

# IISC Admission Syllabus – Research Programme

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## MATHEMATICS

The [question paper](#) will contain 2 parts : Part A and Part B.

Part A will be of 40 marks and will contain questions of objective types, namely multiple choice and fill in the blanks.

Part B will be of 60 marks and will contain 10 questions out of which 6 will have to be answered. The syllabus for the entrance test is given below

### 1. Real Analysis

Real valued functions of a real variable: continuity and differentiability, sequences and series of real numbers and functions, uniform convergence, Riemann integration, fundamental theorem of integral calculus. Topology of  $\mathbb{R}$ , Compactness and Connectedness.

### 2. Complex Analysis

Continuity and differentiability, analytic functions. Cauchy's theorem, Cauchy's integral formula. Taylor and Maclaurin expansions, Laurent's series, singularities, theory of residues and contour integration, conformal mappings.

### 3. Linear Algebra

Vector space: linear independence, basis, dimension, linear transformations and matrices, Systems of linear equations, rank and nullity, characteristic values and characteristic vectors, Cayley-Hamilton theorem, characteristic and minimal polynomials, diagonalizability, Jordan canonical form.

### 4. Abstract Algebra

Groups: subgroups. Lagrange's theorem, normal subgroup, quotient group. homomorphisms, permutation groups. Cayley's theorems, Sylow theorems, Rings, Ideals Fields.

## 5. Ordinary Differential Equations

First order ODEs and their solutions, singular solutions, existence and uniqueness of initial value problems for first order ODE. General theory of homogeneous and nonhomogeneous linear differential equations. Variation of parameters. Types of singular points in the phase plane of an autonomous system of two equations.

## CHEMISTRY

All questions will be of objective types.

## SYLLABUS

**Structure and Bonding :** Atomic orbitals: electronic configuration of atoms (Aufbau principle); periodic properties of elements; chemical bonding; the concept of hybridization; molecular orbitals; electronic configuration of diatomic molecules; shapes of molecules and physical properties; bond length, bond angles, bond order and bond energies; intermolecular forces; hydrogen bond; kinetic theory of gases. solutions-colligative properties, activity coefficients; solids-types of solids, crystal structure and packing.

**Spectroscopy :** Principles of electronic, vibrational, rotational and magnetic resonance spectroscopy and mass spectrometry and their application to simple structural problems in chemistry. Dipole moment and molecular structure.

**Chemical Energetics and Chemical Dynamics :** Law of conservation of energy; enthalpy, entropy and free energy of chemical reaction: relationship between free energy change and equilibrium. Rates of chemical reactions; theories of chemical reactions and Arrhenius equation; homogeneous and heterogeneous catalysis; Electro-chemistry; strong and weak electrolytes, Debye-Huckel-Onsager treatment; Electrochemical cells. Electrode-electrolyte interface.

**s, p, d, f, Block Elements and Coordination Compounds :** General characteristics of each block; Nuclear Chemistry: Noble gas compounds; Lanthanides and actinides: Co-ordination

compounds, Crystal and ligand field theories; Spectral and magnetic properties; Stereochemistry and isomerism.

### **Nomenclature of Organic Compounds and Stereo Chemistry of Organic**

**Compounds:** Compounds containing not more than three rings and three heteroatoms; principles of chirality and optical activity; optical and geometrical isomerism, methods of resolution, conformational analysis of cyclohexanes.

**Common Organic Reactions and Mechanisms :** Formation, stability and structure of carbonium ions, carbanions and radicals: nucleophilic and electrophilic substitution and addition reactions; mechanism of SN1 and SN2 reactions; the concept of aromaticity and characteristic reactions of aromatic compounds; elimination reactions; rearrangements such as Beckmann, Hoffman, Claisen, pinacol-pinacolone and ben7idine rearrangement. Routine functional group transformations and interconversion of simple functionalities.

## **BIOLOGICAL SCIENCES**

All questions will be of objective types.

### **SYLLABUS**

Acids, Bases and solutions: Chemical reactions; Energy; Enzymes: Viruses. prokaryotes and eukaryotes; Cellular organisation and function; Cell cycle; Genetic material; Inheritance; Vitamins and hormones; Body defence mechanisms, Evolution.

Structure of biomolecules; Viruses, bacteriophages, prokaryotic and eukaryotic cells; Nutrition and growth of prokaryotic and eukaryotic cells; Enzymes and enzyme kinetics; Intermediary metabolism and its regulation; Structure and function of cell membranes; Photosynthesis; Gene structure, expression and regulation; Transduction, conjugation and transformation; Recombinant DNA methodology: Mutation and gene mapping: Micro-organisms and diseases: Environmental and industrial microbiology; Antimicrobial agents and their mode of action; Biogeochemical cycles: Plant and animal hormones and their mode of action: Pathogens and host parasite relationships. Antibody structure and function; Humoral and cellular immune responses and their regulation, Morphogenesis and differentiation. Mechanisms and evolution of Animal behaviour; Systematics; Population dynamics and Community Ecology of plants and animals. Population Genetics, Basic Statistical Analysis. Basic statistics and Mathematics. Basic Principles in Evolutionary Biology.

## **ECOLOGICAL SCIENCES**

All questions will be of objective types.

## **SYLLABUS**

M Sc. Level: Population ecology, community ecology, ecosystem ecology, animal behaviour, evolutionary biology, population and classical genetics, conservation biology, environmental science, botany, zoology and statistics.

Class XII Level: Basic mathematics, physics, chemistry, cell and molecular biology.

## **MANAGEMENT**

### **NOTE**

The question paper consists of three parts: Part A, Part B, and Part C. Candidates seeking admission to research in management must compulsorily write Part A and one of the five sections in Part B. Part A is on “Analytical Ability and Management Aptitude” and carries 50% weightage. Part B consists of FIVE sections, which are as follows:

a) Section I Business Administration [for MBAs] b) Section II Economics [for MA (Econ) students] c) Section III Psychology [for MA or MSc (psycho) students] d) Section IV Social Work [for MA (SW) students] e) Section V Management Science [for students with Masters in Mathematical Sciences]

Candidates have to choose one section, consistent with their background, in this part. For example, a candidate with M.A. (Economics) may prefer to write Section II: Economics, while a student with M.B.A. degree must choose Section I: Business Administration. This part also carries 50% weightage.

Candidates with a Bachelor’s degree in Engineering or Technology who intend to apply for admission to any of the research programmes in Management Studies may write Sections A & B above. Alternatively, they can opt for paper in their respective engineering discipline, if [available](#). For the papers available in engineering disciplines [check](#) page 15 of this [brochure](#). They should make their choice clear in [application form](#). Those who opt for Management paper have to answer Part A compulsorily and any one of the section in Part B. The choice from the Sections in Part B may be made at the time of examination.

Part C consists of ONE section, which is as follows:

a) Section I German

Only candidates with M.A. (German) seeking admission to research in languages should answer Section I in Part C and it carries 100% weightage.

### **PART A: Analytical Ability and Management Aptitude**

This is primarily an aptitude test of a general nature and no specialized training is required to answer this section. The aspects covered in this part are logical and analytical reasoning, understanding of descriptive material and verbal ability, and quantitative aptitude with mathematical knowledge at +2 level.

**Type of Paper:** Objective type (Multiple-choice) with 50 questions. Candidates have to choose and tick the correct answer from among a choice of four.

### **PART B: Section I: Business Administration**

**Development of Management Thought:** Principles of Management Functions and Processes of Management as they relate to Planning, Organizing, Directing and Control of Business and Industry. Man Power Planning, Selection and Recruitment. Training and Development, Compensation of Employees, Motivation and Communication.

Production Planning and Control, Facility. Location and Plant Layout, Productivity Improvement through Work Study, Production and Inventory Control, Quality, Project Planning and Control using Networks.

Organizational Funds — Sources, Financial Statement, Determination of Cost of Capital, Use of Capital Budgeting, Time Value of Money, Cost-Value, Profit Analysis, Investment Decisions. Use of Accounting for Planning and Control, Marketing of Goods and Services, Buyer Behavior. Market Segmentation, Marketing Planning. Marketing Mix, Product Life-Cycle, Pricing, Distribution, Advertising and Promotion, Marketing Control. Management Information Systems, Applications of Computers. Statistical and Quantitative Techniques for Management Decisions.

### **PART B: Section II: Economics**

Theories of Consumer Behavior, Production Function, Cost Function, Economics of Scale and Scope, Market Structure, Pricing of Products, National Income Accounting, National Income Measurement in India, Theories of Inflation, Price Indices and Inflation Measurement in India, Economic Reforms, Monetary Policy, Industrial Policy, Small Scale Industry, Foreign Investment. Theories of Economic Growth. and Industrial Development.

### **PART B: Section III: Psychology**

Concepts and Principles of Human Behavior — Determinants of Behavior — Attention — Perception — Memory — Learning — Motivation — Emotion – Frustration and Conflict. Application of Social Psychology in Industries — Attitudes and morale — the role of Industrial Psychology, its scope and application – Job Analysis — Job Evaluation — Training — Leadership – Communication-Group Counseling – Problems of Mental Health in Industries.

### **PART B: Section IV: Social Work**

Nature of Industrial Society : Social consequences of industrialization, Industrialism and Indian Society. History, Philosophy and fields of Social Work. Social case work, group work and community organization. Attitude, Morale and Motivation. Leadership, Groups and individual behavior. Personnel Management : Concept and functions. Industrial labour legislation. Labour movement in India. Labour welfare. Social research — design and methodology.

### **PART B: Section V: Management Science**

Calculus & Linear Algebra – Limits. Differentiation. Integration. Addition, Subtraction, Multiplication, and Inversion of matrices. Linear System of Equations. Rank. Determinants. Eigenvalues & Eigenvectors.

Probability Theory – Combinatorics. Probability Laws. Conditional Probability Bayes Theorem. Univariate Discrete & Continuous Random Variables. p.m.f. p.d.f. c.d.f. & m.g.f. Standard Univariate Discrete & Continuous Distributions: Binomial, Geometric, Poisson, Negative Binomial, Hyper-Geometric, Uniform, Exponential, Gamma. Normal & Weibull.

Model construction (LP, IP, MILP), Simplex Method, Sensitivity Analysis, Economic Interpretation, Allocation Problems: The Assignment and Distribution of Resources, Inventory Problems, Forecasting problems, Replacement. Maintenance, and Reliability Problems,

Dynamic Programming, Queuing Problems, Sequencing and Coordination (PERT and CPM) Problems, Routing Problems in Networks, Simulation.

Applied Statistics – One & Two Sample Parametric and Non-Parametric tests for Location and Scale. Analysis of Variance. Simple and Multiple Correlation & Regression. Analysis of Covariance. Chi-Square tests for categorical variables.

Classification of Information Systems, Software Engineering, UML, Database Management Systems, SQL, Fundamental Data Structures : Linked Lists, Stacks, Queues, Binary Trees, Directed Graphs.

### **PART C: Section I: German**

1. Methodik und Didaktik

2. Sprachgebrauch.

1. Methodik und Didaktik

Kurze Einführung in die Methoden des fremdsprachlichen Unterrichts — Grammatik-Obersetzungsmethode, audio-linguale Methode, vermittelnde Methode, direkte Methode, kommunikative Methode, interkulturelle Methode, Merkmale dieser Methode, Lernsituation. Lehrsituation, Lernerperspektive, Lehrerperspektive.

2. Sprachgebrauch

Texte schreiben — Schilderung, Bericht, Erörterung, Beschreibung, Aufsatz usw. Grammatik, Satzstruktur usw.

### **MATERIALS SCIENCE**

Materials Science

(i) Elementary quantum mechanics, atomic structure, wave mechanical model, electronic configurations, ionic, covalent, metallic and van der Waals bonding; interatomic potentials.

(ii) Crystal symmetry, point group, space group, indices of planes, close packing in solids, type structures, coordination, radius ratios concepts, special structures (silicate, spinel etc.), amorphous materials.

(iii) X-ray, electron and neutron diffraction techniques, indexing of diffraction patterns, crystal structure analysis: non-destructive testing.

IV. Defects in solids, point defects, dislocations (edge and screw) Burgers vector, grain boundaries, defect interactions; surface energy; equilibrium shape.

V. Thermodynamics, phase rule, phase diagrams, solid solution, invariant reactions, lever rule; iron-carbon diagram, solidification, phase transformation, recrystallization, diffusion, Ficks laws, mechanisms of diffusion, temperature dependence of diffusivity; zone refining; crystal growth.

VI. Physical properties of materials; specific heat, thermal conductivity, electrical conductivity, magnetism; dia. para, ferro and ferro-magnetism, dielectric behaviour, piezo and ferroelectric materials, domains; free electron theory, fermi energy, density of states, elements of band theory; semiconductors, Hall effect, optical properties.

VII. Mechanical properties, elements of elastic and plastic behaviour of materials, stress-strain relations, slip planes and systems, modes of deformation, hardness, strengthening mechanisms, effect of temperature on strength, relations between mechanical properties and microstructure; fatigue, creep and fracture of materials.

VIII. Effect of environment on materials; corrosion, oxidation, biological attack.

IX. Processing of materials; chemical synthesis; powder processing: sintering.

X. Special materials in modern technology: composite materials, high Te superconductors; diamond; nanophase materials; electrooptic and magneto optic materials; C50 and related materials.

XI. Elements of mathematics-Analytical solid geometry, differentiation, integration, differential equations, typical differential equations in science; vectors, determinants, matrices, Fourier series, complex analysis, probability and statistics.