भारतीय विज्ञान शिक्षा एवं अनुसंधान संस्थान मोहाली
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दिनांक: 10-10-2022

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Syllabus and Pattern of Examination for the post of Scientific Assistant

1. There will be two Papers (Paper-1 & Paper-2)
2. The Exam will be of 90 minutes duration for **Paper-1**.
3. The **Paper-1** will have three Parts, Part-A, Part-B and Part-C.
4. **Part A** will have 15 multiple choice questions (MCQs) of Mental Ability, all of which have to be answered by the candidates.
5. **Part B** will have 15 multiple choice questions (MCQs) of Instrumentation and research equipment, all of which have to be answered by the candidates.
6. **Part C** will have 60 multiple choice questions (MCQs) from Biology, Chemistry and Physics (20 Questions from each subject). Candidates have to attempt any 20 Questions out of 60 of his/her choice.
7. For MCQs, each correct answer will be awarded 2 marks, and for each wrong answer there will be negative 0.5 marks.
8. **Paper-2**: 8 descriptive questions out of which candidate has to attempt any 5 questions of 5 marks each (Total Marks 25)
9. The Exam will be of 90 minutes duration for **Paper-2** also.
10. **Merit shall be drawn combined with marks obtained in Paper-1 and Paper-2** for final selection of the candidate/s.
11. Both Paper-1 & Paper-2 shall be conducted on the same day.

Syllabus for Paper 1:

Part A: Logical and Mathematical Aptitude, Logical Reasoning, General Knowledge, English (of the Graduation level in Indian Universities)

Part B: Instrumentation and research equipment

Part C: Physical Sciences, Chemical Sciences and Life Sciences (of the Post-graduation level in Indian Universities)

The detailed syllabus for **Part B** and **C of Paper-1** and **Syllabus for Paper-2** is provided below:

Syllabus for Part B (Paper 1)

Basic principles and operation of UV-Vis, IR, Raman, NMR spectroscopy, Fluorescence spectroscopy, Single crystal and powder X-ray, X-ray diffraction, Mass Spectrometry including High Resolution Mass Spectrometry, SAXS/WAXS, Transmission Electron Microscopy (TEM), Scanning Electron Microscopy (SEM), Superconducting Quantum Interference Device (SQUID), Confocal Microscopy, Super resolution microscopy, Flow Cytometry & Cell Sorter, Circular Dichroism (CD) spectroscopy, Electron Paramagnetic Resonance (EPR) spectroscopy, Elemental Analysis, Automated liquid handling system etc.

Syllabus for Part C (Paper 1)

Physical Sciences:

Mathematical Physics:

Vector Analysis, Differential equations and Special functions, Fourier Analysis and Complex analysis

Classical Mechanics:

Newtonian formulation of Classical dynamics, Central force problems, Rigid body Dynamics, Lagrangian and Hamiltonian formulations including variational principles

Electromagnetism:

Electrostatics, Boundary value problems, magneto-statics, Dielectric and magnetic properties of materials, Circuit theory, Maxwell's equations Electromagnetic waves in free space and media, Basics of Waveguides and Antenna, Formulation of Optical phenomena in terms of Electromagnetism, Special theory of relativity and relativistic formulation of electromagnetic theory

Quantum Mechanics:

Hilbert space formulation of state vectors with examples like spin 1/2 and polarization of light, Schrodinger formulation, exactly solvable problems like particle in box, tunnelling, Harmonic Oscillator, Hydrogen atom, Heisenberg formulation of matrix mechanics, Fock representation for Harmonic oscillator, non-determinate and degenerate time independent perturbation theory, time dependent perturbations, variational method.

Thermodynamics and Statistical Physics:

Laws of thermodynamics and their consequences. Thermodynamic potentials, Maxwell relations, chemical potential, phase equilibria. Phase space, micro- and macro-states. Micro-canonical, canonical and grand-canonical ensembles and partition functions. Classical and quantum statistics, ideal Fermi gas , Bose-Einstein condensation,

Electronics and Experimental methods:

Basics of Semiconductors, devices like PN diodes, Schottky diode, Bipolar Transistors MOSFETS and JFETS. Equivalent passive circuits to model transistors and FETs. Operational Amplifiers, Feedback oscillators. Basics of digital circuits, basics of DAC and ADCs, Basics of errors in measurements, error propagation and least squares fitting.

Chemical Sciences:

Inorganic Chemistry:

Chemical periodicity, Structure and bonding in homo- and heteronuclear molecules including shapes of molecules (VSEPR Theory), Concepts of acids and bases, Hard-Soft acid base concept, Main group elements and their compounds (Allotropy, synthesis, structure and bonding), Transition elements and coordination compounds (structure, bonding theories, spectral and magnetic properties, redox chemistry, reaction mechanisms), Organometallic compounds (synthesis, bonding, structure, reactivity and catalytic applications), Cages and metal clusters, Analytical chemistry (separation and spectroscopic, methods, Bioinorganic chemistry (photosystems, porphyrins, metalloenzymes, etc.), Characterization of inorganic compounds (by IR, Raman, NMR, EPR, Mössbauer, UV-vis, NQR, MS, electron spectroscopy and microscopic techniques).

Organic Chemistry:

IUPAC nomenclature of organic molecules including regio- and stereoisomers, Conformational analysis, Stereochemistry, Aromaticity, Reactive intermediates, Organic reaction mechanisms, Reagents in organic synthesis, Functional group transformations, Retrosynthesis, Asymmetric synthesis, Chemistry of heterocyclic compounds, carbohydrates, amino acids and peptides, Polymer Chemistry, Protecting groups, Natural product chemistry (isolation and synthesis), Photochemistry, pericyclic reactions and Structure determination of organic compounds by IR, UV-Vis, ^{1}H & ^{13}C NMR and Mass spectroscopic techniques.

Physical Chemistry:

Basic principles of quantum mechanics, Approximate methods of quantum mechanics, Atomic structure and spectroscopy, term symbols, Chemical bonding in diatomics (elementary concepts of MO and VB theories), Huckel theory for conjugated π-electron systems, Chemical applications of group theory (symmetry elements, point groups, character tables, selection rules), Molecular spectroscopy, Chemical thermodynamics, Statistical thermodynamics, Electrochemistry, Chemical kinetics, Colloids and surfaces, Instrumentation methods (NMR, IR, UV, X-ray, TEM, SEM, Mass Spectrometry, Raman, HPLC, GC, etc.).

Life Sciences:

Biomolecules and Biochemistry:

Structure of atoms, molecules and chemical bonds; Composition, structure and function of biomolecules; Stabilizing interactions; Principles of biophysical chemistry (pH, buffer, reaction kinetics, thermodynamics, colligative properties); Catalysis, enzymes, enzyme kinetics and regulation, isozymes; Conformation and stability of proteins and nucleic acids; Metabolic pathways

Fundamental Processes:

DNA replication, repair and recombination**,** RNA synthesis and processing, Protein synthesis and processing, Control of gene expression at transcription and translation level

Cell Biology:

Membrane structure and function, Structural organization and function of intracellular organelles, Organization of genes and chromosomes, Cell division and cell cycle**,** Cell signaling, Cellular communication, Cancer, Innate and adaptive immune system, Host pathogen interaction

Developmental Biology:

Basic concepts of development; Gametogenesis, fertilization and early development; Morphogenesis and organogenesis in animals; Morphogenesis and organogenesis in plants; Programmed cell death, aging and senescence

Microbiology:

Microbial taxonomy and diversity; Structure of the prokaryotic cell; Microbial growth and differentiation; Microbial genetics

Plant Physiology:

Photosynthesis; Respiration and photorespiration; Nitrogen metabolism; Plant hormones

Sensory photobiology, Solute transport and photoassimilate translocation, Secondary metabolites, Stress physiology

Animal Physiology:

Blood and circulation, Cardiovascular System, Respiratory system, Nervous system, Excretory system, Thermoregulation, Stress and adaptation, Digestive system, Endocrinology and reproduction

Inheritance Biology:

Mendelian principles, Concept of gene, Extensions of Mendelian principles, Gene mapping methods, Extra chromosomal inheritance, Human genetics, Quantitative genetics, Mutation, Structural and numerical alterations of chromosomes, Recombination

Diversity of Life Forms:

Principles & methods of taxonomy; Levels of structural organization; Classification of plants, animals & microorganisms; Natural history of Indian subcontinent; Organisms of health & agricultural importance; Common parasites and pathogens of humans, domestic animals and crops; Organisms of conservation concern

Ecological Principles:
Biotic and abiotic environment and interactions; Habitat and Niche; Population Ecology; Species Interactions; Community Ecology; Ecological Succession; Ecosystem Ecology Biogeography; Applied Ecology; Conservation Biology

Evolution and Behavior:
Emergence of evolutionary thoughts; Origin of cells and unicellular evolution; Paleontology and Evolutionary History; Molecular Evolution; Population genetics; Brain, Behavior and Evolution

Bioinformatics:
Biological databases (Primary, Secondary and Tertiary), DNA and protein sequence alignment-pairwise and multiple sequence alignment, database search using BLAST

Methods in Biology:
Molecular Biology and Recombinant DNA methods, Histochemical and Immunotechniques, Biophysical Methods, Statistical Methods, Radiolabeling techniques, Microscopy techniques, Electrophysiological methods, Methods in field biology, NMR, EPR, Flow Cytometry and cell sorting, Confocal microscopy, Mass Spectrometry, UV-visible and fluorescence spectroscopy, X-ray diffraction.

Applied Biology:
Microbial fermentation; Application of immunological principles, vaccines, diagnostics; Tissue and cell culture methods for plants and animals; Transgenic animals and plants, molecular approaches for diagnosis and strain identification; Genomics and its application to health and agriculture; Bioresource and uses of biodiversity; Breeding in plants and animals; Bioremediation and phytoremediation; Biosensors

Syllabus for Paper 2

The descriptive type questions will be asked from the syllabus of Part B of Paper 1.

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