



Frontier Research Institute for Interdisciplinary Sciences  
ISLAMIC UNIVERSITY OF SCIENCE & TECHNOLOGY  
AWANTIPORA-192122, J&K

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**Syllabus for Ph. D. Entrance Test: FRIIS**

**Time Duration: 90 min**

**Maximum Marks: 70**

**Part-I — 35 Multiple Choice Questions**

**35 x 1 = 35**

**Part-II/III — 35 Multiple Choice Questions**

**35 x 1 = 35**

**Note:** The syllabus comprises of three sections I, II and III. Section I is compulsory while students have an option to choose between Section II (Physical, Chemical, and Materials Science) and Section III (Biological Science). Only two sections must be attempted in the test.

**Part-I**

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**Unit 1: Fundamentals of Research Methodology**

Meaning and Types of Research; Objective of Research; Definition and Motivation; Types of Research; Research Approaches, Steps in Research Process; Criteria of Good Research; Ethics in Research. Research Formulation and Literature Review: Problem Definition and Formulation.

**Unit 2: Quantitative Aptitude for Research**

Arithmetic: Percentages, profit & loss, ratio & proportion, averages, time & work, simple and compound interest; Algebra: Simplification, linear equations, quadratic equations; Geometry and Mensuration: Shapes, areas, volumes, angles; Number Systems: Divisibility, LCM & HCF, factors.

**Unit 3: Logical Reasoning in Research**

Verbal Reasoning: Syllogisms, analogies, critical reasoning; Non-Verbal Reasoning: Pattern recognition, puzzles, figure completion; Seating Arrangements: Circular and linear arrangements; Blood Relations: Understanding family hierarchies; Series Completion: Number and letter series.

**Unit 4: Data Interpretation and Analysis**

Data analysis process: mean, mode, median, sample variance and sample standard deviation; Data Sufficiency: Techniques such as least squares fitting, linear and non-linear regression, and correlation analysis; Hypothesis Testing: Covering T-tests and F-tests for significance; Chi-Square Goodness of Fit Tests: Understanding the significance of fit; Visual Data Representation: Proficiency in interpreting tables, pie charts, bar graphs, line graphs, and mixed data formats.

**Unit 5: Experimental and Analytical Techniques**

X-ray Diffraction (XRD): Principles and applications; Microscopy Techniques: Scanning Electron Microscopy (SEM) and Transmission Electron Microscopy (TEM) ; Scanning Probe Microscopy: Atomic Force Microscopy (AFM), Scanning Tunneling Microscopy (STM) ; Optical Characterization: Raman spectroscopy and UV-Vis spectroscopy; Thermal Analysis: Thermogravimetry, Differential Thermal Analysis, and Differential Scanning Calorimetry.

## Part-II

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### **Unit 1: Condensed Matter Physics**

Materials and their types; Crystalline Solids: Close-packed structures, unit cells, and their classifications; Bravais lattices, Miller indices, and crystal planes; Symmetry in crystals: Point groups and space groups; Reciprocal Lattice, Definition and significance; Diffraction: Bragg's law and structure factor; Defects and Dislocations: Types and effects on material properties; Ordered Phases: Translational and orientational order; liquid crystalline phases and quasicrystals.

### **Unit 2: Properties of Materials**

Bonding of solids, Types and characteristics; Elastic Properties: Phonons and lattice-specific heat; Electron Theories: Free Electron Theory and electronic specific heat, Drude model for electrical and thermal conductivity; Hall Effect and Thermoelectric Power: Principles and applications; Band Theory: Metals, insulators, and semiconductors.

### **Unit 3: Thermodynamics and Statistical Physics**

Phase Transitions: First- and second-order transitions; Bose-Einstein Condensation: Principles and implications; Diffusion and Dynamics: Random walks and Brownian motion; Nonequilibrium Processes: Basic concepts.

### **Unit 4: Magnetism and Superconductivity**

Magnetic Materials: Dia-, para-, and ferromagnetism; Origin of Magnetism: Theoretical frameworks and temperature effects; Magnetic Domains: Structure and properties; Superconductivity Concepts: Critical temperature, Type-I and Type-II superconductors; Zero resistance, Meissner effect, perfect diamagnetism, Meissner effect, Cooper pairs, Josephson junctions, and BCS theory.

### **Unit 5: Nanoscience and Nanotechnology**

Definitions, history, and significance; Nanomaterial Classification: Zero-dimensional (clusters), one-dimensional (nanowires), two-dimensional (thin films, graphene), and hierarchical nanomaterials; Nano-size effects: surface to volume ratio (surface effects) and quantum confinement effect in quantum dots; Variation in physical properties of nanomaterials in comparison to bulk materials: Lattice constants, melting point and electrical conductivity.

### **Unit 1: Introductory Topics**

Biomolecules, Enzymes, Metabolism of carbohydrates, Proteins and Lipids; Understanding of Normality, Molarity, Molality, preparation of solutions, Buffers, media; Cell and Bacterial cultures; Basic introduction to spectroscopy and microscopy.

### **Unit 2: Cell Biology**

Structure of Cell; Functions of different organelles of cell; Cell division and cell death. Different modes of cell death; Cell- cell communication; Different types of Receptors and signalling pathways: TLR, GPCR, NLR, CLR, RLR; In-depth understanding of RAS, MAPK, PI3/AKT/mTOR pathways

### **Unit 3: Molecular Biology and Applications**

Introduction to nucleic acids; DNA replication, transcription, Translation; Post transcriptional and translational modifications. Splicing; Understanding of Basic molecular biology techniques (Plasmids and different types of plasmids in use; Nucleic acid purification (RNA and Genomic DNA), Cloning, Gateway cloning. Plasmid isolation, Tag based protein purification, Agarose and SDS PAGE electrophoresis).

### **Unit 4: Immunology**

Innate and adaptive immune system. Antigen processing and Presentation; Overview of immune breakdown in the initiation and progression of Cancer; Immunotherapy. Checkpoint blockade therapy; Basic understanding of commonly used techniques in Immunology (ELISA, FACS, Marker based identification of different immune cells, Immunohistochemistry, H&E staining)

### **Unit 5: Cancer Biology**

Hall marks of cancer cells; Mutational landscape (consequences in terms of pathways initiated and blocked) of some common cancers (Lung, Gastric, Pancreatic, Colon, Breast, Brain); Mechanism of Apoptosis inhibition and immune evasion in cancer cells; Common anticancer drugs and mechanism of action (Gemcitabine, Folfirinox, Doxorubicin, Cisplatin etc.)