics, antacids, antihistamines. Chemicals in food-preservatives, artificial sweetening agents, elementary idea of antioxidants. Cleansing agents-soaps and detergents, cleansing action.

#### Chromatography

- Separation of pigment from extracts of leaves and flowers by paper chromatography and determination of  $R_f$  values.
- Separation of constituents present in an inorganic mixture containing two cations only (constituents having wide difference in  $R_f$  values to be provided).

#### Detail Characteristics of Carbohydrates, Fat and Protein.

**Concentration/Molarity of  $KMnO_4$  Solution by titrating it against a Standard Solution of –**

- Oxalic acid
- Ferrous ammonium sulphate
- (Students will be required standard solution by weighing themselves).

**Qualitative Analysis:** Determination of one cation and one anion in a given salt. Cations-  $Pb^{2+}$ ,  $Cu^{2+}$ ,  $As^{3+}$ ,  $Al^{3+}$ ,  $Fe^{3+}$ ,  $Mn^{2+}$ ,  $Ni^{2+}$ ,  $Zn^{2+}$ ,  $Co^{2+}$ ,  $Ca^{2+}$ ,  $Sr^{2+}$ ,  $Ba^{2+}$ ,  $Mg^{2+}$ ,  $NH_4^+$ . Anions-  $CO_3^{2-}$ ,  $S^{2-}$ ,  $SO_3^{2-}$ ,  $SO_4^{2-}$ ,  $NO_2^-$ ,  $NO_3^-$ ,  $Cl^-$ ,  $Br^-$ ,  $I^-$ ,  $PO_4^{3-}$ ,  $C_2O_4^{2-}$ ,  $CH_3COO^-$

**7.0 Material Science:--** Role of materials selection in design, structure-property – processing performance relationships. Miller's indices of direction and planes, packing of atoms inside solids, close-packed structure, structure of ceramics, ionic solids, glass and polymers,

density of various material. Yield strength, tensile strength and ductility of materials: stress strain behavior of metals, ceramic and polymer, tensile test, plastic deformation, necking, creep behaviors and fatigue. Non-crystalline/amorphous materials: Silicates, glass transition temperature, viscoelasticity. Corrosion, Degradation and Recycling. Biomaterial, material related to catalyst such as zeolites silica etc. and other selected materials. Introduction of experimental techniques: XRD, NMR, PSA, etc. for material characterization highlighting links between molecular structure and macroscopic properties.

**8.0 Knowledge of Computer System- Microsoft Office (Excel, Word, Power point presentation), chart analysis etc.**

**9.0 Industrial Management**

**10.0 Others:** ISO standards, Quality management 7QC tools. SPC/SQC Techniques. Calibration, Gauging, Digital Measurements, Safety Guidelines, Factory Act, Environment Aspects, Discharge and their control, industry 4.0, material handling, BS Standards for materials & Materials testing.

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## 7. Assistant Manager (Quality Assurance)

1. **Thermodynamics**- Scope, Dimensions and Units, Temperature, pressure, work, energy, Heat; Laws of Thermodynamics, Heat Effects-Latent heat, sensible heat; Thermodynamic property of fluids, Maxwell relations, 2 phase system, Application of thermodynamics to flow processes- pumps, compressors and turbines; Thermodynamic analysis of Steam Power- Rankine Cycle, Internal combustion engine, Otto Engine, Diesel engine; VLE-Raoult's Law, Liquid phase properties from VLE, Model for excess Gibbs energy, heat effects and property change on mixing, Liquid-liquid Equilibria; Vapour-Liquid-Liquid Equilibria; Solid-Liquid Equilibria; Solid -Gas Equilibria.
2. **Heat Transfer** – Modes of Heat Transfer, thermal diffusivity, Differential equation of Heat transfer; Conductive and convective Heat transfer , Design aspects of finned tube and other compact heat exchangers, Reboilers and Evaporators. Heat Transfer to Agitated tanks, unseat state heat transfer. Introduction to Radiative Heat Transfer, Design aspects of Furnaces.
3. **Mass transfer** – Perspective on unified approach to operations. Liquid-liquid Extraction, Leaching & washing, Adsorption, Ion-Exchange; Fixed bed absorbers, breakthrough, simultaneous Heat & Mass Transfer: Humidification and dehumidification: Simultaneous Heat and Mass Transfer: Drying, Design of Cooling Towers. Membrane processes. Ultrafiltration and osmosis, Reverse Osmosis.
4. **Material Science**- Introduction to materials bonding between atoms: metallic bonding, ionic bonding, covalent bonding, VanDer Waals bond, thermal expansion, elastic modulus and melting point of materials, Role of materials selection in design, structure- property-processing performance relationships. Miller indices of directions and planes, packing of atoms inside , close -packed structures, structure of ceramic, ionic solids, glass and polymers , density of various materials. Imperfection of solids, vacancies, equilibrium concentration of vacancies, interstitial and substitutional impurities in solids, dislocations, types and characteristics of dislocation. Interfacial defects, stacking faults. Structure of materials and Strength of materials: Yield strength, tensile strength and ductility of materials: stress strain behavior of metal, ceramic and polymers, tensile test plastic deformation, necking, creep behavior and fatigue. Non-crystalline/ amorphous material: silicates, glass transition temperature, viscoelasticity . Polymer nano-composite materials Nano-composites, role of reinforcement-matrix interface strength on composite behavior. Corrosion, Degradation and Recycling. Biomaterials materials related to catalyst such as zeolites, silica etc. and other selected materials. Introduction to experimental technique: XRD, NMR, PSA, etc. for material characterization highlighting links between molecular structure and macroscopic properties.

**5. Chemical Engineering:** Basic principal of Chemical Engineering, Electrolysis, vaporization, synthesis, Environmental science, coating and deposition, reactivity of molecules, quantum theory of chemical system, reactivity, synthesis, nano-science, Chemical Reactions, inorganic chemical industries (sulfuric acid, phosphoric acid, chlor-alkali industry), fertilizers (Ammonia, Urea, SSP and TSP); natural products industries (Pulp and Paper, Sugar, Oil, and Fats); petroleum refining and petrochemicals; polymerization industries (polyethylene, polypropylene, PVC and polyester synthetic fibers).

**6. Some Basic Concepts of Chemistry**

**General Introduction:** Importance and scope of chemistry. Historical approach to particulate nature of matter, laws of chemical combination, *Dalton's atomic theory*: concept of elements, atoms and molecules. Atomic and molecular masses. Mole concept and molar mass; percentage composition and empirical and molecular formula; chemical reactions, stoichiometry and calculations based on stoichiometry.

**States of Matter: Gases and Liquids:** Three states of matter, intermolecular interactions, types of bonding, melting and boiling points, role of gas laws in elucidating the concept of the molecule, Boyle's law, Charle's law, Gay Lussac's law, Avogadro's law, ideal behavior, empirical derivation of gas equation, Avogadro number, ideal gas equation. Kinetic energy and molecular speeds (elementary idea), deviation from ideal behaviour, liquefaction of gases, critical temperature. Liquid State - Vapour pressure, viscosity and surface tension (qualitative idea only, no mathematical derivations).

**Equilibrium:** Equilibrium in physical and chemical processes, dynamic nature of equilibrium, law of mass action, equilibrium constant, factors affecting equilibrium- Le Chatelier's principle; ionic equilibrium-ionization of acids and bases, strong and weak electrolytes, degree of ionization, ionization of polybasic acids, acid strength, concept of pH., Hydrolysis of salts (elementary idea), buffer solutions, Henderson equation, solubility product, common ion effect (with illustrative examples).

**Redox Reactions:** Concept of oxidation and reduction, redox reactions, oxidation number, balancing redox reactions in terms of loss and gain of electron and change in oxidation numbers, applications of redox reactions.

**s-Block Elements (Alkali and Alkaline earth metals):**

*Group 1 and Group 2 elements:* General introduction, electronic configuration, occurrence, anomalous properties of the first element of each group, diagonal relationship, trends in the variation of properties (such as ionization enthalpy, atomic and ionic radii), trends in chemical reactivity with oxygen, water, hydrogen and halogens; uses. Preparation and Properties of Some Important Compounds: Sodium carbonate, sodium chloride, sodium hydroxide and sodium hydrogen carbonate, biological importance of sodium and potassium. CaO, CaCO<sub>3</sub> and industrial use of lime and limestone, biological importance of Mg and Ca.

## **Some p-Block Elements: General Introduction to p-Block Elements**

**Group 13 elements:** General introduction, electronic configuration, occurrence, variation of properties, oxidation states, trends in chemical reactivity, anomalous properties of first element of the group; Boron- physical and chemical properties, some important compounds: borax, boric acids, boron hydrides. Aluminum: uses, reactions with acids and alkalies.

**Group 14 elements:** General introduction, electronic configuration, occurrence, variation of properties, oxidation states, trends in chemical reactivity, anomalous behavior of first element. Carbon - catenation, allotropic forms, physical and chemical properties; uses of some important compounds: oxides.

**Group 15 elements:** General introduction, electronic configuration, occurrence, oxidation states, trends in physical and chemical properties; nitrogen-preparation, properties and uses; compounds of nitrogen: preparation and properties of ammonia and nitric acid, oxides of nitrogen (structure only); Phosphorous-allotropic forms; compounds of phosphorous: preparation and properties of phosphine halides (PCl<sub>3</sub>, PCl<sub>5</sub>) and oxoacids (elementary idea only).

**Group 16 elements:** General introduction, electronic configuration, oxidation states, occurrence, trends in physical and chemical properties; dioxygen: preparation, properties and uses; classification of oxides; ozone. Sulphur-allotropic forms: compounds of sulphur: preparation, properties and uses of sulphur dioxide; sulphuric acid: industrial process of manufacture, properties and uses, oxoacids of sulphur (structures only).

**Group 17 elements:** General introduction, electronic configuration, oxidation states, occurrence, trends in physical and chemical properties; compounds of halogens: preparation, properties and uses of chlorine and hydrochloric acid, interhalogen compounds, oxoacids of halogens (structures only).

**Group 18 elements:** General introduction, electronic configuration, occurrence, trends in physical and chemical properties, uses.

Important compounds of silicon and a few uses: silicon tetrachloride, silicones, silicates and zeolites, their uses.

## **Organic Chemistry - Some Basic Principles and Techniques**

General introduction, methods of purification, qualitative and quantitative analysis, classification and IUPAC nomenclature of organic compounds. Electronic displacements in a covalent bond: inductive effect, electrometric effect, resonance and hyper conjugation. Homolytic and heterolytic fission of a covalent bond: free radicals, carbocations, carbanions; electrophiles and nucleophiles, types of organic reactions.

**Environmental Chemistry:** Environmental pollution-Air, water and soil pollution, chemical reactions in atmosphere, smogs, major atmospheric pollutants; acid rain,

ozone and its reactions, effects of depletion of ozone layer. greenhouse effect and global warming-pollution due to industrial wastes; green chemistry as an alternative tool for reducing pollution, strategy for control of environmental pollution.

**Study of pH change by common-ion effect in case of weak acids and weak bases.**

**Basics of Quantitative Estimation**

**Qualitative Analysis:**

a) Determination of one anion and cation in a given salt.

Cations-  $\text{Pb}^{2+}$ ,  $\text{Cu}^{2+}$ ,  $\text{As}^{3+}$ ,  $\text{Al}^{3+}$ ,  $\text{Fe}^{3+}$ ,  $\text{Mn}^{2+}$ ,  $\text{Ni}^{2+}$ ,  $\text{Zn}^{2+}$ ,  $\text{Co}^{2+}$ ,  $\text{Ca}^{2+}$ ,  $\text{Sr}^{2+}$ ,  $\text{Ba}^{2+}$ ,  $\text{Mg}^{2+}$ ,  $\text{NH}_4^+$

Anions-  $\text{CO}_3^{2-}$ ,  $\text{S}^{2-}$ ,  $\text{SO}_3^{2-}$ ,  $\text{SO}_4^{2-}$ ,  $\text{NO}_2^-$ ,  $\text{NO}_3^-$ ,  $\text{Cl}^-$ ,  $\text{Br}^-$ ,  $\text{I}^-$ ,  $\text{PO}_4^{3-}$ ,  $\text{C}_2\text{O}_4^{2-}$ ,  $\text{CH}_3\text{COO}^-$

Detection of nitrogen, Sulphur, Chlorine, in organic compounds

**Solutions:** Types of solutions, expression of concentration of solutions of solids in liquids, solubility of gases in liquids, solid solutions, colligative properties-relative lowering of vapour pressure, Raoult's law, elevation of B.P., depression of freezing point, osmotic pressure, determination of molecular masses using colligative properties, abnormal molecular mass, Vant Hoff factor.

**Electrochemistry:** Redox reactions, conductance in electrolytic solutions, specific and molar conductivity variations of conductivity with concentration, Kohlrausch's Law, electrolysis and laws of electrolysis (elementary idea), dry cell-electrolytic cells and Galvanic cells; lead accumulator, EMF of a cell, standard electrode potential, Nernst equation and its application to chemical cells. Relation between Gibbs energy change and EMF of a cell, fuel cells, corrosion

**Chemical Kinetics:** Rate of a reaction (average and instantaneous), factors affecting rates of reaction: concentration, temperature, catalyst, order and molecularity of a reaction; rate law and specific rate constant, integrated rate equations and half life (only for zero and first order reactions); concept of collision theory (elementary idea, no mathematical treatment). Activation energy, Arrhenius equation.

**Surface Chemistry:** Adsorption-physisorption and chemisorption, factors affecting adsorption of gases on solids, catalysis homogenous and heterogeneous, activity and selectivity; enzyme catalysis; colloidal state: distinction between true solutions, colloids and suspensions, lyophilic, lyophobic multimolecular and macromolecular colloids, properties of colloids, Tyndall effect, Brownian movement, electrophoresis, coagulation, emulsions-types of emulsions.

**d and f/Block Elements:** General introduction, electronic configuration, occurrence and characteristics of transition metals. general trends in properties of the first row transition metals-metallic character, ionization enthalpy. oxidation states, ionic

radii, colour, catalytic property, magnetic properties, interstitial compounds, alloy formation. Preparation and properties of  $K_2Cr_2O_7$ , and  $KMnO_4$

Lanthanides-electronic configuration, oxidation states, chemical reactivity and lanthanide contraction and its consequences. Actinides-Electronic configuration, oxidation states and comparison with lanthanides.

**Coordination compounds:** Coordination compounds Introduction, ligands, coordination number, colour, magnetic properties and shapes, IUPAC nomenclature of mononuclear coordination compounds, bonding, Werner's theory VBT.CFT, isomerism (structural and stereo) importance of coordination compounds (in qualitative analysis, extraction of metals and biological systems).

**Alcohols, Phenols and Ethers:** *Alcohols:* Nomenclature, methods of preparation, physical and chemical properties (of primary alcohols only); identification of primary, secondary and tertiary alcohols; mechanism of dehydration, uses, with special reference to methanol and ethanol. *Phenols:* Nomenclature, methods of preparation, physical and chemical properties, acidic nature of phenol, electrophilic substitution reactions, uses of phenols. *Ethers:* Nomenclature, methods of preparation, physical and chemical properties, uses.

**Aldehydes, Ketones and Carboxylic Acids:** *Aldehydes and Ketones:* Nomenclature, nature of carbonyl group, methods of preparation, physical and chemical properties, and mechanism of nucleophilic addition, reactivity of alpha hydrogen in aldehydes; uses. *Carboxylic Acids:* Nomenclature, acidic nature, methods of preparation, physical and chemical properties; uses.

**Biomolecules:** Carbohydrates-Classification (aldoses and ketoses), monosaccharide (glucose and fructose), D-L configuration, oligosaccharides (sucrose, lactose, maltose), polysaccharides (starch, cellulose, glycogen): importance. Proteins-Elementary idea of  $\alpha$ -amino acids, peptide bond, polypeptides, proteins, primary structure, secondary structure, tertiary structure and quaternary structure (qualitative idea only), denaturation of proteins, enzymes.

**Hormones- Elementary idea (excluding structure):** Vitamins- Classification and functions. Nucleic Acids: DNA and RNA

**Chemistry in Everyday Life:** Chemicals in medicines-analgesics, tranquilizers, antiseptics, disinfectants, antimicrobials, antifertility drugs, antibiotics, antacids, antihistamines. Chemicals in food-preservatives, artificial sweetening agents, elementary idea of antioxidants. Cleansing agents-soaps and detergents, cleansing action.

### **Chromatography**

- a) Separation of pigment from extracts of leaves and flowers by paper chromatography and determination of  $R_f$  values.
- b) Separation of constituents present in an inorganic mixture containing two cations only (constituents having wide difference in  $R_f$  values to be provided).

## **Detail Characteristics of Carbohydrates, Fat and Protein.**

### **Concentration/Molarity of $\text{KMnO}_4$ Solution by titrating it against a Standard Solution of –**

- i. Oxalic acid
- ii. Ferrous ammonium sulphate
- iii. (Students will be required standard solution by weighing themselves).

**Qualitative Analysis:** Determination of one cation and one anion in a given salt.  
Cations-  $\text{Pb}^{2+}$ ,  $\text{Cu}^{2+}$ ,  $\text{As}^{3+}$ ,  $\text{Al}^{3+}$ ,  $\text{Fe}^{3+}$ ,  $\text{Mn}^{2+}$ ,  $\text{Ni}^{2+}$ ,  $\text{Zn}^{2+}$ ,  $\text{Co}^{2+}$ ,  $\text{Ca}^{2+}$ ,  $\text{Sr}^{2+}$ ,  $\text{Ba}^{2+}$ ,  $\text{Mg}^{2+}$ ,  $\text{NH}_4^+$ .  
Anions-  $\text{CO}_3^{2-}$ ,  $\text{S}^{2-}$ ,  $\text{SO}_3^{2-}$ ,  $\text{SO}_4^{2-}$ ,  $\text{NO}_2^-$ ,  $\text{NO}_3^-$ ,  $\text{Cl}^-$ ,  $\text{Br}^-$ ,  $\text{I}^-$ ,  $\text{PO}_4^{3-}$ ,  $\text{C}_2\text{O}_4^{2-}$ ,  $\text{CH}_3\text{COO}^-$

Entropy and free energy changes in chemical processes, chemical equilibria, phase transformation, structure and dynamics of microscopic system, physical basis of atomic and molecular structure, three –dimensional arrangement of atoms in molecules, structure and reactivity of organic, inorganic and organometallic compounds, basic strategies chemistry, role of inorganic chemistry in living system.

**Transition and Inner Transition Metal Chemistry-** Introduction of coordination chemistry , crystal field theory, Ligand field theory, Molecular orbital theory , Magnetic and spectral characterization of inner transition complexes, substitution , Electron transfer and photo-chemical reaction of transition metal complexes. Physical, spectroscopic and electrochemical methods used in the study of transition metal complexes, Metal –metal bonded compounds and transition metal cluster compounds, uses of lanthanide complexes : as shift reagent, as strong magnets, and in florescence , Bioinorganic chemistry : introduction, Bioinorganic chemistry of iron, Hemoglobin, myoglobin, cytochromes , bioinorganic chemistry of zinc, cobalt and copper.

**Solid state chemistry** – Crystal chemistry, Bonding in solids, Defect and non-stoichiometry, A range of synthesis and analytical technique to prepare and characterize solid, Electronic, magnetic and superconducting properties , optical properties which include: Luminescence and lasers, nanostructures and low dimensional properties etc.

7. **Knowledge of Computer System- Microsoft Office (Excel, Word, Power point presentation), chart analysis etc.**
8. **Industrial Management**
9. **Others:** ISO standards, Quality management 7QC tools. SPC/SQC Techniques. Calibration, Gauging, Digital Measurements, Safety Guidelines, Factory Act,

**Environment Aspects, Discharge and their control, industry 4.0, material handling,  
BS Standards for materials & Materials testing.**

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8. SYLLABUS FOR THE POST OF Assistant Manager (Assay)  
(TECHNICAL SUBJECT)

Physical chemistry

**General topics**

Concept of atoms and molecules; Dalton's atomic theory; Mole concept; Chemical formulae; Balanced chemical equations; Calculations (based on mole concept) involving common oxidation-reduction, neutralisation, and displacement reactions; Concentration in terms of mole fraction, molarity, molality and normality.

**Gaseous and liquid states**

Absolute scale of temperature, ideal gas equation; Deviation from ideality, van der Waals equation; Kinetic theory of gases, average, root mean square and most probable velocities and their relation with temperature; Law of partial pressures; Vapour pressure; Diffusion of gases.

**Atomic structure and chemical bonding**

Bohr model, spectrum of hydrogen atom, quantum numbers; Wave-particle duality, de Broglie hypothesis; Uncertainty principle; Qualitative quantum mechanical picture of hydrogen atom, shapes of *s*, *p* and *d* orbitals; Electronic configurations of elements (up to atomic number 36); Aufbau principle; Pauli's exclusion principle and Hund's rule; Orbital overlap and covalent bond; Hybridisation involving *s*, *p* and *d* orbitals only; Orbital energy diagrams for homonuclear diatomic species; Hydrogen bond; Polarity in molecules, dipole moment (qualitative aspects only);

**Energetics**

First law of thermodynamics; Internal energy, work and heat, pressure-volume work; Enthalpy, Hess's law; Heat of reaction, fusion and vapourization; Second law of thermodynamics; Entropy; Free energy; Criterion of spontaneity.

**Chemical equilibrium**

Law of mass action; Equilibrium constant, Le Chatelier's principle (effect of concentration, temperature and pressure); Significance of  $\Delta G$  and  $\Delta G^\circ$  in chemical equilibrium; Solubility product, common ion effect, pH and buffer solutions; Acids and bases (Bronsted and Lewis concepts); Hydrolysis of salts.

**Electrochemistry**

Electrochemical cells and cell reactions; Standard electrode potentials; Nernst equation and its relation to  $\Delta G$ ; Electrochemical series, emf of galvanic cells; Faraday's laws of electrolysis; Electrolytic conductance, specific, equivalent and molar conductivity, Kohlrausch's law; Concentration cells.

**Chemical kinetics**

Rates of chemical reactions; Order of reactions; Rate constant; First order reactions; Temperature dependence of rate constant (Arrhenius equation).

**Solid state**

Classification of solids, crystalline state, seven crystal systems (cell parameters *a*, *b*, *c*,  $\alpha$ ,  $\beta$ ,  $\gamma$ ), close packed structure of solids (cubic), packing in fcc, bcc and hcp lattices; Nearest neighbours, ionic radii, simple ionic compounds, point defects.

**Surface chemistry**

Elementary concepts of adsorption (excluding adsorption isotherms); Colloids: types, methods of preparation and general properties; Elementary ideas of emulsions, surfactants and micelles (only definitions and examples).

**Classification of Elements:** Classification – periodic law – periodicity and periodic properties classification of elements into *s*, *p*, *d*, *f* blocks.

**“s” block elements:** (Alkali metals and Alkaline earth metals) Elements of group IA – General properties, physical and chemical properties of compounds of I group i.e. NaOH, Na<sub>2</sub>CO<sub>3</sub> – preparations, properties and uses. **“p” block elements:** (III, IV, V, VI, VII group elements) A. III Group: General Properties – Physical properties, chemical properties and uses. **“d” block elements:** (Transition Elements) General properties of transition elements – some general characteristics – werner’s theory of complex compounds – effective atomic number.

**Solutions:** Concentration methods, problems – buffer solutions – colligative properties - solubility

**Acids-bases:** Arrhenius acid base theory – Lowry Bronsted concept – Lewis concept – pH Problems-theory of indicators.

**Oxidation-Reduction:** definition - rules determining – calculation of oxidation numbers.

Bonding Group Theory and its Applications, Molecular Orbital Theory of Metal Complexes, Mono, Di and Tri haptic Complexes, Tetra, Penta, Hexa, Hepta and Octahaptic Complexes, Catalytic Role of OTMC-I & II.

**Analysis of non- Ferrous alloys:** Analysis of Tin, Zinc and Copper in Brass, Bronze. Analysis of Tin and lead in Solder.

Ethyl Chloride, Chloroform, Alcohols, Aldehydes, Ketones, Carboxylic acids, Ethers. Polymerization-Addition and Condensation polymerization. Preparation, properties and uses of – Benzene, Nitro benzene, Aniline. Electrolytes, non-electrolytes, Arrhenius theory- Faraday’s laws of electrolysis.

Chemical equilibrium – Law of mass action – Effect of concentration, pressure, temperature and catalyst on chemical equilibrium – Lechatelier’s principle – Applications.

**Industrial acids and gases:** Hydrochloric acid and synthesis process - Nitric acid by ammonia oxidation process –Extraction of sulphur - Sulphuric acid by Contact process & DCDA process. Hydrogen Electrolytic method – steam hydrocarbon reforming process.

**Miscellaneous Inorganic Chemicals:** Potassium permanganate -Potassium chloride, NPK fertilizers – Alum from Bauxite – silicon carbide, by electric arc furnace – calcium carbide by quick lime process.

**Second law of thermodynamics, Chemical reaction equilibria :** Application of equilibrium criteria to chemical reactions – The standard Gibbs energy change and the equilibrium constant – Effect of temperature on the equilibrium constant – Evaluation of equilibrium constants – Relation between equilibrium constants and composition.

**Chemical kinetics and ideal reactors:** Chemical kinetics – Classification of reactions – Variables affecting the rate of reaction – Reaction rate- Concentration – Dependent term of a rate equation – Single and multiple reactors, elementary and non-elementary reactions– Rate constant K – Representation of a rate equation – Constant volume batch reactor .

**Catalysis and Industrial Reactors :** Types of catalysis – Characteristics of catalytic reactions – Auto catalysis – Accelerators, Promoters, inhibitors, poisons- some important catalysts- industrial catalytic processes-Important industrial reactors.

### Inorganic chemistry

#### **Isolation/preparation and properties of the following non-metals**

Boron, silicon, nitrogen, phosphorus, oxygen, sulphur and halogens; Properties of allotropes of carbon (only diamond and graphite), phosphorus and sulphur.

### Preparation and properties of the following compounds

Oxides, peroxides, hydroxides, carbonates, bicarbonates, chlorides and sulphates of sodium, potassium, magnesium and calcium; Boron: diborane, boric acid and borax; Aluminium: alumina, aluminium chloride and alums; Carbon: oxides and oxyacid (carbonic acid); Silicon: silicones, silicates and silicon carbide; Nitrogen: oxides, oxyacids and ammonia; Phosphorus: oxides, oxyacids (phosphorus acid, phosphoric acid) and phosphine; Oxygen: ozone and hydrogen peroxide; Sulphur: hydrogen sulphide, oxides, sulphurous acid, sulphuric acid and sodium thiosulphate; Halogens: hydrohalic acids, oxides and oxyacids of chlorine, bleaching powder; Xenon fluorides.

### Transition elements (3d series)

Definition, general characteristics, oxidation states and their stabilities, colour (excluding the details of electronic transitions) and calculation of spin-only magnetic moment; Coordination compounds: nomenclature of mononuclear coordination compounds, cis-trans and ionisation isomerisms, hybridization and geometries of mononuclear coordination compounds (linear, tetrahedral, square planar and octahedral).

### Preparation and properties of the following compounds

Oxides and chlorides of tin and lead; Oxides, chlorides and sulphates of  $\text{Fe}^{2+}$ ,  $\text{Cu}^{2+}$  and  $\text{Zn}^{2+}$ ; Potassium permanganate, potassium dichromate, silver oxide, silver nitrate, silver thiosulphate.

### Ores and minerals

Commonly occurring ores and minerals of iron, copper, tin, lead, magnesium, aluminium, zinc and silver.

### Extractive metallurgy

Chemical principles and reactions only (industrial details excluded); Carbon reduction method (iron and tin); Self reduction method (copper and lead); Electrolytic reduction method (magnesium and aluminium); Cyanide process (silver and gold).

### Others for Gold and Silver processing:

- Chemistry and Metallurgy (gold / silver alloy properties) and purity measurement for Precious Metals
- Methods of calculating required quantities of alloys
- Malleability of the metal and Allegation
- The chemical compositions, structure, and properties of substances used in the refining process
- The chemical processes and transformations that they undergo in the refining process
- Uses of different processes for different purposes and end results
- Potential work hazards while handling molten metal and chemicals

**Properties of Gold & Silver**, Applications and uses of Gold & Silver plating. Equipments for Silver plating. Various types of Gold & Silver solutions, their compositions and operating conditions, their preparation and maintenance. Processing steps of Gold & Silver plating. Various defects generally encountered in the Gold & Silver plating, causes for these defects and their remedies. Methods for the removal of Gold & Silver deposit from various metals. Applications of electroless plating in electroplating industry. Electroless plating solutions and their operating conditions of copper, silver and gold. General defects, their causes and remedies in electroless plating.

### Principles of qualitative analysis

Groups I to V (only  $\text{Ag}^+$ ,  $\text{Hg}^{2+}$ ,  $\text{Cu}^{2+}$ ,  $\text{Pb}^{2+}$ ,  $\text{Bi}^{3+}$ ,  $\text{Fe}^{3+}$ ,  $\text{Cr}^{3+}$ ,  $\text{Al}^{3+}$ ,  $\text{Ca}^{2+}$ ,  $\text{Ba}^{2+}$ ,  $\text{Zn}^{2+}$ ,  $\text{Mn}^{2+}$  and  $\text{Mg}^{2+}$ ); Nitrate, halides (excluding fluoride), sulphate and sulphide.

### Standards

Knowledge of Assaying Process as per IS1417:2016, IS: 1418 – 2009 for Gold and IS 2113: 2016 for Silver, Hall Marking as per IS 15820:2009

## 9. Assistant Manager (Technical Control)

**1. Introduction to Printing Process :** Basics of Print Media & Printing Technique, Digital Printing Technology, Technology of offset printing, Flexography Printing, Principle and Technology of Gravure & Screen Printing, Printing & Technology of offset Printing (Dry-Wet), Principle & technology of Intaglio Printing

**2. Basic Principles of Imaging Techniques:** Pre-Press → DTP, Camera Processing, Conversion to film output- negative, CTP, technology, surface preparation for letterpress, lithography, dry-wet offset, screen, gravure & flexography; Basic concept of printing designs- Layout style, art work, Typography, Symbol & logos, layout and colour etc; Presses → Configuration of machine part and accessories, Dry-Wet offset, flexography, gravure, intaglio, digital and screen printing machines.

**3. Technology Security Printing:** Introduction of security printing, Requirement of security printing, Counterfeiting creation graphics, Types of security product, Overt & Covert features

**4. Security Printing Inks:** Type of Security Printing Inks, Migrating Heat reactive Ink, Erasable & Fugitive Inks, Copy protection & Thermo chromic Ink, Penetrating Ink, OVI & UV Curing Ink, IR Ink, Monochromic Ink, Water Resistant & Invisible Phosphorescent Ink tec

**5. Security Substrates:** Security Fibers, Planchettes, Fluorescent Hi-Lites, Iridescent coating, Security threads, Holographic foil, Colour Centered paper, Chemically Void, Toner fused Paper, Visible security fibers, Invisible fluorescent fibers and Other security papers.

**6. Print Processes used in Security Printing :** Printing Processes such as Gravure, Offset, Intaglio, Flexo, Letterpress, Screen, Variable Data Printing, Software and Digital printing equipment used for variable data printing, Recent trends and developments in security printing, Process of Gravure, offset, Intaglio, Flexo Image Carrier, Inking, Drying and Impression system of offset, Intaglio, Flexo etc.

**7. Printing Electronics :** Materials in Printed Electronics, Basic Electronic components, Printing Process used for printing electronics, Impact Printing Processes: Offset, Screen, Gravure, Flexography, Non-impact printing processes-Inkjet Drop on demand for production of PE, scope and limitations, Printed Electronics Applications, Advances and Future Trends.

**8. Maintenance Management of Printing Machines:** Printing machine technology in sheetfed & Webfed Offset Printing Machines, Flexography Digital Printing Machine, Maintenance Management, Preventive Maintenance, Corrective Maintenance, Quality and Safety in Maintenance, Predictive Maintenance Techniques, Breakdown Maintenance and Reconditioning and Replacement Theory

**9. Management information System and Cost:** Basics concepts of Management, Basics of MIS, Requirement & Types of MIS, Enterprise Management Systems, Costing & Estimation, Print Production Planning and Control

**10. Knowledge of computer system Microsoft Office, Excel etc.**

**11. Industrial Management.**

**12. Pollution from printing, CNC M/Cs in printing, Tooling**

**13. Others -** • ISO standards • Quality Management 7QC tools. SPC/SQC Techniques • Calibration, Gauging, Digital Measurements • Safety Guidelines, Factory Act, • Environment Aspects , Discharge and their control • Industry 4.0 • Engineering Mathematics + Engineering Drawing • Material handling • BS Standards for materials & Material testing

## 10. Assistant Manager (Artist/Designer)

### **History of Indian and Western Art:**

**a) Indian Art:** Ajanta Murals, Ellora Cave Temples, Buddhist & Jain Manuscript Painting, Rajput, Kalighat Patachitras, Indus Valley Civilization-Sculpture, Terracotta & Pottery, Mauryan Sculpture, Shunga Sculpture – Sanchi, Bharahut and Bodhgaya, Amaravti Sculpture, Kushan Period – Gandhara and Mathura Sculpture, Origin of the Buddha Image, Gupta Sculpture-Hindu, PalaSena Sculpture, Pallava Sculpture, Khajuraho, Bhuvaneshwar and Konarak, Chola Sculpture, Pallava sculpture

**b) Metal Sculptures of North India**

**c) Metal Sculptures of Western India**

**d) Metal Sculptures East India.**

**e) Metal Sculptures South India**

**f) Western Art:** Realism – Gustave Courbet & Mile, Impressionism- Manet, Monet, Renoir, Degas, Post Impressionism- Gauguin, Van Gogh, Seuratm Cezanne, Fauvism-Matisse, German Expressionism, Edward Munch, Modigliani, Influence of Cubism on later Modern Art, Modern Sculpture-Rodin, Brancusi, Giacometti, Henry Moore, Futurism-A brief introduction, Dadaism- Marcel Duchamp, Egyptian Sculpture, Greek Sculpture and Paining, Roman Sculpture.

**g) History of Art**

**Graphic Design/Applied Art:** Introduction to Typography, Study of basic type forms, terminology, and specification. Application of type to layout design, with stress on rendering techniques. Includes the historical developments, POP/POS design, design making techniques, computer graphics etc.

**Drawing and Sketch:** Drawing, Instruments include graphite pencils, pen and ink, inked brushes, wax colored pencils, crayons, charcoal, chalk, pastels, various kinds of erasers, markers, styluses, etc, Graphic work executed in a dry medium such as pencil, charcoal or pastel, Identity design and Serigraphy Printing etc.

**Print making techniques, Merchandizing design, 3d design, poster design, multimedia etc.**

### **SCULPTURE DESIGN**

- 1) Study of the development of sculpture organization observed from objective and non-objective forms in order to explore the expressive possibilities.
- 2) A segment in round and relief in clay and plaster creating structural forms through various mixed Medias and various medium such a bronze, lead wax etc.
- 3) Antique Study

- 4) Portrait study
- 5) Composition in clay
- 6) Glass sculpture
- 7) Print making etc.

### **CERAMIC SCULPTURE**

- 1) Preparing various bodies of clay and selecting three out of these bodies from sculptures.
- 2) Soft Body- Earthen wears, semi stone wear also executing sculpture either by slip, slab, and hand built method. Making piece slip casting & surface made with various methods used in ceramics. To utilize the methods of Hand Building process and process for constructing the sculpture.
- 3) Terracotta relief & round sculpture relief & round sculpture decorated with the following methods-
  1. Engobing, 2. Incising 3. Perforation, 4. Applique, 5. Coiling & 6. Impression.

### **METAL SCULPTURE (WELDED SCULPTURE & BRONZE CASTING)**

- 1) Copper, Brass, Lead and their use in response in round and in relief.
- 2) Possibilities and limitations of metals sculptures by casting Exercise in all stages of Bronze casting taking mold casting , Finishing & Platination.
- 3) Hammering & Casting Techniques
- 4) Embossing & Repousse Technique
- 5) Chasing Techniques
- 6) Engraving Techniques
- 7) Inlaying Techniques
- 8) Drawing From Cast and Figure
- 9) Enamel Design
- 10) Repousse Design
- 11) Visualization Enamel Design
- 12) Visualization Repousse Design

### **Creating & Transferring Designs on Metal Surfaces**

1. Design Principles and Conceptualization.
2. Drawing Techniques for Engraving.
3. Transferring Design

### **Hand Engraving Techniques**

- 1) Incised Line Engraving
- 2) Relief Engraving
- 3) Bullino Engraving

### **Painting:**

- 1) Drawing (Manmade & Nature)
- 2) Head Study
- 3) Drawing From life

- 4) **Painting:** Study of visual Element, Point, Line, Planes and Shapes, Study of Design Principles, Organization in space (positive and negative). Basic and free shapes- Line, Colour, Tone, Texture Form and space.
- 5) **Colour:** Perception of colour, Light and Pigment theory, Understanding of Primary and Secondary colours. Number of secondary colours that can be made from basic colours. Colour wheel and various colour schemes derived from it. Complementary Scheme, Analogous Colour. Split and Double Split Complementary Colour scheme. Gray Scale, keys and Contrast.
- 6) **PRINT MAKING:** Fundamentals of various methods of taking prints. Rubbing Mono-print in single or two colour with various types of materials and their combinations, viz. paper, card board, cloth etc. Various categories of print making into the surface of a printing block viz. Plano-graph, relief process, intaglio and stencil. The method and materials used in various processes of print making viz. Lino cut, Wood cut, knowledge of terminology and mounting a print.
- 7) **Painting In water colour, coloured pencils or coloured inks.** Extension of Painting. Arrangements of figure and forms in pictorial space, expression of specific mood and emotions.
- 8) **Drawing and Painting from life:** Drawing from life (Human forms), Painting of full human figure in various Colours media (water, Pastel, oil) Portrait painting, Half-length studies of human figure, Bust of male and female in different age groups.
- 9) **Pictorial Design:** Study of composition (principals), Placements of the element on the surface, compositional problems of each types of painting.
- 10) **PRINT MAKING:** Introduction of material and tools, its use for making a design for relief print. Making relief print from wooden blocks, knowledge of registration, design prints with more than two Colour, Use of overlapping of colours, Possibilities of the textural value of various types of materials like wood, linoleum, zinc plate etc.

## 11. Assistant Manager (Materials Management)

- 1. Procurement and Inventory Management:** Purchasing or Procurement, Purchase Organisation, Buying Techniques, Quantity and Quality Standards, The Purchasing Procedure, Accounting, ABC Analysis, Stores, Material Control & Scrap Disposal, Receipts and Issue of Materials, Store Records, Codification of Material, Physical Verification of Stores, Inventory Control, Inventory Classification, Inventory Management, Objectives of Inventory Control, Functions of Inventories, Economic Order Quantity, Inventory Models, Material Requirements Planning, Manufacturing Resources Planning, Operation Cycle
- 2. Trends in Procurement:** Government e-Marketplace (GEM), Type of Tender, GFR Rules for GeM, Public Procurement Policy in context of MSMEs
- 3. Principles and Practices of Management:** Basic Concepts of Management - Definition, Need and scope; Different schools of management – Behavioural, Scientific, Systems, Contingency; Management theories - F.W. Taylor - Henry Fayol - Elton Mayo; Managerial skills and functions Levels of management; Functions of management
- 4. Operations Management:** Types of Industries, Facilities Location and Layout, PERT/CPM, Inspection, Construction and Interpretation of Control Charts, Productivity – Work Study, Lean Production Systems, TQM
- 5. Engineering Mathematics and Statistical Tools:** Linear Algebra, Calculus, Differential Equations, Complex Variables, Probability and Statistics, Numerical Methods, Replacement Analysis, Micro Economics - applied to plant and industrial undertaking
- 6. Industrial Production & Manufacturing:** Production Function, Process Planning, Manufacturing Schedule, Industrial Management
- 7. Knowledge of Computer System Microsoft Office, Excel etc.**

## 12. Assistant Manager (IT)

1. Operating System
2. Data Structure
3. Object Oriented Programming
4. Database Management Systems
5. Compiler Design/language Processor
6. Computer Organization
7. Microprocessor and Computer Hardware
8. Computer Network
9. Software Engineering
10. Web Technology
11. Data Warehousing and Data Mining
12. Computer and Network Security