MATHEMATICS / STATISTICS

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 cotain 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 spaces: 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 theorem, 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.

MODEL QUESTIONS

Let Z, R and C denote the set of all integers, real numbers and complex numbers respectively.

PART A

I. Choose the correct alternative

(1) If $f : \mathbb{R} \to \mathbb{R}$ is a continuous function and $f'(x) \neq 0$ for every $x \in \mathbb{R}$, then f is

(a) onto

(b) one-one

(c) one-one and onto

(d) neither one-one nor onto

(2) Let $f \to \mathbb{C}$ be analytic. If the complex conjugation $\overline{f} : \to \mathbb{C}$ is also analytic, then

(a) f is real valued.

(b) f is a constant function.

(d) f does not take any real value

(d) f is purely imaginary.

3) Let $A : \mathbb{R}^7 \to \mathbb{R}^7$ be a linear transformation such that $A^2 = 0$. Then the rank of A is

(a) £ 3

(b) 3

(c) = 5

(d) = 6

(4) The differential equation $y' = y$ with initial conditions $y(0) = 0$ has

(a) a unique solution.

(b) two distinct solutions

(c) infinitely many solutions

(d) no solution

Questions (II). Fill in the blanks:

(1) Let $\rho : : \mathbb{R}^2 \to \mathbb{R}^2$ be the reflection with respect to line defined by the equation $y = -x$. Then the eigenvalues of ρ are .....

(2) The number of elements in the subgroup generated by 15 in the group $\mathbb{Z}_{20}$ is .....

(3) The map $f(z) = \pi \cot(\pi z)$ is analytic in the region .....$\subseteq \mathbb{C}$ and every $m \in \mathbb{Z}$ is a pole of order .....

(4) Let $G \subseteq \mathbb{R}$ be a connected subgroup of the additive group $(\mathbb{R}, +)$. Then either $G =$ .....or $G =$ .....

(5) The general solution of $y' = e^{2x} - e^x y$ is .....

Part B

(1) (a) Let a be a positive real number. Let $x_1 = 1$ and $x_n = \frac{1}{2}\left(x_{n-1} + \frac{a}{x_{n-1}}\right)$ for $n \geq 2$. Is the sequence $\{x_n\}_{n\geq 1}$ convergent? If yes then find $\lim_{n\to\infty} x_n$.

(b) For $t \in (0, 2\pi)$, show that $\sum_{n=1}^{\infty} \frac{\sin(nt)}{n} = \frac{\pi - t}{2}$.

(2) (a) Let $f : \mathbb{R} \to \mathbb{R}$ be a non-zero continuous function with $f(x + y) = f(x) \cdot f(y)$ for all $x, y \in \mathbb{R}$. Show that there exists $a \in \mathbb{R}$ $a \neq 0$ such that $f(x) = a$ for every $x \in \mathbb{R}$.

(b) Let $f : \mathbb{R}^n \to \mathbb{R}$ be a function of class C^1 (i.e., all the partial derivatives of f exist and are continuous) and $f(0,\ldots,0) = 0$ then show that there exist continuous functions $g_1, \ldots, g_n : f : \mathbb{R}^n \to \mathbb{R}$ such that $f(x_1, \ldots, x_n) = \sum_{i=1}^{n} x_i . g_i(x_1, \ldots, x_n)$.

(3) Let $f : \mathbb{C} \to \mathbb{C}$ be an entire function.

(a) Suppose that there exists an integer $k \geq 0$ and positive constants A and B such that $|f(z)| \leq A + B|z|^k$ for all $z \in \mathbb{C}$. Show that $f(z)$ is a polynomial in z of degree almost k.

(b) Suppose that $|f'(z)| \leq |z|$ for all $z \in \mathbf{C}$. Show that $f(z) = a + bz^2$ for some $a, b, \in \mathbf{C}$ with $|b| \leq \frac{1}{2}$.

(4) Let $A = \begin{pmatrix} a & b \\ c & d \end{pmatrix}$ be a 2×2 matrix with a, b, c, d real numbers. Then the following is true.

(a) If λ is an eigenvalue of A, then show that $\begin{pmatrix} b \\ \lambda - a \end{pmatrix}$ is an eigenvector of A.

(b) If all a, b, c, d are positive, then prove the following
(i) A has two real eigenvalues
(ii) A eigenvectors in both first and second quadrants.

(5) (a) Let G be non-abelian group of order p^3, where p is a prime number. Show that the center $Z(G)$ of G has order p.

(b) Find the least value of n such that the permutation group S_n has an element of order 3000.

(6) Find a solution of the equation

$$y' \sin x - y \cos x = -\frac{\sin^2 x}{x^2}$$

which satisfies the condition $y \to 0$ as $x \to \infty$.

CHEMISTRY

All questions will be of objective types.

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

Spectroscopy : Principles of electronic, vibrational and magnetic resonance spectroscopy and mas spectrometry and their application to simple structural problems in chemistry. Dipole moment and molecul 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 o chemical reactions; collision theory of chemical reactions and Arrhenius equation; homogeneous an 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, biogochemical cycles, animal behaviour, basic principles in 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. A particular population of forest trees is found in a place where the environment is becoming progressively drier. The average surface area of leaves has been decreasing in successive generations. This is an example of

   (a) stabilising selection

   (b) directional selection

   (c) disruptive selection

   (d) character displacement

2. Inorder to establish whether the average length of males and females of a fish species is different, one should use

   (a) a regression analysis

   (b) a chi-squarre goodness-of-fit-test

   (c) a t-test

   (d) a Mann-Whitney U-test

3. A Calvin cycle is seen

   (a) only in C3 plants

   (b) only in C4 plants

   (c) only in CAM plants

   (d) in C3 and C4 plants

4. Small populations of species are at high rish of extinction because of
   (a) chance fluctuations in birth and death rates
   (b) limitation of habitat
   (c) high predation pressure
   (d) increased levels of competition

5. Kin selection is
   (a) the mating of relatives
   (b) the recognition of relatives in societal groups
   (c) the adoption of young by unrelated adults
   (d) a behaviour that increases the survivorship of an individual's relatives

6. The dominant phase in the life cycle of a fern plant is
   (a) the haploid sporophyte
   (b) the haploid gametophyte
   (c) the diploid sporophyte
   (d) the diploid gametophyte

Department of Management to be insert

MATERIALS SCIENCE

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

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 equaitons, typical differential equations in science; vectors, determinants, matrices, Fourier series, complex analysis, probability and statistics.

MODEL QUESTIONS

PART A : OBJECTIVE

(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 piezoelctric
   (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) $\sqrt{2}$

PART B : DESCRIPTIVE

1. Calculate the concentration of Schottky defects in NaCl near its melting point (1000K) assuming that the Schottky defect formation energy is 45 kcal mol^{-1}.

   Mol wt of NaCl=58.8

   Density of NaCl=1.544 g cm^{-3}

2. Show that the critical radius for octahedral coordination is 0.414 using close packing of hard spheres.

3. Show the relation between the mean free path and the mobility of an electron.

4. In germanium, the intrinsic electron density at 300 K is 2.5 x 10^{13} cm^{-3}. Assume that the resistivity is 509 ohm-cm and that the lowest impurity concentration that can be attained is 10^{12} impurity atoms per cm^3. Can germanium be considered intrinsic at room temperature (Eg=0.72 eV)?

5. Find the eigen vectors and eigen values of the matrix.

$$\begin{pmatrix} 5 & 4 \\ 1 & 2 \end{pmatrix}$$

6. Sketch the variation of dielectric constant as a function of frequency of a typical alkali silicate glass and a ferroelectric material such as $BaTiO_3$. Comment on the contribution of different polarization mechanisms to dielectric constant in these two materials.

ATMOSPHERIC SCIENCES

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 of the atmosphere, 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 through 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 prints of the function

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

(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) lesser than the moist adiabatic lapse rate
   (c) equal to the moist adiabatic lapse rate
   (d) some times greater than and some times lesser 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
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 900 mb. Assume that the gas constant for air is 287 J/Kg-K.

(b) Consider an atmosphere with a temperature lapse rate L. 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 300m from the centre of the tornado What will be the tangential velocity of the air when it spiral inwards and reaches a point 30m 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/ m3. neglect friction.

4. Consider two points in the ocean A and B located at 300N and 400N respectively. At the southern point A the windtress is zero. At B the windstress is r_y=0 r_x=0.1 Nm^{-2}. Compute the Ekman mass transport and geostrophic transport at A. What is Sverdrup mass transport as A? Assume rx 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 and no friction.

6. Calculate the wavelength of stationary, mid-latitude Rossby waves in a zonal current u for the cases a)u=0.3ms^{-1} b) u=0.3ms^{-1}

Integrated Ph D (Biological, Chemical, Mathematical & Physical Sciences)

Candidates have to choose any one of the following papers for admission to the Integrated Ph D Programme (Biological / Chemical / Physical / Mathematical Sciences), depending on their choice of the programmes.

1. Biological Sciences
2. Chemical Sciences
3. Physical Sciences
4. Mathematical Sciences

BIOLOGICAL SCIENCES

Biological Sciences question paper will be fully of objective type. There will be negative marking for negative answer.

SYLLABUS

General Biology

Taxonomy and physiology, Pro-and eukaryotic organisms; cell organelles and their function; multicellular organisation; energy transformations; internal transport systems of plants; respiration; regulation of body fluids and excretory mechanisms; cellular reproduction; Mendolian genetics and heredity; biology of populations and communities; evolution; genesis and diversity of organisms; animal behaviour; plant and animal diseases.

Basics of Biochemistry, Biophysics, Molecular Biology

Buffers; trace elements in biological systems; enzymes and proteins; vitamins; biological oxidations, carbohydrates and lipids and their metabolisms; digestion and absorptioin; detoxifying mechanisms; plant and animal hormones and their action, neuromuscular systems, nucleic acids, nature of gene and its function, Genetic code, synthesis of nucleic acids and proteins.

Structure of biomolecules; intra and intermolecular forces; thermodynamics and kinetics of biological systems, principles of x-ray diffraction, IR and UV spectroscopy and hydrodynamic techniques.

Microbiology and Cell Biology

Classes of microorganisms and their characterization, nutrient requirements for growth; laboratory techniques in microbiology, pathogenic microorganisms and disease; applied microbiology; viruses, Microbial genetics.

Cell theory : Cell architecture; methods of cell fractionation; cell division; types of chromosome structure; biochemical genetics-inborn errors of metabolisms; viruses and fungi; principles of processes of development.

MODEL QUESTIONS

1. The fluctuation test carriesout by Luria and Delbruck showed that
   (A) Mutations are sponteneous
   (B) Mutations are induced by the virus upon exposure
   (C) Bacteria fluctuate between sensitivity and residence
   (D) Viruses are living entities
2. In a test of an *Aa* heterozygous parent with an *aa* homozygous parent what are the number of classes of genotypes exoected in the progency ?
   (A) 2
   (B) 1
   (C) 3
   (D) 4
3. Attenuation in bacterial operon regulation at the transcription level depends on
   (A) Operator sequence
   (B) tRNA structure
   (C) Special sigma factors
   (D) Charged tRNA levels
4. Codon-anticodon interaction occurs primarily through
   (A) Hydrogen bonds
   (B) Covelant bonds
   (C) Phosphodiester bonds
   (D) Disulfide linkages
5. Among angiosperms, dicots are distinguished by their :
   (A) netted leaf venetion
   (B) Single embryonic leaf
   (C) Scattered vascular bundles in the stem
   (D) Flower parts in multiples of three
6. The distribution and abundance of fungi is usually measured in terms of
   (A) Number of individuals per unit area or volume of habitat
   (B) Surface area per unit area or volume of habitat
   (C) Height of an individual
   (D) Mass per unit area or volume of habitat

7. Maximal quantity of progesterone is produced by
   (A) Corpus luteum
   (B) Placenta
   (C) Foetal adrevals
   (D) Corpus luteum during pregnancy

8. In C4 plants (e.g. maize) the initial carbon dioxide fixation occurs in leaf mesophyll cells containing chloroplasts. This reaction involves the enzyme.
   (A) Ribulous 1,5 bisphophate carboxylase
   (B) Pyruvate carboxulase
   (C) Phosphoenol Pyruvate carboxulase
   (D) Malate enzyme

9. In an enzyme assay in which the substrate concentration, [S] is much lower than K_m, the rate of the enzyme catalized reaction
   (A) approaches V_{max}
   (B) shows zero order kinetics
   (C) is proportional to [S]
   (D) is independent of enzyme concentration

10. The secondary structure of a protein cannot be determined by :
   (A) NMR spectroscopy
   (B) shows crysallography
   (C) Fluorescence spectroscopy
   (D) Circular Dichroism

GGESTED READING

1. Stryer L, Biochemistry, published by W.H. Freeman and company.
2. Madigan MT, Martinko JM & Parker J. BROCK Biology of microorganisms; published by Prentice Hall Internation Inc.

   OR

   Pelczar MJ, Chan ECS, Krieg NR. Microbilogy. Published by McGraw Hill
3. Odum EP, Fundamentals of Ecology.

CHEMICAL SCIENCES

Chemical Sciences question paper will consist of multiple choice question for 100 marks from Chemistry, Physics and Mathematics with greater emphasis on Chemistry.

SYLLABUS

General and Inorganic Chemistry

Valency, Equivalent weight, periodic classification of elements, Atomic structure, Isotopes, Raidoactivity, Electronegativity, Hybridisation, Oxidation states. Compounds of Main Group elements; preparation, structures and Reactivity.

Transition metals; Electronic structure, magnetic and spectral properties of metal complexes. Stability, structure and reactivity of coordination compounds.

Main Ores and Minerals, Principles of exatraction of metals like Cu, Au, Na, Zn, Mg, and Al. Iron and Steel manufacture. Common chemical processes used in industry.

Analytical Chemistry

Principles of Analytical Chemistry, Qualitative analysis and quantitative estimation of elements and groups.

Physical Chemistry

The laws of Thermodynamics, Thermodynamic functions, Kinetic theory of gases, Specific heats, Adiabatic and isothermal processes, Liquids, The solid state, x-ray Diffraction, Mixtures and solutions, colligative properties, chemical Equilibrium, phase rule. Thermochemistry, Electrochemistry, Reaction Kinetics. Surface and Colloid Chemistry. Catalysis, use of catalysts in important industrial processes. **Mathematics and Physics essential for Physical Chemistry.**

Organic Chemistry

Geometric and optical isomerism in organic molecules. Preparation and reactions of alkanes, alkenes, alkynes, alcohols, alky halides, amines, ethers and carbonyl compounds.

Aromatic ring systems, aromatic animes and nitro derivatives, phenols, Heterocyclinc systems, Carbohydrates, Oils, Fats, Soaps and detergents, Aminoacids, Proteins, enzymes, dyes, drugs, synthetic and natural polymers.

Basic reaction mechanisms : SN1, SN2, E1 and E2 reactions, Free radical reactions, Markownikoff rule, Electrophilic aromatic substitution.

Synthetic uses of Grignard reactions, reactions involving acetoacetic ester and malonic ester.

MODEL QUESTIONS

1. The pH of 10^{-10} molar solution of HCl is :
   (a) 10 (b) 7 (c) 4 (d) 1

2. The molecular weight of $MgCl_2$ determined from elevation of boiling point experiment is (atomic masses of Mg and Cl are 24 and 35.5 respectively):
   (a) 47.5 (b) 95.0 (c) 63.4 (d) 31.7

3. The maximum number of electrons in an atom that can posses a principal quantum number of 4 is :
   (a) 8 (b) 14 (c) 18 (d) 32

4. Condition under which aldol condensation is carried out is :
   (a) acidic (b) basic (c) neutral (d) pyrolytic

5. Enolisation involves :
   (a) resonance (b) complexation (c) tautomerisation (d) aromatisation

6. There is 32% of adenine in the DNA of sea urchins. The percentage of quanine
   (A) 32 (B) 68 (C) 36 (D) 18

7. The angle between the vectors **I+j** and **j+k** is
   (a) 30° (B) 45° (C) 60° (D) 90°

8. You are given the periodic function y=5 cos (x/2). Its frequency is
   (A) 2π (B) $1/2\pi$ (C) 4π (D) $1/4\pi$

9. A 220 V alternating current source is connected across a 2μF capacitor. If the frequency of the source is 50 Hz, the current through the capacitor is approximately equal to
   (A) 140.0A (B) 14.0A (C) 1.4A (D) 0.14A

10. A soap film has an index of refraction of 1.333. The smallest thickness of this film which gives an interference maximum when light of wavelength 500nm is incident normally on it, is
    (A) 47nm (B) 94nm (C) 188nm (D) 375nm

PHYSICAL SCIENCES

Physical Sciences question paper will consist of multiple choice question for 100 marks.

SYLLABUS

Mechanics

Newtonian mechanics of a system of particles. Conservation of energy and momentum, collisions, simple harmonic motion, static equilibrium of a rigid body, rotational dynamics, angular momentum, gravitation, Kepler's laws.

Properties of Matter

Stress and strain, elastic properties of solids, elastic modulii; Hydrostatics, elements of fluid mechanics, surface, tension and viscosity.

Wave Motion

Wave propagation, phase and group velocities, standing waves, Fourier analysis, sound as elastic waves, interference and diffraction of sound waves, Doppler effect.

Thermal Physics

Kinetic theory of gases, the Maxwell-Boltzmann distribution, thermal properties of ideal and real gases, liquids and solids, laws of thermodynamics, entropy, reversible and irreversible processes, Carnot cycle, heat engines, changes of phase, blackbody radiation, the Stefan-Boltzmann law, Planck's law.

Electromagnetism, Electronics and Optics

Electric field and potential, Gauss law, Laplace and Poisson equations, electrostatic equilibrium, capacitance, dielectrics, electrostatic energy;

The magnetic field, magnetic forces on moving changes and current carrying wires, the Biot-Savart law, electromagnetic induction and Faraday's law, magnetic susceptibility and permeability, direct and alternating current circuits, Maxwell's equations, electromagnetic waves;

Semiconductor junctions; principles of rectification and amplification.

Reflection, refraction and polarisation of light, ray optics, thin lenses, aberrations, interference and diffraction of light, optical instruments.

Modern Physics

Frames of reference, time dilation and length contraction, simultaneity, the Lorentz transformation, relativistic energy and momentum, mass-energy relation;

The photoelectric effect, the Compton effect, atomic spectra, wave-particle dualism, the wave function and its interpretation, the uncertainty principle, the Schrodinger equation.

Atomic structure, the Pauli exclusion principle, periodic classification of elements, spin of electrons, the Zeeman effect; generation and diffraction of x-rays, radioactivity, nucleus-constituents, binding, nuclear reactions, fission and fusion, nuclear reactors, particle accelerators, cosmic rays.

Experiments and Measurements

Errors in measurement, accuracy, measurements of length, mass and charge of small and large objects, fundamental constants. Basic knowledge of scientific instruments and their working.

Mathematical Physics

Theory of Systems of linear Equation, Linear algebra and matrices.

Series and their convergence.

Limits and continuity, differentiation and integration, Taylor's expansion, L'Hospital rule, maxima, minima.
Analytical geometry of curves and surfaces.
Ordinary (first and second order) differential equations.
Complex numbers, roots of complex numbers, trigonometric identities, Argand's diagram.
Vector addition and products, gradient, divergence and curl, Gauss and Stokes theorems.
Probability, basic laws of probability, mean, standard deviation.

MODEL QUESTIONS

1. A heavy ball tied to a string spins around the circle. While the ball is spinning, the length of the string is slowly halved. The angular frequency of rotation of the ball is
   a) halved
   b) doubled
   c) quadrupled
   d) unchanged

2. Unpolarized light passes through three polarizing filters. The axis of the second one is at an angle of $+30^0$ with respect to the first, and the axis of the third is at an angle $+30^0$ with respect to the second. The fraction of the original intensity that emerges from the third polarizer is
   a) 9/32
   b) 3/8
   c) 2/9
   d) 1/8

3. Two large metal spheres, A and B are near each other. The electrostatic force between them is attractive. Of the three possibilities :
   i) the two spheres are oppositely charged
   ii) one sphere is charged and the other is uncharged
   iii) both spheres are uncharged
      a) only case i) is possible.
      b) Cases i) and ii) are possible, but not iii).
      c) All three cases are possible.
      d) It depends on the size of the spheres compared to their separation.

4. A resistor inductor, and a capacitor are connected in series to an AC voltage source $\mathbf{U}(t) = V \cos[2\pi ft]$. The peak voltages across the three elements are V_R, V_L and V_C respectively. Then
   a) V_R, V_L and V_C must be less than V.
   b) V_R must be less than V, *but* V_L and V_C need not.
   c) At any instant, the voltage across the resistor and the voltage from the source must have the same sign.
   d) At any instant, the voltage across the resistor must be smaller in magnitude than the voltage from the source.

5. Two spheres of radius and r1 and r2 and at temperatures T1 and T2, are placed in vacuum. The first sphere is a blockbody. The second sphere may absorb more heat from the first than it radiates out if

   a) $T_1 = T2$, but r1 is sufficiently large compared r2.

   b) $T_1 = T2$, but the second sphere is painted, with a colour matching the peak of the radiation from the first.

   c) $T_1 > T2$,.

   d) Nobne of the above.

MATHEMATICAL SCIENCES

Mathematical Scinces question paper will consist of multiple choice questions for 100 marks from mathematics. There will be negative marking for negative answer.

SYLLABUS

1. Algebra :

Theory of Equations :

Relations between roots and Coefficients, Newton's identities, Rolle's theorem, Reciprocal Equations, Des Cartes, Rule of Signs, Cubic and quartic equations, Complex numbers and De Moivre's Theorem.

Determinants :

Cofactors, Properties of determinants, Solution of a Linear System, Cramer's Rule.

Inequalities :

AM-GM inequality, Cauchy-Schwarz inequality.

Set Theory :

Relations, Functions, Cardinality.

Algebraic Structures :

Binary Operations, Groups, Rings: Definitions, Examples and Elementary Theorems.

Vector Spaces :

Subspaces, Linear Independence, Bases, Dimension, Linear Transformations, Matrices, Rank, Nullity, Eigenvalues and Eigenvectors.

2. Geometry :

Two-dimensional Co-ordinate Geometry :

Conics and their equations in Cartesian and Polar Coordinates, Ellipse, Parabola and Hyperbola.

Three-dimensional Co-ordinate Geometry :

Planes, Lines, Spheres and Cones.

3. Vector Algebra and Vector Calculus :

Vectors addition, Scalar multiplication, Dot Product, Cross Product, Triple Product, Equations to the Line and the Plane, Grad, Divergence and Curl, Vector Integration, Green's Gauss' and Stokes' Theorems.

4. Calculus and Analysis

Real Number System, Sequence and Series, Continuity, Differentiability, Mean Value Theorems, Indeterminate Value Theorem, L'Hospital Rule, Tangents and Normals, Maxima and Minima, Riemann Integration, Multiple Integrals, Partial differentiations, Lengths, areas and volumes by integration.

5. Differential Equations :

First Order ODE; Method of Separation of Variables; Exact equations; Euler's equation; Orthogonal Family of curves, Second Order Linear ODE : Variation of Parameters.

MODEL QUESTIONS

Four possible answers are provided for each question.
Select the correct answer by making ($\surd$) against (A), (B), (C) or (D).

1. Let ρ be a non-trivial relation on a set X. If ρ is symmetric and antisymmetric then ρ is
   (A) reflexive, (B) transitive, (C) an equivalence relation, (D) the diagonal relation.

2. The set $\{5, 15, 25, 35\}$ is a group under multiplication modulo 40. The identity element of this group is
   (A) 5, (B) 15, (C) 25, (D) 35.

3. Let $\mathbb{Z}_n$ be the additive group of integers modulo n. The number of homomorphisms from $\mathbb{Z}_n$ to itself is
   (A) 0, (B) 1, (C) n, (D) n^2.

4. Let $v = (1, 1)$ and $w = (1, -1) \in \mathbb{R}^2$. Then a vector $u = (a, b) \in \mathbb{R}^2$ is in the $\mathbb{R}$-linear span of v and w
   (A) only when $a = b$, (B) always, (C) for exactly one value of (a, b), (D) for at most finitely many values of (a, b).

5. Let A be a 3×3 real matrix. Suppose $A^4 = 0$. Then A has
   (A) exactly two distinct real eigenvalues, (B) exactly one non-zero real eigenvalue, (C) exactly 3 distinct real eigenvalues, (D) no non-zero real eigenvalue.

6. Let a, b, c, d be real numbers and let $f : \mathbb{C} \to \mathbb{C}$ be the map defined by $f(x + iy) := (ax + by) + i(cx + dy)$. Then f is linear over $\mathbb{C}$ if and only if
   (A) $(a, b) = (d, c)$, (B) $(a, b) = (d, -c)$, (C) $(a, b) = (-d, c)$, (D) $(a, b) = (-d, -c)$.

7. The function $f: \mathbb{R} \to \mathbb{R}$ defined by $f(x) = \max\{1 - |x|, 0\}$ is differentiable
   (A) at all points, (B) at all except one point, (C) at all except three points, (D) nowhere.

8. Let $f: [0, 1] \to \mathbb{R}$ be a continuous function with $f(0) = f(1)$. If f is differentiable on $(0, 1)$ and the derivative f' is continuous on $(0, 1)$ then f' is
   (A) strictly positive in $(0, 1)$, (B) strictly negative in $(0, 1)$, (C) identically zero in $(0, 1)$, (D) zero at some point in $(0, 1)$.

9. A unit normal vector to the curve $\mathbf{C} := \{(x, x^2) : x \in \mathbb{R}\}$ in the plane $\mathbb{R}^2$ at the point $(0, 0)$ is given by
   (A) $(0, -1)$, (B) $(-1, 0)$, (C) $(\frac{1}{\sqrt{2}}, \frac{1}{\sqrt{2}})$, (D) $(1, 0)$.

10. The differential equation $\frac{d^2y}{d^2x} + 4\frac{dy}{dx} + 4y = 0$ has general solution of the form:
    (A) $A\cos 2x + B\sin 2x$, (B) $Ae^{-2x} + Bxe^{-2x}$, (C) $Ae^{2x} + Bxe^{2x}$, (D) $Ae^{2x} + Be^{-2x}$.

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

Candidates with M.A. (German) seeking admission to research in languages should only answer the 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 $\frac{a-b}{x+y}$?

   a) $32\frac{1}{3}$ b) $19\frac{4}{5}$ c) $24\frac{1}{2}$ 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, Theories of Inflation, Economic Reforms, 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 not a personality type

   a) Locus of control
   b) Type A, type B
   c) Extraoverism
   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:

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

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. $\lambda e^{-\lambda(y-a)}\, I_{[a,\ ¥]}(y)$. 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 $S_{i = 1..n} C_i$.

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:

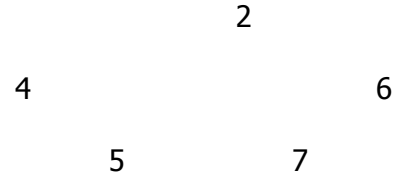
Model	*Y ~ B*	*Y ~ E*	*Y ~ L*	*Y ~ B * E*	*Y ~ B * L*	*Y ~ E * L*	*Y ~ B * E * L*
SSE	25.2787	27.8897	53.0120	0.1510	25.2607	27.8843	0.0996

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 $\overline{Y}_{Science/Engineering} = 6.5592, \overline{Y}_{Commerce} = 4.5244, \overline{Y}_{Humanities} = 4.0941;$ $\overline{Y}_{Experienced} = 6.0824, \overline{Y}_{Inexperienced} = 4.0360; \overline{Y}_{Leaders} = 5.0723; \overline{Y}_{Non-Leaders} = 5.0462.$

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. Methodik und Didaktik

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. Sprachgebrauch

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.