



RECRUITMENT OF SCIENTIFIC ASSISTANT-II (SA-II) – LEVEL 4 (₹25500-81100)

### SYLLABUS FOR WRITTEN EXAMINATION

**METHODOLOGY OF SELECTION: Mode of selection will be based on written examination only and there will be no interview.**

#### Detailed pattern of the Exam

The written exam will be conducted offline (manual) which will be consisting of 200 objective type multiple choice questions (MCQs) of one mark each for a total of 200 marks divided in to PART – A & B as detailed below.

PART	Name of Tests (Subject)	No. of Questions	Marks	Minimum Qualifying Marks	Duration	Level of examination	Weightage
A	Mental Ability/Reasoning	30	100	70	2½ Hours	Intermediate level	20%
	Arithmetical Ability	30					
	English Language	30					
	General Awareness & Current Affairs	10					
B	Chemical Engineering / Metallurgical Engineering / Electrical Engineering {Syllabus: As per 'Annexure' attached}	50	100	70		Diploma level	80%

*Note: The minimum qualifying marks for selection will be 70% marks in both Part-A & B respectively.*

2. The format of the question paper will be of Objective Type-multiple choice questions only. Duration of the examination will be 180 minutes. The language of the exam will be English only. The written test will be conducted at HYDERABAD ONLY.

3. Those who secure prescribed minimum marks in the written test in each Part – A & B i.e., 70% marks will be considered for empanelment in the order of merit. The final merit list would be determined on the basis of total score obtained by the candidates in the WRITTEN EXAMINATION (Part-A & B). Scoring less than 70 marks in Part – A **OR** Part – B **OR** both in Part – A & B will not be empanelled.

4. In case of more than one candidate scoring highest mark, the selection will be as detailed below:

- (a) the final merit will be determined on the basis of highest mark scored among the candidates in the PART-B will be selected.



Illustration: (Part A – 20% weightage & Part B – 80% weightage)

S No	Name	Part – A Marks	Part – B Marks	Total (Part-A+B)	Rank	Order of merit
1	A	16	56	72	1	3
2	B	14	58	72	1	1
3	C	15	57	72	1	2

Result: Mr. B will be selected in the order of merit as 1, since he scored highest marks in the Part-B.

- (b) even then more than one candidate tie up, then final merit shall be based on the older among the candidate as per their “date of birth”.

Illustration:

S No	Name	Date of Birth	Part – A Marks	Part – B Marks	Total (Part-A+B)	Rank	Order of merit
1	A	10.06.1999	15	56	71	1	1
2	B	18.05.2000	13	56	71	1	3
3	C	11.09.1999	14	56	71	1	2

Result: Mr. A will be selected in the order of merit as 1 being the oldest (Date of Birth) among the candidates.

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**THE TENTATIVE DATE OF WRITTEN  
EXAMINATION : 07.06.2024**



## **Electrical/Electronics Engineering**

### **1. Module I**

SI unit of current, voltage, power and energy - temperature coefficient of resistance - comparison of Electric and Magnetic circuits - basic concepts of capacitance, inductance and impedance

### **2. Module II**

Alternating current fundamentals- - wave forms- frequency- period- average value and form factor - power and power factor in ac circuits - Earthing of installation - necessity of earthing- plate and pipe earthing - Protective fuses, MCBs, ELCB

### **3. Module III**

Electrical Drives - dc series, shunt and compound motors - transformers - Principle of operation.

### **4. Module IV**

Basics of electronic passive and active components, Resistors, Capacitors & Inductors —Diodes & Transistors, Rectifier Circuits, Zener diodes, SCR.

### **5. Module V**

Basic principles of UPS, inverter and batteries

### **6. Module VI**

Basics of microprocessor, microcontroller, ADC & DAC  
Electronic Instrumentation: Measuring instruments: voltmeter, ammeter, Transducers - strain gauges, Thermocouples. ON / OFF controllers, PID Controllers, solid state relay, linear/ Digital Control Signals

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## Diploma in metallurgical engineering

### 1. Crystal Geometry

Fundamental Terms of Crystallography, Types of Crystals, Relation between the Interplanar and Interatomic Distance, Crystal Structures of Materials (Simple Cubic Crystal Structure, BCC, FCC and HCP), Bragg's Law.

### 2. Copper Extraction

Ores, roasting, pyro metallurgical Extraction, smelting, Electrolytic refining, Recovery of precious Metals, Hydrometallurgy of copper, Properties and uses.

### 3. Aluminum Extraction

Ores, Bayer process, Hall Heroult's process, refining of Aluminum, Properties, uses.

### 4. Zinc Extraction

Ores, Extraction Methods, Roasting, distillation, Pyro metallurgical Extraction, Horizontal Retort, Vertical Retort process, Electro thermic reduction, Imperial smelting process, Hydro metallurgy; Galvanizing, Properties uses.

### 5. Lead Extraction

Ores, roasting, sintering, smelting in Blast Furnace, Treatment of base bullion, Refining of lead, Parke's process of desilverisation, Properties, uses.

### 6. Magnesium Extraction

Ores, Pidgeon process, Dow process, Properties, uses.

### 7. Titanium extraction

Ores, metallothermic reduction, Treatment of Ilmenite, chlorination, Kroll process, Van-Arkel process, Properties, Applications.

### 8. Zirconium Extraction

Ores, Treatment of Zircon, Solvent extraction, production of pure zirconium oxide, Zirconium sponge, Properties, Uses.

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## Syllabus for Chemical Engineering (Diploma level)

**MECHANICAL OPERATIONS AND SOLID HANDLING:** Concepts and role of unit operation in process industries, Characterization of Solid Particles, Particle shape, particle size, mixed particle sizes and size analysis, average particle size, number of particles in mixture, Rittinger's law, Bond's law and Kick's law, Crushing efficiency, Gyratory Crusher, Jaw crusher, Grinding rolls, Impact or Attrition mill, Ball mill, Fluid energy mill, Filtrations: Classification of filtrations, filter media, filter aids, mechanisms of filtrations, discontinuous Pressure filters, Filter press, Vacuum filters, Rotary drum filters, Centrifugal filters; Suspended batch centrifuges.

**FLUID MECHANICS:** Measurement of fluid flow with the help of flow meters- Venturimeter: Construction Principle, Working, Coefficient of discharge, Calibration, Derivation, Orifice meter: Construction, principle, Working, Coefficient of discharge, Calibration, Derivation for calculating the flow rates, Rota meter: construction, principle working and Calibration, Pitot tube: Construction, BWG Number Joints and fittings, Gate valve, Globe valve, Ball valve, Needle valve, Nonreturn valve, Butterfly valve, Diaphragm valve. Transportation of Fluids: Pumps-Centrifugal Pump: Parts of centrifugal pump, working of Centrifugal pump. Compressor-Reciprocating & centrifugal compressor, Vacuum Pump, jet ejector - its working and application.

**CHEMICAL ENGINEERING THERMODYNAMICS:** Systems, processes and surroundings, homogenous and heterogeneous systems, closed, open and isolated, intensive and extensive properties, state and path functions. Concept of internal energy, enthalpy, entropy, free energy and equilibrium equation of state, ideal gas law, Vander Waals equation. Amagat's law, Dalton's law, Henry's law, Zeroth law of thermodynamics. First Law of Thermodynamics, second law of thermodynamics, Carnot cycle and its efficiency, concept of entropy, Heat pump and heat engine (coefficient of performance and efficiency), Maxwell relation, Third Law of Thermodynamics. Chemical Reaction Equilibrium and Vapor Liquid Equilibrium. Concept of chemical potential, Gibb's Duhem Equation, Raoul's law, Gibb's phase rule, vapor liquid equilibrium, dew point and bubble point, calculations for two component systems, fugacity, fugacity coefficient, activity, and activity coefficient.

**CHEMICAL REACTION ENGINEERING:** Chemical Kinetics: rate of reaction, rate equation, rate constant, order of reaction, Molecularity of reaction. Theories of reaction rates constant- Arrhenius law, Activation Energy. Batch reactor, semi Batch reactor, constant and variable volume reactions. Integral and Differential method of analysis of batch reactor data. Type of reactor: Batch reactor, Continuous reactor, Plug flow reactor, Mixed flow reactor, Biological reactor, Fixed (packed) bed reactor, fluidized bed reactor.

**CHEMICAL TECHNOLOGY:** Chemical process industries, Process symbols used for various equipment, Uses of different process equipment. Good Manufacturing practices (GMP) and Good Laboratory Practices (GLP)

**MASS TRANSFER OPERATIONS:** Definition of diffusion and its classification viz diffusion under concentration, pressure and thermal gradient, forced diffusion and eddy diffusion. Role of



diffusion in mass transfer, Fick's law, diffusion in the gas phase equimolecular counter diffusion, diffusion through stationary gas. Mass transfer coefficient, film theory and penetration theory, surface renewal theory of mass transfer, diffusion in solids, interface mass transfer, relation between film and overall mass transfer coefficient, Knudsen diffusion. Effect of temperature on adsorption and industrial application, adsorption isotherms, Freundlich absorption isotherm

**Drying:** General Definition – moisture content (wet and dry basis), equilibrium moisture content, bound moisture content, unbound moisture content, free and critical moisture content, rate of drying curve, time of drying, constant and falling rate periods, drying equipment – tray dryer, rotary dryer, spray dryer, fluidized bed dryer and application.

**Distillation:** Concept of Distillation, Vapour Liquid Equilibria, Raoult's Law, Dalton's Law Volatility, Differential or simple Distillation, Rayleigh's equation. McCabe Thiele Method, Feed plate, feed line, q-line, effect of feed condition, reflux ratio, total reflux ratio, Batch Distillation, Azeotropic Distillation, Extractive Distillation, steam Distillation.

**Extraction:** Definition and application of extraction, equipment: mixer settler, spray and packed extraction towers, perforated plate extraction tower, agitated tower extractor.

## MATERIAL SCIENCE

**Properties of Matter:** Elasticity, Pressure, Surface tension, Viscosity and coefficient of viscosity, Concept of fluid motion, stream line and turbulent flow, Reynold's number Equation of continuity, Bernoulli's Theorem and their applications. Atomic Structure, Periodic Table and Chemical Bonding: Fundamental particles- mass and charges of electrons, protons and neutrons Bohr's model of atom and successes and limitations of atomic theory Atomic number, atomic mass number isotopes and isobars.

**Crystallography and imperfections:** Concept of unit cell, space lattice, Bravais lattices, common crystal structures, Atomic packing factor and density. Miller indices. X-ray crystallography techniques, imperfections, Defects & Dislocations in solids.

**Magnetic Properties:** Concept of magnetism-Dia, para, ferro magnetic materials, Hysteresis, Soft and hard magnetic materials. Ferrous and Non-ferrous Materials and Alloys Ceramics and Other Materials

**MEASURING INSTRUMENTS AND MEASUREMENTS:** Introduction and Classification of Instruments. Pressure Measurements, Temperature Measurement: Temperature scales, Bimetallic thermometer, Liquid expansion thermometer, Thermocouples, Resistance thermometer, Optical and radiation pyrometers, Thermistor. Liquid-Level Meters: Float actuated instrument, the-bubbler system, diaphragm box and air trap systems, electrical contact type liquid level indicators. Hydrostatic head density compensator level meter, hydro step, Radar or microwave level indicator, Ultrasonic or sonic level indicator.



**PROCESS EQUIPMENT DESIGN:** Fabrication Techniques, Equipment classification: Pressure Vessels: Pressure vessel code, Design stress and design criteria, Corrosion allowance, Joint efficiency, Shell thickness for spherical and cylindrical vessels, Head or covers- crown and knuckle radius, Thickness of head subjected to internal pressure

### HEAT TRANSFER OPERATIONS

Conduction, Convection, Radiation, concept of steady state and unsteady state heat transfer

**Heat Exchanger:** Codes and standards for heat exchangers, Overall heat transfer coefficient, Shell and tube heat exchangers: Tubes, Shell, Tube sheet layout. (Tube count), Shell types (Passes), Baffles, tie rods, tube joining methods, Flow patterns: Kern's Methods, U tube and floating and heat exchanger Supports for Vessels  
**Distillation Column:** Columns internals, Selection of Key component for multicomponent distillation, vacuum distillation, McCabe Thiele Method

**PROCESS CONTROL:** Automatic control, control systems, Process variables, process degree of freedom, forcing function, step function, ramp, impulse, sinusoidal function and Laplace transformation. Time constant and oscillatory element, determination of system function or transfer Function. 1st order system or time constant element- Naked bulb thermometer, Stirred tank heater, Mixing process, R.C. Circuit, Liquid levels, Two time constant type liquid vessel cascaded non interacting and non-cascaded, interacting. 2nd order system or oscillatory type element- Bulb in thermometer, Mechanical damper.

Closed Loop in Automation Control: Introduction to Programmable Logic Controller (PLC) and Distributed Control System (DCS)

### ENVIRONMENTAL STUDIES

Basics of ecology, eco system- concept, and sustainable development, Resources renewable and non renewable.

**Air Pollution:** Source of air pollution. Effect of air pollution on human health, economy, plant, animals. Air pollution control methods.

**Water Pollution:** Impurities in water, Cause of water pollution, Source of water pollution. Effect of water pollution on human health, Concept of dissolved O<sub>2</sub>, BOD, COD.

Prevention of water pollution- Water treatment processes, Sewage treatment. Water quality standard.

**Soil Pollution:** Sources of soil pollution, Types of Solid waste- E-waste, - Solid Waste Management, Noise pollution

Source of noise pollution, Unit of noise, Effect of noise pollution, Acceptable noise level, Different method of minimize noise pollution.

Environmental Legislation: Water (Prevention and Control of Pollution) Act 1974, Air (Prevention and Control of Pollution) Act 1981 and Environmental Protection Act 1986, Role and Function of State Pollution Control Board and National Green Tribunal (NGT), Environmental Impact Assessment (EIA).

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Impact of Energy Usage on Environment: Global Warming, Green House Effect, Depletion of Ozone Layer, Acid Rain. Eco-friendly Material, Recycling of Material, Concept of Green Buildings.

Recommended books:

- Chemistry in Engineering by J.C. Kuricose & J. Rajaram, Tata McGraw Hill, Publishing Company Limited, New Delhi.
- Unit Operation of Chemical Engineering by McCabe and Smith; McGraw Hill Publication
- Introduction to Chemical Technology by Badger and Banchero, McGraw Hill Publication
- Introduction to Chemical Engineering by Badger & Banchero; McGraw Hill
- Chemical Engineering Thermodynamics by K.V. Narayanan; Prentice Hall India.
- Heat Transfer by McAdams, McGraw Hill Publication
- Chemical Engineering Kinetics by J.M Smith; McGraw Hill Publication
- Mass Transfer Operations by Treybal, Kogakusha Publication
- Material Science by V. Raghvan; Prentice Hall of India.
- Industrial Instrumentation by Donald P. Eckman, Wiley Eastern Publications.
- Environmental Engineering and Management by Suresh K Dhamija; S K Kataria and Sons, New Delhi