5 Syllabi and Model Questions for Entrance Test

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 R^n, 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, dimention, 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.

Suggested Books for reference :

1. Rudin, W.: Principles of Mathematical Analysis, Third Edition, International Edition, 1976, McGraw-Hill Book Co.Singapore.

2. Churchil, R V. and Brown, J.W.: Complex Variables and Applications, McGraw-Hill, New York, 1990.

3. Hoffman, K. and Kunze, R.: Linear Algebra, Prentice Hall of India Pvt Ltd., Newe Delhi,1978.

4. Herstein, I,N.: Topics in Algebra, Second Edition, Vikas Publishing House Pvt Ltd, New Delhi, 1976.

MODEL QUESTIONS

Let $\mathbb{Z}$, $\mathbb{R}$, $\mathbb{Q}$ and $\mathbb{C}$ denote the set of integers, real numbers, rational numbers and complex numbers respectively.

PART A

(1) The function $f : \mathbb{R} \to \mathbb{R}$ satisfies $|f(x) - f(y)| \leq c|x - y|$ for all $x, y \in \mathbb{R}$ and some constant $c \in \mathbb{R}_+$. Then,

    (A) f must be bounded.

    (B) f must be continuous but may not be uniformly continuous.

    (C) f must be uniformly continuous but may not be differentiable.

    (D) f must be differentiable.

(2) Let $f : \mathbb{R} \to \mathbb{R}$ be continuous with $f(0) = f(1) = 0$. Which of the following is **not** possible.

    (A) $f([0, 1]) = \{0\}$.

    (B) $f([0, 1]) = [0, 1)$.

    (C) $f([0, 1]) = [0, 1]$.

    (D) $f([0, 1]) = [-\frac{1}{2}, \frac{1}{2}]$.

(3) The function $f(z) = \exp\left(\left(\dfrac{\cos z - 1}{z^2}\right)^2\right)$

    (A) has a removable singularity at $z = 0$.

    (B) has a pole of order 2 at $z = 0$.

    (C) has a pole of order 4 at $z = 0$.

    (D) has an essential singularity at $z = 0$.

(4) The region described by $\left|\dfrac{z - i}{z + i}\right| < 1$, where $z = x + iy \in \mathbb{C}$ is

    (A) $\{z \in \mathbb{C} : x > 0\}$.

    (B) $\{z \in \mathbb{C} : x < 0\}$.

    (C) $\{z \in \mathbb{C} : y > 0\}$.

    (D) $\{z \in \mathbb{C} : y < 0\}$.

(5) Let $X = \{1/n : n \in \mathbb{Z}, n \geq 1\}$ and let $\bar{X}$ be its closure. Then

    (A) $\bar{X} \setminus X$ is a single point.

    (B) $\bar{X} \setminus X$ is open in $\mathbb{R}$.

    (C) $\bar{X} \setminus X$ is infinite but not open in $\mathbb{R}$.

    (D) $\bar{X} \setminus X = \phi$.

(6) Let A be a matrix such that $A^3 = -I$. Then which of the following numbers can be an eigenvalue of A.

(A) i.

(B) 1.

(C) -1.

(D) $\frac{1}{2} + \frac{\sqrt{3}}{2}i$.

(7) Let V be the vector space of all polynomials whose degree is less than or equal to n. Let $D : V \to V$ be the differentiation operator on V, that is, $DP(x) = P'(x)$. Then the trace of D, $\text{tr}(D)$ equals

(A) 0.

(B) 1.

(C) n.

(D) n^2.

(8) Let G be the cyclic subgroup of order 18. The number of subgroups of G, including G and the trivial group, is

(A) 4.

(B) 6.

(C) 9.

(D) 18.

PART B

(1) Let $F_n : \mathbb{R} \to [0, 1]$, $n \geq 0$, be functions satisfying

(i) $F_n(x) \leq F_n(y)$ for all $x \leq y$,

(ii) $\lim_{x \to -\infty} F_n(x) = 0$, and

(iii) $\lim_{x \to \infty} F_n(x) = 1$.

If $F_n(x) \to F_0(x)$ for all $x \in \mathbb{R}$, show that F_n converges uniformly to F_0 on $\mathbb{R}$, as $n \to \infty$.

(2) Given n points $z_1, z_2, \cdots, z_n$ on the unit circle $\{z \in \mathbb{C} : |z| = 1\}$, prove that there exists a point z on the unit circle such that $\prod_{i=1}^{n} |z - z_i| \geq 1$.

(3) Let $\Delta(0, R) = \{z \in \mathbb{C} : |z| < R\}$, denote the open disc in the complex plane around the origin of radius R and let $n \geq 1$ be an integer. Let $f : \Delta(0, R) \to \mathbb{C}$

be an analytic function. Evaluate

$$\int_{\Delta(0,R)} \overline{z}^{\,n-1} f(z) \, dx \, dy.$$

(4) For $A, B \subseteq \mathbb{R}^2$, define the distance $d(A, B) := \inf\{\|x - y\| \; : \; x \in A, \; x \in B\}$. Let $C, D \subseteq \mathbb{R}^2$ be two closed subsets. If $C \cap D = \emptyset$ and $d(C, D) = 0$ then show that both C and D are unbounded.

(5) Let $L : \mathbb{R}^n \to \mathbb{R}^n$ be an invertible linear transformation and let $V \subset \mathbb{R}^n$ be a subspace such that $L(V) \subseteq V$. Show that $L(V) = V$. Here $L(V) = \{L(v) : v \in V\}$.

(6) Let A be a 2×2 invertible matrix over real numbers such that for some 2×2 invertible matrix P, $PAP^{-1} = A^2$. Show that either $A^3 = I$ or $QAQ^{-1} = \left(\begin{smallmatrix} 1 & 1 \\ 0 & 1 \end{smallmatrix}\right)$, for some invertible 2×2 matrix Q.

(7) Suppose G is a finite group. Show that every element x of G can be expressed as $x = y^2$ for some $y \in G$ if and only if the order of G is odd.

(8) Let G be a group with identity e. Let N_1, N_2, N_3 be three normal subgroups of G. If $N_i \cap N_j = \{e\}$ and $N_i N_j = G$ for $1 \leq i \neq j \leq 3$ then show the following:
  (i) $xy = yx$ for $x \in N_i$, $y \in N_j$, $1 \leq i \neq j \leq 3$.
  (ii) $yz = zy$ for $y, z \in N_i$, $1 \leq i \leq 3$.
  (iii) G is commutative.

(9) Let $y : \mathbb{R} \to \mathbb{R}$ be an infinitely many times differentiable function which satisfies

$$y'' + y' - y \geq 0, \quad y(0) = y(1) = 0.$$

If $y(x) \geq 0$ for all $x \in [0, 1]$, prove that y is identically zero in $[0, 1]$.

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 S_N1 and S_N2 reactions; the concept of aromaticity and characteristic reactions of aromatic compounds; elimination reactions; rearrangements such as Beckmann, Hoffman, Claisen, pinacol-pinacolone and benzidine rearrangement. Routine functional group transformations and interconversion of simple functionalities.

MODEL QUESTIONS

1. The bond order of the molecular species CO, O_2^+, O_2^- and He_2^+ increases in the order :

   (a) $CO < He_2^+ + < O_2^- < O_2^+$

   (b) $He_2^+ < O_2^- < O_2^+ < CO$

   (c) $He_2+ < CO < O_2^+ < O_2^+$

   (d) $He_2^+ O_2^+ < CO < O2^-$

2. The energy levels (E_n) of a harmonic oscillator are quantized as :

   (a) $(n+1)h\nu$ (b) $nh\nu$

   (c) $(n+1/2)h\nu$ (d) $(n^2+1/2)h\nu$

3. The ratio of the crystal field splitting in tetrahedral and octahedral environments for identical ligands is :

   (a) 2/3   (b) 5/8   (c) 4/9   (d) 1/2

4. The reaction of benzoic acid with diazomethane yields -

   (a) phenylacetic acid   (b) methyl benzoate

   (c) acetophenone   (d) p-toluic acid

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; Bio-geochemical cycles; Plant and animal harmones 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.

MODEL QUESTIONS

(CIRCLE THE CORRECT ANSWER)

1. What is the molarity of water in pure water
    (a) 18   (b) 1000   (c) 55.5   (d) 1.0

2. For sedimentation velocity studies by using UV optics one requires larger amounts of protein than nucleic acid because :

    (a)   The absorption co-efficient of DNA is higher than protein
    (b)   Proteins rapidly sediment to form pellets
    (c)   Proteins tend to denature during sedimentation
    (d)   Proteins are smaller than nucleic acids.

3. Mitosis occurs between :
    (a) G1 and S phase   (b) S phase and G1
    (c) G2 and G2 phase   (d) S phase and G2

4. The amino acid which has only one codon is :
    (a) Glycine   (b) Arginine
    (c) Tryptophan   (d) Cysteine

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.

MODEL QUESTIONS

(CIRCLE THE CORRECT ANSWER)

1. Current phylogenetic studies indicate that seals and sealions are part of :

(A) Perissodactyla

(B) Sirenia

(C) Carnivora

(D) Cetacea

2. Of three lizard species A, B and C that form a monophyletic group, A and B possess the ability to glide in the air, while C does not. Molecular genetic studies indicate that B and C are more closely related to each other than either is to A. Which of the following statements is most likely to be true, given the principle of parsimony?

(A) Gliding in the air is an ancestral trait for this group

(B) Gliding in the air is a derived trait for this group

(C) Gliding in the air is an ancestral trait for all lizards

(D) The ability to glide has been lost only in this group of lizards

3. Which theory proposes that the number of species at a site is determined by the balancing of rates of immigration of species to that site with the local extinction of species already present?

(A) Stability-Time Hypothesis

(B) Pleistocene Forest Refugia Hypothesis

(C) Theory of Island Biogeography

(D) Periodic Extinction Hypothesis

4. Three predators are foraging independently in a habitat patch where the probability of a predator finding a prey individual during a foraging session is 0.3. The probability that at least one predator successfully feeds in that foraging session is:

(A) 0.30

(B) 0.66

(C) 0.90

(D) 0.70

5. A 22 meter long python is just able to curl itself around the trunk of a cylindrical tree. The radius of the tree-trunk is

(A) 7 meters

(B) 349.86 meters

(C) 350.14 cms

(D) 3.14159 meters

6. The dominant stage in the life cycle of which of the following groups of plants is the sporophyte?

(A) Bryophytes, Pteridophytes and Gymnosperms

(B) Bryophytes, Gymnosperms and Angiosperms

(C) Pteridophytes, Gymnosperms and Angiosperms

(D) Only Angiosperms

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.

MODEL QUESTIONS

1. Changes in Soviet Russia have been attributed to as the failure of communism. There has been widespread poverty and shortage of essential goods / commodities caused by state regulations. There is therefore disillusionment among the poor and the middle class. The question uppermost in the minds of those concerned is whether:

   a) a fairly high level of economic development is essential for the success of communism.
   b) there is an alternative to communism, which will protect the poor-exploitation
   c) a market oriented economy can provide the basic necessities at an affordable price.
   d) the communist econocrat will be replaced by the political autocrat.

2. A right-cylindrical container is half full with water, and mango pulp is poured into it from a right-circular cone, full to its brim, with the same height and base radius of that of the right-cylindrical container. Half of the mixture is poured out and mango pulp is added till the right-cylindrical container became half full again. The ratio of mango pulp to the water in the container is now

   a) 1:1   b) 1:2   c) 2:1   d) 2:3

3. If a, b, x, and y stand for different positive integers not greater than 100, what is the largest possible value of $\dfrac{a - b}{x + y}$?

   a) $32\dfrac{1}{3}$ b) $19\dfrac{4}{5}$ c) $24\dfrac{1}{2}$ d) none of these.

4. Choose one of the following pairs appropriate for describing the relationship as Prism : Triangle :

   a) Cylinder : Circle   b) Cylinder : Sphere
   c) Pyramid : Cone   d) Glass : Metal

5. Fill in the blanks with appropriate pair of words: Despite his _____ unwillingness, the promoters were still hopeful of _____ him into signing the contract.

   a) patent ; ensnaring   b) extreme ; influencing
   c) apparent ; joining   d) obvious ; ingratiating

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.

Type of Paper: Essay Type and Problems.

MODEL QUESTIONS

1. Describe any four statistical techniques used in Market Research.

2. What are the barriers in effective decision-making? How would you go about decision-making under uncertainty and risk?

3. What is the role of budget in organizational control? Explain zero-based budgeting.

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.

Type of Paper: Essay Type.

MODEL QUESTIONS

1. Distinguish isoquants from isocost lines. Analyze the role of each for a firm's equilibrium.

2. Analyze how product differentiation can be used as a means of price discrimination in a monopolistic competitive market.

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.

Type of Paper: Objective questions, short notes, essay type.

MODEL QUESTIONS

1. Explain briefly the factors, which influence effective communication in a team. What are the roles in a team and how does communication change according to a given role?

2. Which of the following is <u>not</u> a personality type

   a) Locus of control
   c) Extraoverism

   b) Type A, type B
   d) Shyness

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.

Type of Paper : Short notes plus essay type.

MODEL QUESTIONS

1. What is work? Discuss the nature of work in industrial society.

2. Write short notes on any one of the following:

   a) Social case work

   b) Experimental design.

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.

Type of Paper : Short answer type; problems.

MODEL QUESTIONS

1. Find the inverse of the following matrix:

$$\begin{bmatrix} \lim_{x \to 0} x \sin x & \dfrac{1}{e^e} \dfrac{d}{dx} x^x \big|_{x=e} \\ \int_0^1 \log x\, dx & \lim_{x \to 0} \dfrac{e^{2x} - 1}{x} \end{bmatrix}$$

2. A multi-national bank venturing into the rural sector has set up the following procedure akin to their global credit policies, for approval of renewal of loan applications from farmers requesting for a loan of less than Rs.10,000. An application is outright rejected if there ever has been a default of payments in the past and 40% of the farmers fall in this category. An application is renewed if either the total amount of outstanding debt of the farmer to the bank, say X in thousands of Rs., is less than 10; or if the amount of collateral held by the bank, say Y in thousands of Rs., is more than 25. X and Y are empirically found to be independent of each other. Marginal distributions of X and Y respectively are $N(12,2^2)$ and $exp(15,0.12)$ for all the farmers tied up with the bank, while the respective distributions are $N(11,0.75^2)$ and $exp(15,0.09)$ among the farmers who have never defaulted a payment, where $exp(a,\lambda)$ is the two-parameter exponential distribution with the p.d.f. $\lambda e^{-\lambda(y-\alpha)} I_{[\alpha,\cdot]}(Y)$. It is also known that among the farmers who have defaulted payments in the past, only 1% have both $X < 10$ and $Y > 25$. What percentage of loan applications of the farmers will be renewed?

3. Consider the *single machine multiple job* sequencing problem. Each $J_i(I = 1..n)$ undergoes processing at the machine for a deterministic duration of p_i time units. Define the completion time for a job as $c_i = b_i + p_i$, where b_i is the beginning time for job J_i. Assume that the beginning time for the first job that is sequenced on this machine is 0.

Prove that if we sequence the jobs in the non-decreasing order of their respective processing times, we minimize the total completion time $\sum_{i=1..n} C_i$.

4. A study is conducted to investigate how quality-consciousness, say Y; of entry-level managers in the manufacturing industry is affected by their educational background, say B; experience, say E; and leadership trait, say L. Y is measured in a 1 to 10 scale by means of a questionnaire. B has 3 levels, namely Science/Engineering, Commerce and Humanities. E has two levels namely inexperienced and experienced. L, also assessed through the questionnaire, has two levels namely presence and absence of leadership trait. A sample of 24 managers is obtained with 2 managers at each treatment combination. The adjusted Total Sum of Squares is found to be 53.0162 and the Residual Sum of Squares (SSE's) for all the 7 possible models for quality-consciousness involving one, two or all three factors (educational background, experience and leadership trait) are as follows:

Model	$Y \sim B$	$Y \sim E$	$Y \sim L$	$Y \sim B * E$	$Y \sim B * L$	$Y \sim E * L$	$Y \sim B * E * L$
SSE	25.2787	27.8897	53.0120	0.1510	25.2607	27.8843	0.0996

Answer the following:

a) Write the ANOVA table for the full model showing the Sum of Squares for all the main effects and interactions and recommend and justify an appropriate model.

b) Based on the model fitted in **a**, categorize the managers in an increasing order of quality-consciousness, given that $\overline{Y}_{Science/Engineering} = 6.5592$, $\overline{Y}_{Commerce} = 4.5244$, $\overline{Y}_{Humanities} = 4.0941$; $\overline{Y}_{Experienced} = 6.0824$, $\overline{Y}_{In\,experienced} = 4.0360$; $\overline{Y}_{Leaders} = 5.0723$; $\overline{Y}_{Non-Leaders} = 5.0462$.

5. Write the pre-order and in-order traversals of the following binary tree.
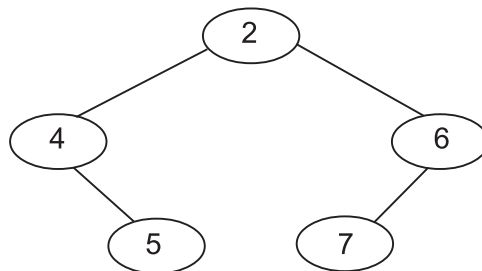
PART C: Section I: German

1.   Methodik und Didaktik

2.   Sprachgebrauch.

1.   <u>Methodik und Didaktik</u>

Kurze Einfuhrung in die Methoden des fremdsprachlichen Unterrichts – Grammatik-übersetzungsmethode, audio-linguale Methode, vermiltelnde Methode, direkte Methode, kommunikative Methode, interkuturelle Methode, Merkmale dieser Methode, Lernsituation, Lehrsituation, Lernerperspektive, Lehrerperspektive.

2.   <u>Sprachgebrauch</u>

Texte schreiben – Schilderung, Bericht, Eroterung, Beschreibung, Aufsatz usw. Grammatik, Satzstruktur usw.

Type of Paper : Both essay and multiple-choice questions.

MODEL QUESTIONS

I.   Ergänzen Sie!

Beispiel

_____ wann lernst du Deutsch? – ich habe schon vor drei Jahren angefangen.
- a)   seit
- b)   über
- c)   auf
- d)   bis

1.   Ist das hinten nicht Klaus? – Doch, das _____ Klaus sein.

- a) möchte
- b) wollte
- c) sollte
- d) könnte

2.   Wo ist dein wagen? Oaul hat ihn, aber _____

- a) er weiderbringt ihn morgen
- b) er bringt ihn morgen wieder
- c) er bringt wieder ihn morgen
- d) er wiederbringt ihn morgen

3.   Ich dachte, du kommst nicht mit ins Schwimmbad. – Doch, Karl hat mich _____

        a) übergeredet
        b) übergereden
        c) überredet
        d) überreden

4.   Sag deiner Schwester bitte, daß sie zum Essen _____

        a) herunterkommen soll
        b) soll herunterkommen
        c) heruntergekommen soll
        d) kommen herunter soll

5.   Möchtest du ein Glas Wasser? - Nein, lieber _____ Tee mit Zitrone.

        a) ein heißes
        b) ein heißer
        c) heißer
        d) einen heißen

II.   Nehmen Sie Stellung zu einer der folgenden Aussagen und schreiben einen Aufsatz
        dazu.
        Das Erlernen von Fremdsprachen hat eine Zukunft in Indien.

Oder

Englisch als Verkehrssprache der Welt.

MATERIALS SCIENCE

Materials Science

I. Elementary quantum mechanics, atomic structure, wave mechanical model, electronic configurations, ionic, covalent, metallic and van der Walls 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 T_c superconductors; diamond; nanophase materials; electrooptic and magnetooptic materials; C_{60} 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.

MODEL QUESTIONS

All Questions will be of objective types
(Choose the correct answer)

1. Boron (group III B) and oxygen (group IV B) combined by the formation of a bond of the type
    (a) metallic (b) Ionic
    (c) van der Walls (d) mixed ionic-covalent

2. The addition of a network modifier to silica (SiO_2)

    (a) enhances the network structure

    (b) produces vacancies

    (c) Produces Nonbridging oxygen atoms

    (d) increases the viscosity

3. All ferrolectric materials are

    (a) only piezoelectric

    (b) only pyroelectric

    (c) both piezoelectric and pyroelectric

    (d) none of the above

4. If the atomic magnetic moments are randomly oriented in a solid, its magnetic behaviour is termed

    (a) polymagnetic   (b) paramagnetic

    (c) ferrimagnetic   (d) gyromagnetic

5. The slip plane and the slip direction in the fec structure are [111] and [110] respectively. Hence the number of slip systems in the fec structure is

    (a) 12   (b) 6   (c) 24   (d) 5   (e) 16

6. A container of gas molecules is held at a constant temperature T. If the temperature of the container is increased to 2T, then the most possible speed changes by a factor of

    (a) 2   (b) 4   (c) 1   (d) $\sqrt{2}$

ATMOSPHERIC SCIENCES

The question paper will contain two parts : Part A and Part B.

SYLLABUS

Fluid Mechanics : Pressure and pressure gradient force, equation of continuity, stream function and velocity potential, rotational and irrotational motion, Euler's equations of motion, Bernoulli's equation.
Mathematics : First and second order ordinary differential equations with constant coefficients, classification of partial differential equation and their elementary solutions, basics of Fourier series and Taylor series, matrices; basic concepts, solution of simultaneous equations, eigen values, Frequency distributions, mean, median, mode and standard deviation, Binomial, normal and Poisson distribution, curve fitting, correlation and regression.
Earth atmosphere system : Composition and vertical structure of the atmosphere, seasonal meridional structure of the atmosphere, coriolis force, geostrophy, thermal wind and gradient wind, vorticity and circulation, cyclones, anticyclones, airmasses and fronts, monsoons. Properties of sea water. Vertical structure of the oceans, mixed layer, thermocline, Pycnocline; measurement and distribution of surface current in the ocean, gravity waves, tides, air sea interaction, heat, momentum and moisture fluxes at the surface.
Physical and dynamical meteorology : Solar radiation, geographical and seasonal distribution, absorption of solar radiation by the atmospheric constituents in the cloudless condition, terrestrial radiation, longwave absorption by the atmosphere, dry and moist adiabatic lapse rates, stic stability, formation of clouds, equations of motion in a rotating frame of reference, continuity equation, energy equation, Rossby waves, tropical cyclones, monsoon and its variability; ENSO phenomenon, Hadley and Ferrel Cells.
Dynamical oceanography : Scales of oceanic motion, equations of motion, Boussinesq approximation, shallow water equations, surface Ekman layer, Sverdrup relation and transport, gravity waves in the ocean, tides and tidal currents.

MODEL QUESTIONS

PART A

1. The differential equation

    $$\frac{a^2y}{dx^2} + \frac{dy}{dx} + y = 0 \text{ is of}$$

    (a) first order first degree

    (b) second order second degree

    (c) first order second degree

    (d) second order first degree

2. The singular points of the function

    $$y = \frac{1}{1 - x^2} \ occur \ at$$

    (a) x=1   (b) x=-1   (c) x =±1   (d) x=0

3. The temperature was measured five times during an experiment. The values obtained are 23, 24, 25, 26 and 27°C. The standard deviation of the data is
    (1) 1°C   (2) 0°C   (3) 2°C   (4) None of the above

4. The variation of pressure (in the vertical) in the earth's atmosphere is determined by a balance between
   (a) pressure and gravitational force
   (b) pressure and inertial forces
   (c) inertial and gravitational force
   (d) pressure, inertial and gravitational force

5. Surface currents in the Arabian Sea are determined primarily by
   (a) wind
   (b) temperature gradient
   (c) Salinity gradient
   (d) all of the above

6. If a beam of electromagnetic radiation falls on gaseous matter
   (a) it is always completely absorbed
   (b) it always passes without extinction
   (c) it always gets competely reflected
   (d) its history in the gas depends on the properties of the gas and also the nature of the radiation

7. The dry adiabatic lapse rate is
   (a) greater than the moist adiabatic lapse rate
   (b) less than the moist adiabatic lapse rate
   (c) equal to the moist adiabatic lapse rate
   (d) some times greater than and some times less than the moist adiabatic lapse rate

8. In a stable atmosphere the potential temperature
   (a) decreases with height
   (b) increases with height
   (c) remains constant with height
   (d) all of the above possible depending on clouds

9. If the zonal mean temperature is increasing towards the poles, the thermal wind is
   (a) westerly   (b) easterly   (c) zero   (d) all of the above

10. When there is wind shear there can be
   (a) vorticity only
   (b) divergence only
   (c) vorticity and divergence can exist
   (d) vorticity and divergence are zero

PART B:

1. Venus Earth and Mars are at a distance of 100, 150 and 225 million kilometers from the Sun respectively. The albedo of Venus, Earth and mars are 0.7, 0.3 and 0.2 respectively. Find the equilibrium temperatures of Venus, Earth and Mars. Assume that Sun is a blackbody at 5800 K and its radius is .75 million kilometers.

2. (a) The surface pressure in Cochin on a certain day is 1010 mb and the height of 900 mb surface is 1 Km. Find the mean temperature of air between 1010 mb and 900mb. Assume that the gas constant for air is 287 J/Kg-K.

   (b) Consider an atmosphere with a temperature lapse rate equal to zero. Assuming that the atmosphere is an ideal gas and is in hydrostatic equilibrium, find the variation of pressure with height.

3. (a) In a tornado, air has a tangential velocity of 30 m/s at a radius of 100 m from the centre of the tornado. What will be the tangential velocity of the air when it spiral inwards and reaches a point 30 m from the centre. Neglect Coriolis force and friction.

   (b) The radial pressure gradient in a tornado is 0.25 mb/meter. Find the tangential velocity at a distance of 100 meters from the centre of the tornado. Assume that the density of air is 1 Kg/m^3. Neglect friction.

4. Consider the two points A and B in the ocean located at 30^0N and 40^0N respectively. At point A the windstress is zero. At B the windstress is $z_y = 0$, $z_x = 0.1$ Nm^{-2}. Compute the Ekman mass transport and geostrophic transport at A. What is Sverdrup mass transport at A? Assume z_x varies linearly in the north-south direction.

5. Consider a small volume of seawater at the equator with zero velocity. It is then moved to the north pole. What is the vorticity and angular velocity of the parcel at north pole? Assume constant depth, constant density and no friction.