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# University of Rajasthan Jaipur

## SYLLABUS

**B.Sc. (Hons.)PART-III**

**2016**

  
Asstt. Registrar (Acad.)  
University of Rajasthan  
JAIPUR 

**B. Sc Honors PART III**  
**1** PHYSICS  
**Paper IX: Basic Computer Physics and Applications**

**Unit- I**

Algorithm development: Problem analysis, flow chart, decision tables; Examples of simple algorithms; Programme Design: Debugging syntax error, run-time error, logical error, programme verification and testing.

Data Representation: Representation of positive and negative numbers, fixed point representation, floating point representation. Arithmetic operations with normalized floating point numbers and its consequences, character representation, rounding off of numbers, absolute and relative errors, error detection and error correcting codes.

**Unit- II**

Programming Language C:

Numeric constants, declaring variable names, character data type; Arithmetic operators, hierarchy of operations, assignment statements, Input/output statements; Library functions, Elementary Programmes in C for numeric and string processing.

Conditional statements: relational operators; Arithmetic IF and Logical IF statements; Unconditional transfer: GO TO statement; Looping: DO loops, nested loops; Functions and subroutines; Subscripted variables: vectors and arrays; Writing and executing C programmes. Programmes in C to (i) compute magnetic field due to a current carrying coil (ii) compute electric field due to a system of point charges (iii) study frequency response of an LCR circuit (iv); Evaluate Bessel's function, Legendre function, Hermite Polynomial, Langerre's Polynomial by series expansion. Evaluation of simple functions by Taylor Series Expansion.

**Unit- III**

Iterative Methods: Solution of algebraic and transcendental equations using bisection method, method of false position, Newton-Raphson method; Complex zeros, zeros of polynomials; Simple applications related to Physics like programmes in C to evaluate zeros of simple functions.

Interpolation: Lagrange interpolation, Difference tables, truncation error in interpolation, Spline interpolation.

#### Unit- IV

Least Square Approximation: Linear regression, Polynomial regression, fitting exponential and trigonometric functions, approximation of functions by Taylor' series and Chebyshev polynomials, curve fitting and polynomial fitting; Programmes in C related to physics on above topics.

Numerical Integration: Trapezoidal rule, Simpson's rule, errors in integration formulae, Gaussian quadrature formulae. Programmes in C related to physics on above topics.

#### Unit- V

Numerical Solution of Ordinary differential equations: Taylor's method, Euler's method and Runge-Kutta methods; Programmes in C related to physics on above topics.

Numerical Solution of Partial Differential Equations

Finite Difference methods for solution of (i) The diffusion equation (ii) the wave equation and (iii) the Laplace equation; Programmes in C related to physics on above topics.

#### *Reference Books:*

1. Computer Science, R. Dheen Dayal (Tata Mc Graw Hill)
2. Computer System Architecture, Morris-Mano (Prentice Hall of India)
3. Computer Oriented Numerical Methods, V. Rajaraman (Prentice Hall of India)
4. Mathematical Methods, Potter and Goldberg (Prentice Hall of India)
5. Computational Methods for Partial Differential Equations, M. K. Jain, S. R. K. Iyenger, R. K. Jain, (New Age International)

**Paper-X : Introductory Nuclear and Particle Physics**

Note : Five questions are to be set taking one from each unit (each question will have an internal choice). Student will attempt all the five questions. 40% weightage will be given to problems and numericals.

**Unit I : Basic Nuclear Characteristics**

- (i) Nuclear mass, nuclear size and nuclear matter—The mass table, binding energy of nucleons, nuclear size, semiempirical mass formula, Nuclear matter-characteristics, theory of binding energy and the pairing energy, Nuclear stability and abundance of nuclides. Spin and parity of nuclear states, magnetic dipole and electric quadrupole moments of nucleus (Qualitative discussion only).
- (ii) General nature of force between nucleons, scattering of neutrons by protons at low energy, two nucleon system—the deuteron magnetic dipole and electric quadrupole moments, non-central forces, p-p and n-n scattering at low energy, charge independence of nuclear forces and concept of iso-spin invariance.

**Unit II : Nuclear Models and Fission**

- (i) Empirical evidence for the regularity of nuclear properties—nuclear mass and binding energy, magic numbers. The single particle shell model—the average shell model potential. Multipole fields, the electromagnetic matrix elements, life time-energy relations, the Weisskopf formula of transition rate, nuclear isomerism, internal conversion. Zero-zero transitions.
- (ii) Fission—Discovery of fission, Theory of fission, Energy release, criticality of a Reactor and four factor formula, types of fuels and types of reactors, Breeder Reactor, Neutron cycle in a thermal Nuclear Reactor.

**Unit III : Nuclear Interaction**

- (i) Weak interactions : nuclear beta decay, the neutrino, electron capture experimental information, Fermi and Gamow Teller transitions, Fermi Theory, selection rules (non-relativistic case only). Mass of neutrino, parity violation.

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- (ii) The strong interaction: strength of strong interaction, nuclear and particle resonances i.e. introduction of resonance states in high energy particle interactions. Alpha decay and barrier penetration and related experimental information. Selection rules of strong interaction. Introduction of SU (3) symmetry.

**Unit IV : Introduction of Particles and Conservation Laws**

Introduction of Electron, alpha particles, photon, positron, neutron neutrino and the muons. Baryons and leptons.

Discovery of pion and its characteristics, deltas, Stangeness and kaons etc, lambda and other hyperons. Introduction of charge conjugation, space parity and Gellman Nishijima Scheme. Patron, quark model-quark and gluons, quark composition of baryons and mesons  $J/\Psi$  particle, W and Z-particles and Higgs. Emphasis should be given on experimental discoveries and conservation laws while introducing the particles and resonances.

**Unit V : Passage of radiation in matter**

- (i) The interaction of neutron and gamma-radiation with matter : related effects and Laws, passage of charged particles through matter, energy loss by collision, energy loss by radiative processes, absorption of electromagnetic radiation. Experimental Studies-Multipole coulomb scattering, range-energy curve straggling, capture and loss, stopping power for heavy ions, concept of radiation safety.
- (ii) Nuclear techniques-Tandem, electrostatic generator Linear accelerators-drift tube accelurators, orbital accelerators-cyclotrons, the Synchro cyclotron, Bending and Focussing magnets-The magnetic spectrometer. Production of high energy neutrons.

Detectors-Ionization Chamber technique, G.M. Counter, scintillation detector, Emulsions, neutron detectors.

In general the scope of the syllabus is defined by Chapters 5, 6 and 7 for unit I and II Chapters 2, 3 and 4 for unit V and by Chapters 9, 10 and 11 for unit III and IV of the book entitled "Elements of Nuclear Physics" by W.E. Burcham published by Longman 1979.

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The related examples given at the end of aforesaid chapters of book by Burcham may be done as illustrative exercises for practice.

*Further books suggested for reference :*

1. Nuclear Physics : Irving Kaplan
2. Concepts of Nuclear Physics : B.E. Cohen
3. Introductory Nuclear Physics : Kenneth S. Krane
4. Introduction to Nuclear Physics; CMH. Smith
5. Nuclear Physics, S.N. Ghoshal
6. Introduction to High Energy Physics, Perkins.

**Paper-XI : Physics of Materials**

**Note :** Five questions are to be set taking one from each unit (each question will have an internal choice). Student will attempt all the five questions. 40% weightage will be given to problems and numericals.

***Unit-I***

Introduction : Materials Science and engineering, classification of engineering materials, levels of structure, structure-property relationships in materials.

Crystal Geometry and Structure Determination : Space lattices, Space lattices and crystal structures, Crystal directions and planes, Bragg's law of X-ray diffraction, Powder method, structure determination. Extinction rules for cubic crystals.

Structure of Solids : Crystalline and non-crystalline states, Discussion of solidification and crystallization, glass transition.

Polymers : Classification of polymers, structure of long chain polymers, crystallinity of long chain polymers.

***Unit-II***

Chemical Bonding in Solids : Bond energy, bond type and bond length, Ionic bonding, Calculation of lattice energy of ionic crystals. Madelung constant, covalent bonding, Metallic bonding, Secondary bonding, Variation in bonding character and properties.

Phase diagrams : Covalent solids, Metals and alloys, Ionic solids. Phase rule, Single component systems, Binary phase diagrams, Level rule.

***Unit-III***

Band Theory of Solids : Formation of bands (qualitative discussion), Electrons in a period field of a crystal (Krong-Penney Model), Brillouin zones, number of states in a band, Bloch Theorem and Bloch function,

Dispersion relation inside a band, band shapes, effective mass of an electron, Distinction between metals, insulators and intrinsic semi-conductors.

Lattice Vibration and Thermal Properties of Solids : Lattice vibrations, Linear monoatomic and diatomic chains, Acoustic and Optical photons, Normal modes, Spectral distribution function, Einstein and Debye Theories of specific heat solids, contribution from electron gas in metals, Thermal conductivity of metals.

#### Unit-IV

Electrical conductivity : Equilibrium state of electron gas in a conductor in the absence of electric field, electron drift in an electric field, relaxation time and mean free path, electrical conductivity of electron gas, Wiedmann-Franz law, Temperature dependence of electrical conductivity of pure metal. Hall effect and determination of density and mobility of charge carriers in semi conducting materials.

Dielectric Properties : Polarization, Temperature and frequency effect. Electric break down, classical theory of electronic polarizability, Normal and anomalous dispersion, Complex dielectric constant and loss, Ferroelectric materials, Measurement of dielectric constant and loss. P-E hysteresis loop in ferroelectricity.

Qualitative discussion of pyroelectric and piezoelectricity.

#### Unit-V

Magnetic Properties : Response of substances to magnetic field, dia, para and ferri and ferromagnetic materials. Magnetic moment of atom, orbital part, spin part and total magnetic moment, Langevin's theory of dia- and paramagnetism. Ferromagnetism and related phenomena, domain structure, hysteresis loops. Measurement of magnetic permeability and B.H. hysteresis Soft and hard materials.

Superconductivity : Introduction, Survey of superconductivity. Mechanism of superconductivity, Effect of magnetic field, Meissner effect, Type I and Type II superconductors, Thermal conductivity, Penetration depth. Energy gap and specific heat, Isotope effect, application of superconductivity.

#### Reference Books :

1. Materials Science and Engineering by V. Raghavan, Prentice-Hall Edition 1993.

2. Solid State Electronic Engineering Materials by S.O. Pillai, Wiley Eastern Ltd.
3. Solid state Physics by C. Kittel V. Edition.
4. Introduction to Solid by L. Azaroff.
5. Solid State Physics by N.W. Aschroft and N.D. Mermin CBS Publishing Asia Ltd.

**Paper-XII : Atomic and Molecular Physics**

Note : Five questions are to be set taking one from each unit (each question will have an internal choice). Student will attempt all the five questions. 40% weightage will be given to problems and numericals.

**Unit-I : Monovalent and Divalent Atoms**

Background from quantum theory : The four quantum numbers; spectral terms arising from L-S coupling, s,p,d,f notation, Matrix elements of dipole moment selection rules, emission and absorption probabilities, Half life of excited states; width of a spectral line-natural, Doppler and others, Spectra of mono and divalent atoms; Doublet fine structure of hydrogen lines; screening constants for monovalent atoms, series limits, doublet structure of alkali spectrum, spectra of helium and alkaline earth atoms, singlet and triplet series, Isotope effect and deduction of  $m/M$  from hydrogen and deuterium spectra.

**Unit-II : Magnetic Field effects and x-ray spectroscopy**

Effect of magnetic field on energy levels: Gyromagnetic ratios for orbital and spin moments; vector model, J-J coupling, Lande g factor, strong and weak field effects, illustrative cases of H, Na, Ca, and Hg, X-ray spectra : The continuous X-ray spectrum; Duane and Hunt limit. Characteristic X-rays; Moseley's law, doublet fine structure, H-like character of X-ray energy states, X-ray absorption spectra, absorption edges. Qualitative discussion of near edge and extended fine structure; determination of atomic number of atoms.

**Unit-III : Diatomic Molecules**

Sharing of electrons, formation of molecular orbitals, qualitative discussion of  $H_2$  ion,  $H_2$  molecule, Electronic levels and quantum numbers for electronic states of diatomic molecules: singlet and triplet





characters. Rotational energy levels, internuclear distance, Vibrational energy levels, force constants, anharmonicity, dissociation energy, isotope effect on rotational and vibration energies. Spectra of diatomic molecules : Pure rotation spectra: selection rules. Vibration rotation spectra: selection rules, P, Q, and R branches, Electronic band system, sequences and progressions, Franck-Condon principle.

#### Unit-IV : Triatomic Molecules

Triatomic molecules : Normal modes of a triatomic molecule; selection rules for infrared absorption, Raman effect : Raman shifts, Stokes and anti-stokes lines, selection rules in Raman spectra. The structure of  $H_2O$ ,  $CO_2$  and  $N_2O$  Molecules from IR and Raman spectra, Laser as intense source for Raman excitation.

#### Unit-V : Experimental Techniques

Emission spectroscopy : Emission sources, prism grating and crystal spectrographs, Prism material useful for UV, V and IR regions, constant deviation systems. Concave grating, different types of mountings, monochromators, resolution and dispersion in various spectrographs, high resolution spectroscopy, Fabry-Perot and Lummer plate in high resolution.

Absorption spectroscopy : Continuous sources for absorption studies in X-ray, UV, V and IR region, single-beam and double-beam instruments, detection systems-photographic plate, photomultiplier tube, bolometer. Laser techniques : Laser imaging of objects, burnable lasers for high resolution spectroscopy, pulsed lasers for time resolved spectroscopy.

#### Reference Books :

1. G. Herzberg; "Atomic Spectra and atomic structure".
2. H. Kuhn : "Atomic Spectra".
3. Walker and Straugha, "Spectroscopy, Vol. I, II, III."
4. H. Herzberg; "Molecular Spectra and Molecular structure."
5. H. Barrow : "Theory of Atomic Spectra."
6. R.C. Johnson : "Introduction to Molecular Spectra."
7. White; "Atomic Spectra".
8. B.K. Agrawal : "X-ray Spectroscopy."
9. D.P. Khandelwal : "Optics and Atomic Physics."

List of Physics Practicals

**Max. Marks : 100**

**Min. Pass Mark : 40**

Duration : Two Practicals of five hours duration each spread over two days.

The students are expected to perform 15 experiment in academic session, the suggested list of experiments is given below. The institution may, however, set other experiments of the equivalent level and may communicate the same to the Convener. Board of Studies.

1. Determination of Planck constant by photo cell (retarding potential method using optical filter, preferably five filters).
2. Determination of Planck's Constant using solar cell.
3. Determination of Stefan's Constant (B-B method).
4. Study of Iodine spectrum with the help of grating and spectrometer and ordinary bulb light.
5. To find the magnetic susceptibility of a paramagnetic solution using Quincke's method. Also find the ionic molecular susceptibility of the ion and magnetic moment of the ion in terms of Bohr magnetrons.
6. Study of polarization by reflection from a glass plate with the help of Nicol Prism, and photo cell and verification of Brewster's Malu's law.
7.  $e/m$  measurement by Helical method.
8. Measurement of electric charge by Millikan's oil drop method.
9. Study of the characteristic of a GM counter and verification of inverse square law for the same strength of radio active source.
10. Study of random process and statistical distribution using GM counter.
11. Study of  $\beta$ -absorption in Al foil using GM counter.
12. Study of gamma ray spectra using scintillation spectra meter.
13. Study of Bremsstrahlung by electrons of 100 KeV to 2 MeV energy using scintillation spectrometer.
14. Scintillation spectroscopy of Beta radiation.
15. Study of excitation of characteristic X-rays by electron.
16. Study of X-ray absorption with GM counter.
17. Study of parametric amplifier.
18. Study of normal modes and dispersion relation in a beaded string.



**2. CHEMISTRY**  
**Paper-IX : Inorganic Chemistry**

**Scheme :**

<i>Four Theory Papers</i>	<i>Duration</i>	<i>Max. Marks</i>	<i>Min. Pass Marks</i>
Paper-IX	3 hrs.	75	120
Paper-X	3 hrs.	75	
Paper-XI	3 hrs.	75	
Paper-XII	3 hrs.	75	
Practicals		100	40

**Note :** Each paper will contain ten questions having two questions from each unit. Candidates are required to attempt five questions in all selecting one question from each unit.

**Unit-I****Metal-Ligand Bonding :**

- Limitations of crystal field theory, molecular orbital theory of octahedral, tetrahedral and square planar complexes,  $\pi$ -bonding and molecular orbital theory.
- Organometallic Compounds : Definition and classification of organometallic compounds, synthesis, properties and structures of organometallic compounds of magnesium, aluminium, tin and lead.
- Metal Carbonyls : Preparation, properties and bonding of transition metal carbonyls. Detailed study of mononuclear and polynuclear carbonyls.

**Unit-II****Inorganic Polymers :**

- Types of inorganic polymers, comparison with organic polymers, synthesis, structural aspects and applications of silicones, phosphonitric halides and condensed phosphates.
- Metal Clusters : Higher boranes, carboranes, metalloboranes and metallocarboranes, metal carbonyl and halide clusters, compounds with metal-metal multiple bonds.

**Unit-III****Nuclear Chemistry :**

- Fundamental particles of nucleus (nucleon), concept of nuclides, Representation of nuclides, isotopes, isobars and isotones with specific examples. Applications of radioisotopes, size concept in nucleus and atom. Qualitative idea of the stability of nucleus ( $n/p$  ratio).

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- (b) Nuclear chemistry-II : Shell and liquid drop model, natural and artificial radioactivity, disintegration series, disintegration rates, half life, average life, nuclear binding energy, mass defects, Einstein's mass energy relations, artificial transmutation, nuclear reactions, fissions, nuclear fission and fusion, nuclear reactors, Hazards of radioactive emanations.

**Unit-IV**

**Bioinorganic Chemistry :**

- (a) Role of bulk and trace metal ions in biological systems with special reference to Na, K, Mg, Ca, Fe, Cu and Zn.  
(b) Metalloporphyrins : Chlorophylls and their role in photosynthesis. Hemoglobin and Myoglobin and their role as oxygen carriers.

**Unit-V**

- (a) Nitrogen fixation : Mechanism, nitrogenase enzyme, dinitrogen complexes as models for nitrogen fixation.  
(b) Metalloenzymes : General discussion of enzymes, functions of metal ions, inhibition (explanation based on coordination chemistry), carboxypeptidase-A and cytochrome-C.

**Reference Books :**

1. Manfred Bochmann, Organometallics 1 : Complexes with transition Metal-Carbon  $\sigma$  bonds; (Oxford Chemistry Primers).
2. Manfred Bochmann, Organometallics 2 : Complexes with transition Metal-carbon  $\pi$  bonds; (Oxford Chemistry Primers).
3. R.C. Mehrotra and A. Singh, Organometallic Chemistry.
4. Christoph Elschenbroich, Albercht Salzer, Organometallics : A Concise Introduction.
5. J.E. Huneey, Inorganic Chemistry.
6. F.A. Cotton and G. Wilkinson, Advanced Inorganic Chemistry.
7. D.F. Shriver and P.W. Atkins, Inorganic Chemistry.
8. R. Sarkar and Nityanand Saha, General and Inorganic Chemistry (Hon. Consulting Editor).
9. James E. Mark, H.R. Allcock and Robert West, Inorganic Polymers (2nd Edn.).
10. M.F. Lappert and G.J. Leigh, Developments in Inorganic Polymer Chemistry.
11. H.J. Arniker, Essentials of Nuclear Chemistry.
12. G. Friendlander and J.W. Kennedy, Nuclear and Radiochemistry.
13. S. Glasston, A Source Book on Atomic Energy.
14. A.V.S. Rama Rao, A Text Book of Biochemistry.
15. Dr. A.C. Deb, Fundamentals of Biochemistry.
16. M.N. Hughes, Inorganic Chemistry of Biological Processes.
17. Smith *et. al.*, Principles of Biochemistry.
18. Christopher K. Mathews, Kensal E. van Holde and Kevin G. Ahern, Biochemistry (2nd Edn.).

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Paper-X : Organic ChemistryUnit-I

**Heterocyclic Compounds** : Nomenclature, Five and Six membered heterocyclic compounds, Aromatic Character, preparation, reactions, chemical reactivity, orientation (Electrophilic and nucleophilic substitution reaction) basicity of pyrrole, furan, thiophene and pyridine. Condensed five and six membered heterocycles, structure, preparation and reactions of indole, quinoline and isoquinoline.

**Polynuclear Compounds** : Structure of naphthalene, mechanism and orientation of electrophilic substitution in naphthalene, preparation and properties of naphthalene and anthracene, some important derivatives of naphthalene like naphthols and naphthylamines. Preparation and reaction of diphenyl, diphenylmethane and triphenylmethane.

Unit-II

**Synthetic Dyes** : Color and constitution (electronic concept). Classification of dyes. Chemistry and synthesis of Methyl orange, Congo red, Malachite green, Crystal violet, Phenolphthalein, Fluorescein, Alizarin and Indigo.

**Drugs** : Chemotherapy, Synthetic uses and side effect of :

Analgesics : Aspirin, Phenacetin, Paracetamol.

Antimalarials : Chloroquine, Plasmoquine.

Antibiotics : Chloramphenicol (Chloromycetin).

Sulpha drugs and their mechanism of action. Synthesis of sulphadiazine, sulphapyridine, sulphathiazole, sulphaguanidine and sulphamethazole.

**Polymers and polymerization** : Addition and condensation polymerization, their mechanism, copolymerization, coordination polymerization, Ziegler-Natta catalyst, plastics, thermoplastic and thermosetting resins, plasticizers, polystyrene, PVC, polyacrylates, polyacrylonitrile, dacron, terylene, nylon-66, bakelite, melamine and polyurethanes. Elementary idea of the stereochemistry of polymers. Synthetic and natural rubber.

Unit-III

**Amino Acids, Peptides and Proteins** : Classification, structure and stereochemistry of amino acids, Physical properties, zwitter ion structure, isoelectric point and electrophoresis. Preparation and reaction of  $\alpha$ -amino acids.

Structure and nomenclature of peptides and proteins. Classification of proteins, peptide structure determination, end group analysis, selective hydrolysis of peptides. Classical peptide synthesis, solid-phase peptide synthesis. Structure of peptides and proteins. Levels of protein structure. Protein denaturation/renaturation.



**Nucleic acids** : Introduction, constituents of nucleic acids (RNA and DNA). Ribonucleosides and ribonucleotides. The double helical structure of DNA.

**Unit-IV**

**Carbohydrates** : Introduction, classification, constitution and reaction of glucose and fructose, mutarotation and its mechanism, cyclic structure, pyranose and furanose forms, Haworth projection formulae, configuration of monosaccharides, determination of ring size, conformational analysis of monosaccharides, Epimerization, chain lengthening and chain shortening in aldoses. Interconversion of aldoses and ketoses.

**Disaccharides** : Structure determinations of maltose, lactose and sucrose.

**Polysaccharides** : Structure of starch and cellulose.

**Organometallic Compounds** : Organomagnesium compounds : the Grignard reagents-formation, structure and chemical reactions.

**Organozinc compounds** : Formation and chemical reactions.

**Organolithium compounds** : Formation and chemical reactions.

**Unit-V**

**Mass Spectroscopy** : Introduction, instrumentation, factors affecting fragmentation, ion analysis, ion abundance, fragmentation modes, mass spectral fragmentation of simple organic compounds—alkanes, primary alcohols, aliphatic ketones, aldehydes and carboxylic acids, Types of peak : molecular ion peak, isotopic peak, base peak, metastable peak, doubly charged ion, Mc Lafferty rearrangement, retro Diels-Alder fragmentation, Nitrogen rule.

**Organosulphur compounds** : Nomenclature, structural features, methods of formation and chemical reactions of thiols, thioethers, sulphonic acids, sulphonamides.

**Reference Books :**

1. T.W. Graham Solomons and Craig B. Fryhle; John Wiley and Sons, Organic Chemistry : Seventh Edition, Inc. USA.
2. Robert Thornton Morrison and Robert Neilson Boyd, Organic Chemistry; Sixth Edition, Prentice-Hall of India Pvt. Ltd, New Delhi.
3. Jonathan Clayden, Nick Greeves, Stuart Warren and Peter Wothers; Organic Chemistry; First Edition; Oxford University Press, USA.
4. I.L. Finar; Organic Chemistry Vol. I and II; Fifth Edition; Longman Scientific and Technical, Singapore.
5. R.M. Silverstein and F.X. Webster; Spectrometric Identification of Organic Compounds, Sixth Edition; John Wiley and Sons, Inc., Singapore.

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6. William Kemp; Application of Spectroscopy; Third Edition; Palgrave Publisher Ltd., New York.
7. P.S. Kalsi; Spectroscopy of Organic Compounds; Sixth Edition; New Age International (P) Ltd. Publishers, New Delhi.

**Paper XI : Physical Chemistry**

**Unit-I : Quantum Mechanics**

Schrödinger's wave equation for particle in three dimensional box, H-atom, quantum no. and their importance, hydrogen like wave functions, radial wave functions, angular wave functions.

M.O. Theory, basic ideas—criteria for forming M.O. from A.O. construction of M.O.'s by LCAO- $H_2^+$  ion, calculation of energy levels from wave functions, physical picture of bonding and antibonding wave functions, concept of  $\sigma$ ,  $\sigma^*$  and  $\pi$ ,  $\pi^*$  orbitals and their characteristics Hybrid orbitals— $sp$ ,  $sp^2$ ,  $sp^3$ , calculation of coefficients of A.O.'s used in these hybrid orbitals.

Introduction to Valence bond model of  $H_2$ , comparison of M.O. and V.B. model.

**Unit-II**

**(a) Photochemistry :**

Introduction of radiation with matter, difference between thermal and photochemical processes, Laws of photochemistry : Grothus—Dropper law, Stark—Einstein law, Jablonski diagram depicting various processes occurring in the excited state, qualitative description of the fluorescence, phosphorescence, non radioactive processes (internal conversion, intersystem crossing), quantum yield, photosensitized reactions—energy transfer processes (simple example).

**(b) Physical properties and molecular structure :**

Optical activity, polarization (Clausius Mossotti equation), orientation of dipole in the electric field, dipole moment, induced dipole moment, measurement of dipole moment temperature method and refractivity method, dipole moment and structure of molecules, magnetic properties—paramagnetism, diamagnetism and ferromagnetism.

**Unit-III**

**Electrochemistry :**

Types of reversible electrodes : Gas-metal ion, metal-metal ion, metal insoluble salt anion, and redox electrodes, Electrode reactions, Nernst's equation, derivation of cell E.M.F. and single electrode potential. Standard hydrogen electrode. reference electrode, standard electrode potential, sign conventions, electrochemical series and its significance.

Electrolytic and Galvanic cells—Reversible and irreversible cells, conventional representation of electrochemical cells. E.M.F. of cell and its measurements, computation of cell e.m.f. Calculation of

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thermodynamic quantities of cell reaction ( $\Delta G$ ,  $\Delta H$  and  $k$ ), Polarization, Overpotential and Over Voltage. Structure of double layer, theories by Helmholtz, Guoy-Champman and Stern. Concentration cells with and without transport, Liquid junction potential, application of concentration cells, valency of ions, solubility product and activity coefficient, potentiometric titrations. Determination of pH using hydrogen, quinhydrone and glass electrodes by potentiometric methods. Introduction of Polarographic technique.

Classification of electrochemical cells, Requirement of power source, Lead storage cell and fuel cell.

Corrosion—Types, Theories and methods of combating it.

**Unit-IV**

**(a) Macromolecules :**

Linear, Branches, network and homopolymer.

Polymer Classification—Condensation polymers and addition polymers number average and weight average, molecular weight determination methods of polymers by (I) Osmotic pressure (II) Viscosity (III) Light scattering. Properties of macromolecules.

**(b) Chemical kinetics :**

Catalysis : The simple catalysis mechanism  $S + C \rightarrow SC \rightarrow P + C$ . Its mathematical treatment and its consequences. Specific and general acid base catalysis, Enzyme catalysis, Surface catalysis and Langmuir Adsorption Isotherm, Mechanism of surface catalysis.

**Unit-V**

**Phase Equilibrium :**

Solid solutions : Compound formation with congruent M.Pt. (Mg-Zn) and Benzophenone—dimethylamine incongruent M.Pt. NaCl-H<sub>2</sub>O, Picric acid and Benzene, FeCl<sub>3</sub>-H<sub>2</sub>O and CuSO<sub>4</sub>-H<sub>2</sub>O system.

Liquid-Liquid Mixtures : Ideal liquid mixtures, Rault's law and Henry's law, non ideal system, Azeotropes HCl—H<sub>2</sub>O and Ethanol-Water system.

Particularly miscible liquids : Phenol-Water, Trimethylamine—Water; Nicotine—Water system, Lower and upper consolute temperature, Effect of impurities on consolute temperature.

Immiscible liquids—Steam distillation.

Surface Phenomena, Micelles : Surface active agents, classification of surface active agents, micellization, hydrophilic interaction, critical micellar concentration (CMC), factors affecting the CMC of surfactants, counter ion binding to micelles, thermodynamics of micellization. Phase separation and mass action models, solubilization, micro emulsion, reverse micelles.

Adsorption : Gibbs adsorption isotherm, estimation of surface area (BET equation), surface films on liquids (Electro kinetic

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phenomenon), catalytic activity at surfaces; Electrode/electrolyte interface.

**References :**

1. Glasston, Physical chemistry.
2. Puri, Sharma and Pathania, Physical chemistry, Vishal Publication.
3. Behl and Tuli, Physical chemistry, S. Chand Publication, Delhi.
4. J.O.M. Bockris and A.K.N. Reddy, Modern aspect of Electrochemistry (Vol. I and Vol. II), Plenum Press, New York.
5. K. Zutshi, "Introduction of Polarographic and allied techniques", New age International Publication.
6. V. Moroi, Micelles, Theoretical and applied aspects, Plenum Press, New York.
7. V.R. Gowariker, N.V. Vishwanathan and J. Sridhar, Introduction to Polymer science, Wiley Eastern.

**Paper XII : Analytical Chemistry**

**Unit-I**

(a) **Electrogravimetry** : Theory, electrode reactions, overpotential, completeness of deposition, electrolytic separation of metals, character of the deposit, electrolytic separation of metals with controlled cathode potential. Electrolytic determinations at constant current—Copper and Lead. Electrolytic determinations with controlled cathode potential—Antimony, copper, lead and tin in an alloy.

(b) **Coulometry** : Coulometry at controlled potential, separation of Ni and Co by coulometric analysis at controlled potential, coulometry at constant current, coulometry titrations.

**Unit-II**

(a) **Polarography** : Principle and experimental set-up. Diffusion current and Half-wave potential—Qualitative and quantitative applications of polarography in analytical chemistry.

(i) Wave height concentration graph.

(ii) Internal standard (piloton method)

(iii) Standard addition method.

Use of polarography in : (i) Zn and Cu in brass

(ii) Dissolved oxygen in sample.

(b) **Amperometry** : Amperometric titrations, technique of amperometric titrations with the dropping mercury electrode, titration with the rotating platinum micro electrode, biamperometric titrations.

(c) **Modified Voltammetric methods** : Current sampled (TAST) Polarography, Pulse polarography, Differential pulse polarography, Cyclic Voltammetry, Sinusoidal Alternating current polarography, Stripping Voltammetry.

**Unit-III**

(a) **Mass spectrometry** : Instrumentation and technique, Elementary idea about electron impact, chemical ionization and matrix

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assisted laser desorption ionization (MALDI), mass spectrometer techniques. Principle of Fragmentation, Molecular ion peak, base peak, isotopic peaks and metastable ion peak. Determination of molecular formula, mass spectra of alkanes, alkenes, alkynes, cycloalkanes and arenes, alcohols and ethers, aldehydes and ketones.

(b) **Gas Chromatography and HPLC** : Introduction, gas chromatographs, detectors, programmed temperature gas chromatography, quantitative analysis by GLC, gas—solid chromatography. High performances liquid chromatographic methods—Adsorption Chromatography. Liquid-liquid partition chromatography, Ion exchange, HPLC, exclusion chromatography.

**Unit-IV**

**Diffraction Pattern** : Fundamental principles, instrumentation, use of x-ray, electron and neutron in diffractometry and applications of x-ray, electron and neutron diffractometry in biological and as analytical techniques. Applications of x-rays in C.T. scan.

**Unit-V**

(a) **Automated Methods of analysis** : Automatic instruments and automation. Automation of sampling and preliminary sample treatment for air, water and soil, continuous flow method, Discrete methods, Automatic Analysis based on Multilayer Films.

(b) **NMR Spectroscopy** : Theory of nuclear magnetic resonance, experimental methods of NMR spectroscopy, applications of proton NMR including applications in MRI technique.

**Reference Books :**

1. D.A. Skoog, D.M. West and F.J. Holler, Fundamentals of Analytical Chemistry.
2. A.I. Vogel, Analytical Chemistry.
3. H.H. Willard, L.L. Merritt, J.A. Dean and F.A. Settle, Instrumental Methods of Analysis.
4. G.R. Chatwal and S.K. Anand, Instrumental Methods of Chemical Analysis.
5. I.M. Kollthop, Analytical Chemistry.

**Chemistry Practical  
Inorganic Chemistry**

1. Qualitative Analysis of mixture containing six radicals one of which should be a rare ion. The mixture may contain radicals of any combination including interfering acid radicals and insolubles.
2. Quantitative estimation of any three of the following mixture by volumetric and gravimetric methods.
  - (a) Copper-Zinc
  - (b) Zinc-Nickel
  - (c) Silver-Copper

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- (d) Silver-Nickel
  - (e) Silver-Zinc
  - (f) Copper-Nickel.
3. Inorganic Preparations (any four) & its characterisation of coordination compounds :
- (a) Bis(dimethylglyximate)nickel (II) complex.
  - (b) Tetraamminecopper (II) sulphate.
  - (c) Cis-Potassiumdiaquodioxalatochromate (III) complex.
  - (d) Hexaamminenickel (II) chloride.
  - (e) Prussian blue.
  - (f) Chloropentaamminecobalt (III) chloride.
  - (g) Carbonatotetraamminecobalt (III) nitrate.
4. Analysis of (any three) of the following :
- (a) Available chlorine in bleaching powder.
  - (b) Water analysis-for total hardness.
  - (c) Analysis of two components.
  - (d) Analysis of cement for Ca, Al or Mg.
  - (e)  $MnO_2$  in pyrolusite.

#### Organic Chemistry Practicals

1. **Quantitative Estimations**
- (a) Determination of neutralization equivalent of an organic acid.
  - (b) Determination of Saponification value of an ester/oil.
  - (c) Estimation of glucose by titration with Fehling's solution/ Benedict solution.
2. **Qualitative analysis**  
Analysis of an organic mixture containing two solid components using water,  $NaHCO_3$  and  $NaOH$  for separation and preparation of suitable derivatives.
3. **Two step preparation of simple compounds-the students are expected to perform at least three of the following preparations.**
- (a) Preparation of p-aminoazobenzene from aniline.
  - (b) Preparation of p-nitroaniline from acetanilide.
  - (c) Preparation of syn-tribromobenzene from aniline.
  - (d) Preparation of m-nitroaniline from nitrobenzene.
  - (e) Preparation of acetanilide from acetophenone (Beckmann rearrangement).
  - (f) Preparation of anthranilic acid from phthalic anhydride.
  - (g) Preparation of eosin from phthalic anhydride.

#### **B.Sc. (Hons.) Part III Practicals**

#### **Physical Chemistry :**

#### **Section (A) : Potentiometry (Multimeters may also be used)**

1. To find out the strength of acid by titrating it against alkali.
2. Determination of dissociation constants of weak acids.

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3. Determination of no. of electrons involved in a cell reaction by setting up a concentration cell.
4. Determination of transport number of anion by e.m.f. measurements.

**Section (B) : pH metric titrations :**

1. To find out the strength of strong acid by titrating it against strong base.
2. To find out the strength of strong acid by titrating it against weak base.
3. To find out the strength of weak acid by titrating it against strong base.
4. Find out the strength of HCl and CH<sub>3</sub>COOH in a mixture of both by titrating it against NaOH.

**Section (C) : Spectrophotometer experiment or Colourimetric experiment**

- (a) Verify Lambert Beers law & determine the concentration of the given aqueous solution of unknown concentration of salt.

**Kinetics :**

1. Determine the effect of ionic strength on the rate of persulphate iodide reaction.  
Exp. : Determination of mol. Wt. by Rast camphor method.  
Exp. : Determination the conc. Of given solution of H<sub>2</sub>SO<sub>4</sub> acid by measuring heat changes during dilution.  
Exp. : Compare cleansing power of two samples of detergents by surface tension measurement.

**Instructions to the Examiners**

Max. Marks : 100

Duration : 10 hrs.

(Completed in two day)

**Distribution of Marks in Chemistry Practical**

- |   |    |
|---|----|
| 1. Qualitative analysis of Inorganic Mixture for SIX radicals Ox Inorganic Preparation        | 15 |
| 2. Quantitative estimations (gravimetric & volumetric)  | 15 |
| 3. Separation & identification of TWO compounds in a mixture or organic two stage preparation | 15 |
| 4. Quantitative estimations   | 10 |
| 5. Physical   |    |
| (a) Major Ex.   | 15 |
| (b) Minor Ex.   | 10 |
| 6. Record   | 10 |
| 7. Viva   | 10 |

## 3. ZOOLOGY (HONS.)

**Scheme**

<i>Six Theory Papers</i>	<i>Duration</i>	<i>Max. Marks</i>	<i>Min. Pass Marks</i>
Paper-XIII Ecology	3 hrs.	50	
Paper-XIV Environmental Biology	3 hrs.	50	120
Paper-XV Developmental Biology	3 hrs.	50	
Paper-XVI Evolution	3 hrs.	50	
Paper-XVII Applied Zoology-1	3 hrs.	50	
Paper-XVIII Applied Zoology-2	3 hrs.	50	
Practicals		100	40

**Paper-XIII : Ecology****Section-A**

1. Aim and Scope of Ecology.
2. Concepts of limiting factors.
3. Ecosystem : Abiotic and biotic factors.
4. Competition in nature— intraspecific and interspecific. Predation and parasitism—concept, evolution of prey—predator strategies, evolution of parasitism, host parasite relationship : Commensalism and mutualism.
5. Ecosystem : Production, consumption and composition in an ecosystem : Concepts of food chain, food web, trophic structure, ecological pyramids. Biogeochemical cycles of O<sub>2</sub>, CO<sub>2</sub>, H<sub>2</sub>O, N, P, and role of microbes.

**Section-B**

6. Ecosystem homeostasis, Functional aspects, Productivity concepts and its determination, Ecotone, Edge Effect, Niche.
7. Population Ecology : Populations characteristics growth and its analysis, regulation of densities. Density and methods of its measurement, natality, mortality, age ratio and distribution, pyramids, fluctuation, biotic potential. dispersal, growth forms, population interactions and propagation. Brief idea of demography.

**Section-C**

8. Community Ecology : Characteristics of natural communities, structure, composition and stratification.
9. Ecological Succession : Types and patterns, concept of climax, Details of xerosere and hydrosere successions.

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10. Habitat Ecology : Fresh water, marine, terrestrial and estuarine water.

**Section-D**

11. Major biomes of the World : Desert, Grassland, Tundra, Temperate. Tropical moist forest and Seasonal forests.  
12. Ecology and Human Future : Growth rate, role of human kind in modifying natural communities.

**Paper-XIV : Environmental Biology**

**Section-A**

1. Environment and its concepts. Global environment. Hydrosphere, Lithosphere, Atmosphere and Biosphere.  
2. Natural resources : Present status and future needs.  
3. Management of natural resources : Renewable (Forests, Wildlife, Water) and non renewable (Water, Soil, Minerals and Energy)

**Section-B**

4. Environmental pollution I: General outline and various types of pollutants. A detailed account of pollution of water, air and soil.  
5. Environment pollution II : Sources and remedies for thermal, noise, radiation, industrial chemicals, agrochemicals, insecticides and pesticides and household pollutants.

**Section-C**

6. Greenhouse effect, ozone layer depletion, El Nino and La Nina Effects.  
7. Radiation and Environment : Types of radiation, fall out, effects of radiation nuclear accident.  
8. Basic concepts of bioaccumulation, biomagnification and biodegradation of pollutants.

**Section-D**

9. Wild Life Conservation : Vanishing and threatened animals and plants with special reference to Rajasthan. Wildlife management efforts by Government and Non Government Organizations.  
10. Impact of Urbanization : Development and distribution of urban centers, factors, problems and the solutions of urbanization: Brief idea of Human Population with special reference to India and Rajasthan.  
11. Space Ecology: Space problems and their solutions, space ecosystem, space colonization.  
12. Sustainable Environment.

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Paper-XV : Developmental Biology

## Section-A

1. Gametogenesis : spermatogenesis and oogenesis, vitellogenesis, egg membranes.
2. Fertilization- : sperm-egg interactions, biochemical events, post fertilization events.
3. Parthenogenesis.

## Section-B

4. Types of animal eggs, patterns of cleavage, fate maps, germ layers, gastrulation and cell lineage.
5. Extra embryonic membranes, types and physiology of placenta.
6. Organizer concept, induction process.

## Section-C

7. Organogenesis of heart, kidney nervous system and sense organs.
8. Post-embryonic developments-insects and amphibians.
9. Regeneration in invertebrates and vertebrates.

## Section-D

10. Various types of stem cells and their applications (with special reference to embryonic stem cells)
11. Cloning of animals.
  - (i) Nuclear Embryonic Transfer Techniques
  - (ii) Nuclear Transfer Techniques
  - (iii) Embryonic or Therapeutic cloning.
12. Teratological effects of xenobiotics.
13. Ageing-concepts and models.

Paper-XVI : Evolution

## Section-A

1. Concept of evolution.
2. Origin of life on earth.
3. Origin of prokaryotic and eukaryotic cells.

## Section-B

4. Variations, mutations, recombination, ploidy, Isolation, Natural selection : Evolution in action.
5. Concept of species and speciation.
6. Molecular phylogeny : Phylogeny of horse.

## Section-C

7. Adaptations mimicry.
8. Polymorphism : Population genetics, Genetic Drift, Hardy-Weinberg Law.

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9. Macro and microevolution : Evolution of Man.

**Section-D**

10. Zoogeography – Principles and concepts of parallelism, endemism etc., factors influencing animal distribution.  
11. Zoogeographical realms and faunal peculiarities, Evolution of realms. Plate tectonics and continental drifts. Island zoogeography.

**Paper-XVII : Applied Zoology-I**

**Section-A**

1. The scope and history of microbiology.  
2. Major characteristics of microorganisms.  
3. Microbial classification, nomenclature and identification.

**Section-B**

4. Bacteria : Morphology, fine structure, cultivation, reproduction and growth, pure culture and characteristics.  
5. Bacterial nucleic acids.

**Section-C**

6. The world of Bacteria.  
6.1 Ordinary Gram negative bacteria.  
6.2 Ordinary Gram positive bacteria.  
6.3 Bacteria with unusual properties.  
6.4 Gram positive filamentous bacteria.  
7. Microorganisms : General characteristics of fungi (molds and yeast) algae, protozoa, viruses.  
8. Medical Zoology : Brief introduction to pathogenic microbes, viruses, rickettsia, spirochetes and bacteria.

**Section-D**

9. Brief accounts of life history, mode of infection and pathogenicity.  
9.1 *Entamoeba*  
9.2 *Trypanosoma*  
9.3 *Leishmania*  
9.4 *Plasmodium*  
9.5 *Wucheria* and  
9.6 *Dracunculus*  
10. Arthropods as vectors of Human diseases  
Malaria, Dengue, Filariasis, Japanese encephalitis and Plague.

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Paper-XVIII : Applied Zoology-2

## Section-A

1. Bacteria and genetic engineering (outline idea only): benefits of genetic engineering potential hazards and regulations of genetic engineering.
2. Enzymology of genetic engineering : Restriction enzymes. DNA ligase and polymerase.
3. Monoclonal antibodies and their applications.
4. Analysis and expression of cloned gene in host cells : Restriction enzyme analysis, Southern blotting, Northern blotting. In-situ hybridization, PCR (polymerase chain reaction), DNA finger printing.

## Section-B

5. Protoplast fusion in prokaryotes and eukaryotes.
6. Recombinant DNA technology and its application.
7. Cloning vehicles : Plasmids, cosmids, lambda phage, charon phage, shuttle vectors, DNA plasmids, yeast plasmids.
8. Introduction of cloned genes into the host cells : Transformation, transduction.

## Section-C

9. Transgenic animals and their uses.
10. Brief account of cloning : Genomic research, its advantages and disadvantages.
11. Biotechnology in medicine (outline idea only) : P.C.R. (Gene-machine), antibiotics, vaccines, enzymes, vitamins, steroids, artificial blood.

## Section-D

12. Environmental biotechnology (outline idea only): Metal and petroleum recovery, pest control, waste-water treatment.
13. Food, drinks and dairy biotechnology (outline idea only): Fermented food production: dairy products, alcoholic beverages and vinegar : microbial spoilage and food preservation.

*List of Recommended Books:*

1. Giese, A.C. : Cell Physiology.
2. Alexander, R.M. : The Chordates (Cambridge University Press).
3. Balinsky, B.I. : Introduction to Embryology (CBS College Publishers).
4. Barnes, R.D. : Invertebrate Zoology (W.B. Saunders Co.)
5. Berril, N.J: Developmental Biology (Tata-McGraw Hill).

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6. Bhatia, A.L. : Biochemistry and Endocrinology, Indus Valley Publication.
7. Bhatia, A.L. & N. Jain : Biotechnology, Indus Valley Publication.
8. Bhatia, A.L. & K.S. Kohli : Various Dimensions of Environmental Biology, Indus Valley Publication.
9. Voet, D. and Voet, J.G : Biochemistry John Wiley & Sons, New York.
10. Conn. Stumph R.K. Bruening and Doc : Outlines of Biochemistry (Wiley).
11. Davenport : An Outline of Animal Development (Addison-Werley).
12. De Robertis and DeRobertis : Cell and Molecular Biology (Saunders College)
13. Randall, D., Burggren, W., French, K. : Eckert Animal Physiology (W.H. Freeman).
14. Edward Gasque : Manual of Laboratory L.Ed. In Cell Biology (W.C. Brown Publishers)
15. Farnsworth : Genetics (Harper and Row) ,
16. Ganong : Review of Medical Physiology (Lange).
17. Glick : Molecular Biotechnology.
18. Grant : Biology of Developmental System.
19. Hyman, L.H. : The Invertebrates, Vol. I (McGraw Hill).
20. Hyman, L.H. : The Invertebrates, Vol. II (McGraw Hill).
21. Goldsby, R.A., Kindt, T.J., Osborne, B.A. : Kuby Immunology (W.H. Freeman).
22. Lodish, H. et al : Molecular Cell Biology W.H. Freeman and Company.
23. Monicly, A.R. : The Chordates (Cambridge University Press).
24. Moody : Introduction to Evolution (Indian Edition)
25. Odum : Ecology (Amerind).
26. Odum : Fundamentals of Ecology (Saunders).
27. Preseoff, DM : Reproduction in Eukaryotic Cells (Academic press)
28. Meyers, R.A. (Ed.): Molecular Biology and Biotechnology : (VCH Publishers)
29. Old, R.W. and Primrose, S.B. : Principles of gene manipulation: An introduction to Genetic Engineering.
30. Rao, K.V. : Developmental Biology : A modern synthesis (Oxford-IBH Publishers)

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31. Ricklefs : Ecology (W.H. Freeman).
32. Roitt, L : Essential Immunology (ELBS).
33. Savage : Evolution (Holt, Reimhart and Winston.)
34. Strickberger : Genetics (MacMillan).
35. Stryer, L *et al.* : Biochemistry (Freeman).
36. Subramanyan, T: Developmental Biology (Narosa Publishing House).
37. Waterman, A.J. : Chordata-Structure and Function (Macmillan Co.).
38. Watson, J.D. et al : Molecular Biology of the Gene (Benzamin/Cummings)
39. Wilson, E.B. : Cell in Development and inheritance (Macmillan)
40. Young, J.Z.: Life of Vertebrates (Oxford University Press).

### PRACTICAL ZOOLOGY

#### B.Sc. Hons Part III

#### Ecology and Environmental Biology

##### Analysis of Environmental Components

- (i) Soil pH
- (ii) Water analysis – pH, alkalinity, acidity, dissolved O<sub>2</sub> and free CO<sub>2</sub>, Salinity (Chlorides)
- (iii) Study of phyto and Zoo-planktons in a given water sample.
- (iv) Quantitative estimation of Zoo-planktons in given water sample.
- (v) Simple methods to measure population density.
- (vi) Field study of any one of the following habitats; freshwater; lake/pond, river, desert.

##### Developmental Biology

Study of Frog/toad development with the help of :

- (i) Preserved material available : egg, cleavage, blastula, gastrula, neurula, tail bud, mature tadpole larva, metamorphic stages, froglet/toadlet.
- (ii) Histological slides : cleavage, blastula, gastrula, neurula, tail bud.
- (iii) Study of living tadpole larva and its metamorphosis study.

##### Study of Chick Development :

- (i) Whole mounts : 18 hrs, 21 hrs, 24 hrs, 33 hrs, 48 hrs, 72 hrs and 96 hrs of incubation.
- (ii) If possible primitive streak stage in living embryos after removal of the blastoderm from the egg may be demonstrated.
- (iii) Study of the embryo at various stages of incubation in vivo by making a window in the egg shell may also be demonstrated.

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- (iv) Study of various foetal envelopes in a 10-12 day old chick embryos (amnion, chorion, allantois and yolk sac)

**Evolution :**

Simple Neumericals based on population genetics.

**Applied Zoology XVII**

1. Preparation and use of culture media for microbes.
2. Study of microbes in food material (like curd etc.)
3. Preparation of Bacterial slides :
  - (i) Ordinary Gram-positive bacteria
  - (ii) Ordinary Gram-Negative bacteria
  - (iii) Gram-positive filamentous bacteria.
4. Study of Microscopic slides :
  - (i) *Entamoeba*
  - (ii) *Trypanosoma*
  - (iii) *Leishmania*
  - (iv) *Plasmodium*
  - (v) *Wuchereria*
  - (vi) *Dracunculus*

**Applied Zoology XVIII**

- (i) DNA finger printing.
- (ii) Genomic DNA isolation from Eukaryotic cells.
- (iii) Agarose gel electrophoresis of DNA
- (iv) Small scale preparation of Plasmid DNA
- (v) Restriction digestion of genomic and Plasmid DNA.

**ZOOLOGY PRACTICALS**

**Scheme of Examination :**

**Max. Marks : 100**

**Min. Pass Mark : 40**

**Total Duration : 8 hours (In two days, hr. each day)**

**Distribution of Marks :**

1. Exercise in ecology and environmental biology	10
2. Developmental biology	10
3. Evolution	6
4. Applied Zoology-I (Microbiology)	10
5. Applied Zoology-II	10
6. Identification and comment upon spots (1 to 8).	24
7. Viva-voce	10
8. Class-record	10
9. Seminar/project report	10
<b>Total</b>	<b>100</b>

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## 4. BOTANY (HONS.)

*Scheme :*

<i>Four Theory Papers</i>	<i>Duration</i>	<i>Max. Marks</i>	<i>Min. Marks</i>	<i>Pass Marks</i>
Paper-IX Biochemistry and Molecular Biology	3 hrs.	75		
Paper-X Systematics of Angiosperms and Environmental Biology	3 hrs.	75	120	
Paper-XI Biotechnology	3 hrs.	75		
Paper-XII Seed Science	3 hrs.	75		
Practicals 2 days (50 marks each)		100		
Practical-I Paper IX, X				
Practical-II Paper XI, XII				

**Scheme of Examination  
Common for all Papers**

Scheme of Examination

Time : 3 hrs

Max. Marks : 75

1. Two types of question papers for each theory paper will be applicable to total duration of 3 hours. One question paper will comprise the objective type of questions and other will be of descriptive long answer type question.
2. Descriptive type of question paper (to be given during the first two hours of the examination) will have 6 questions out of which a student is supposed to attempt any 3. This portion of the paper will carry maximum 45 marks.
3. The objective type question paper will be given after 2 hours of descriptive type paper and will have 35 questions of the objective types. This portion of the papers will carry 30 marks. The objective types of questions will be of the following types :
  - Multiples choice types questions—20 of 1/2 marks each.
  - Fill in the blanks/one word/true or false type question 10 of 1/2 marks each.
  - Very short answer types questions—5 of 1 mark each.

Paper-IX : Biochemistry and Molecular Biology

*Unit-I*

Nucleic Acids : Compositions of nucleic acids and synthesis

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of nucleotides : DNA structure : A, B and Z form of DNA, denaturation and renaturation of DNA : chromatin structure : DNA application and recombination : DNA polymerases : different forms of RNA and their role.

Amino acid and protein metabolism : Structure, characteristics and classification of amino acids; protein and non-protein amino acids; amino acid biosynthesis; GS/GOGA cycle; Transamination : peptide bond and polypeptide chain; primary, secondary, tertiary and quaternary structure of proteins; protein biosynthesis, and its regulation; post-translational Modification of proteins; protein targeting; protein degradation.

**Unit-II**

Carbohydrate metabolism : Classification; structure of some representative examples of monosaccharides, disaccharides, polysaccharides; stereoisomers, enantiomers and epimer; biosynthesis and degradation of sucrose and starch.

Lipid metabolism : Saturated and unsaturated fatty acids; fatty acid biosynthesis; oxidation of fatty acids; storage and mobilization of fatty acids lipids.

**Unit-III**

Gene structure, expression and regulation : Gene organization in prokaryotes and eukaryotes; operon concept; gene regulation in prokaryotes and eukaryotes; inducible, repressible, positive and negative gene regulation; interrupted genes in eukaryotes; RNA splicing; mRNA stability.

Recombinant DNA technology : Restriction endonucleases prokaryotic and eukaryotic cloning vectors; genomic and cDNA libraries; Southern and northern analysis; various techniques of gene mapping and DNA fingerprinting (RFLP, RAPD, AFLP); chromosome walking, polymerase chain reaction; DNA sequencing.

**Suggested Readings**

- Alberts, B., Bray, O.Lewis; J. Raff., M. Roberts. K and Watson, J.D., 1990. Molecular biology of cell. Garland Publishing Co., Inc., New York, USA.
- Bhojwani. S.S., 1990. Plant Tissue Culture : Applications and limitations. Elsevier Science Publishers, New York, USA.
- Buchanan. B.B.: Grulsem, W.; and Jones. R.L. 2000. Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologists, Maryland, USA.

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Collins, H.A.; and Edwards, S. 1998. Plant Cell, Culture. Bios Scientific Publishers, Oxford, UK.

Delnis, D.T.; Turpin, D.H., Lefebvre, D.O. and Layzell, D.B. (eds) 19-t. Plant Metabolism (~Edition) Longman, Essex, England.

Lea, P.J. and Leegood, R.C. 1999. Plant Biochemistry and Molecular Biology (2nd Edition), John Wiley and Sons, Chichester, England.

Lodish, H., Berk, A., Zipursky, S.L., Matsudaira, P., Baltimore, D. and Darnell. J. 2000. Molecular Cell Biology (4th Edition). W.H. Freeman and Co., New York, USA.

Old, R.W. and Prinrose, S.B. 1989. Principles of Gene Manipulation: Blackwell Scientific Publications, Oxford, UK.

Raghavan, V. 1986. Embryogenesis in Angiosperms: A Developmental and Experimental Study. Cambridge University Press, New York, USA.

Vasil, IX and Thorpe, T.A. 1994. Plant Cell and Tissue Culture. Kluwer Academic Publishers, The Netherland.

**Suggested Laboratory Exercises**

1. Chemical tests to demonstrate the presence of starch, sugar, fat and protein in plant material.
2. To identify the amino acids in a mixture by resolving through paper chromatography or TLC.
3. To prepare the standard curve for protein and determine the protein content in unknown samples by Biuret method.
4. Colorimetric estimation of RNA using orcinol.
5. Colorimetric estimation of DNA using diphenyl amine.
6. Isolation of plant genomic DNA and its pooling.
7. Isolation of total RNA from plant tissue and its colorimetric estimation.
8. Preparation of tissue culture media, sterilization and inoculation of plant material.
9. Demonstration of techniques of invitro culture of various explants.
10. Isolation of plant protoplasts (e.g. tobacco, Petunia) using enzymes available commercially and estimation of their yield.

Note : In the practical classes emphasis should be given on basic principles of spectrophotometry, chromatography, electrophoresis and rDNA technology and related fundamentals.

**Suggested Readings (for laboratory exercises)**

Devi. P. 2000. Principles and Methods of Plant Molecular Biology, Biochemistry and Genetics. Agrobios, Jodhpur. India.

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- Dixon, R.A. (Ed.) 1987. *Plant Cell Culture : A practical Approach*, IRL Press, Oxford.
- Dryer, R.I. and Lata, G.F. 1989. *Experimental Biochemistry*, Oxford University Press, New York.
- Glick, B.R. and Tompson, J.E. 1993. *Methods in Plant Molecular Biology and Biotechnology*, CRC Press, BocaRaton, Florida.
- Hackett, P.B., Fuchs, J.A. and Messing, J.W. 1988. *AI"! Introduction to Recombinant DNA Techniques : Basic Experiments in Gene Manipulation*. The Bengaminl Cummings Publishing Co., Inc., Menlo Paro, California R.D. (Ed.) 1999, *Plant Cell Culture Protocols*. Humana Press Inc., New Jersey, USA.
- Ninfa, A.J. and Ballou, D.P. 1998. *Fundamental Laboratory Approaches for Biochemistry and Biotechnology*. Fitzgerald Science Press, Inc., Maryland, USA
- Scott, R.P.W. 1995. *Techniques and Practice of Chromatography*. Marcel Dekker, Inc., New York.
- Wilson, K. and Goulding, K.H. (Eds.) 1986. *A Biologists Guide to Principles and Techniques of Practical Biochemistry*, Edward Arnold, London, UK.

**Paper-X : Systematics of Angiosperms and Environmental Biology**

**Unit-I**

Introduction: Aims and components of systematics; introduction to identification, nomenclature, phylogeny and classification.

Systematics in practice: Importance of herbarium specimens and their preparation; role of herbaria and botanical gardens; documentation (floras, monographs, manuals, journals, abstracts, indices and dictionaries); keys for identification of plants-single access and multiaccess; value of computers and databases for identification.

Taxonomic hierarchy : Taxonomic category; taxonomic groups; concepts of species, genus and family.

Botanical nomenclature : Principles and rules; ranks and names; type method; principle of priority and its limitations; names hybrids and cultivars; concept of biocode.

Phylogeny of angiosperms: A general account of the origin and evolution of angiosperms (special reference to Bennettitalean Gnetalean, Caytonialean and herbaceous origin theories); primitive

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living angiosperms; co-evolution of angiosperms and animals. Systems of classification: Bentham and Hooker's system, Engler and Prantl's system, and Takhtajan's system.

#### Unit-II

Modern taxonomy : Supporting evidences/inputs for taxonomy; taxonomy in relation to anatomy, embryology, palynology, ecology, cytology (cytotaxonomy), secondary metabolites in plants (chemotaxonomy).

Numerical taxonomy : Concepts, characters and attributes; OTU's; coding; cluster analysis: cladistics.

#### Environmental Biology

Introduction : Inter-relationships between the living world and the environment; the components and dynamism; homeostasis; relevance to man.

Earth as a system : The biosphere, the hydrosphere, the atmosphere and the lithosphere; components within biosphere, (biomes); parameters delimiting individual biomes.

The environment : Soil-general account and adaptations; the living world-biotic component of environment; types of biotic interactions; fire as an ecological factor.

Organismal ecology/biotic components : Individuals species, populations, communities and their characteristics.

Ecosystems : Concepts of ecosystem; homeostasis; structure of ecosystem; functions of ecosystem; transfer of energy and minerals via grazing and detritus chains and role of microorganisms; cycles (hydrologic, gaseous); role of humans in maintaining biogeochemical cycles.

Diversity of ecosystem : Aquatic (fresh water); terrestrial (forest/grassland); man-made ecosystems.

#### Unit-III

Phytogeography : Introduction; endemism, static and dynamic plant geography; a short account of vegetation of India.

Human ecology and ecological management : The human population; renewable and non renewable natural resources and their management; conservation of biodiversity; endangered species; conventional and non-conventional energy sources.

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Impact of human activities : Pollution of air, water and soil; a brief account of environmental toxicology; incidence of noise; thermal and radioactive pollution; prevention and control of pollution; global warming, desertification and ozone depletion. Role of national and International organizations in environmental management; formulation of optimal models.

Bio-indicators.

Environmental impact assessment : A brief account.

***Suggested Readings***

***Angiosperm Systematics***

Davis, P.H. and Heywood, V.H. 1960. Principles of Angiosperm Taxonomy. Oliver and Boyd, London.

Heywood, V.H. and Moore, D.M. 1984. Current Concepts in Plant Taxonomy. Academic Press, London.

Jons, S.B., Jr. and Luchsinger, A.E. 1986. Plant Systematics (edition). McGraw-Hill Book Co., New York.

Lawrence, G.H.M. 1951. Taxonomy of Vascular Plants. MacMillan, New York.

Naik, V.N. 1984. Taxonomy of Angiosperms. TataMcGraw Hill, New Delhi.

Radford, A.E., 1986. Fundamentals of Plant Systematics. Harper and Row, New York.

Singh, G. 1999. Plant Systematics : Theory and Practice. Oxford and IBH Pvt. Ltd. New Delhi.

Jeffrey, C. 1982. An Introduction to Plant Taxonomy. Cambridge University Press, Cambridge, London.

Stace, C.A. 1989. Plant Taxonomy and Biosystematics, 2nd edition. Edward Arnold, London.

Woodland, D.W. 1991. Contemporary Plant Systematics Prentice Hall, New Jersey.

Nordenstam, B., El-Gazaly, G and Kassas, M. 2000. Plant Systematics for 21 Century. Portland Press Ltd., London.

***Environmental Biology***

Ambasht, R.S. 1988. A Text Book of Plant Ecology. Students Friends Co., Varanasi.

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- Botkin, D.B. and Keller, E.A. 2000. Environmental Planet (edition) John Viley & Sons Inc., New York.
- Chapman, J. Land Reiss, M.J. 1995. Ecology : Principles and Applications. Cambridge University Press.
- Cunningham, W.P. and Saign, S.W. 1977. Environmental Science : A Global Concern. WCB, McGraw Hill.
- Dash, M.C. 1993. Fundamentals of Ecology : Tata McGraw Hill Publishing Co. Ltd., New Delhi.
- Caubenmire, R.F. 1974. Plants and Environment A Text Book of Plant Ecology (3rd edition). John Wiley & Sons, New York.
- Kendeigh, S.C. 1980. Ecology with Special Reference to Animals and Man. Prentice Hall of India Pvt. Ltd., New Delhi.
- Kumar, H.D. 1996. Modern Concepts of Ecology (4th edition). Vikas Publishing House Pvt. Ltd., Delhi.
- Kumar, H.D. 1997. General Ecology, Vikas Publishing House Pvt. Ltd., Delhi.
- Koimondy, E.J. 1996. Concepts of Ecology. Prentice Hall of India Pvt. Ltd., New Delhi.
- Miller, W.R. and Donahue, R.L. 1992. Soils An Introduction to Soil and Plant Growth (6th edition). Prentice Hall of India Pvt. Ltd., New Delhi.
- Odum, E.P. 1996. Fundamentals of Ecology. Natraj Publishers, Dehradun.
- Pickering, K.T. and Owen, L.A. 1997. An introduction to Global Environmental Issues (~edition). Butter and Tanner Ltd., Great Britain.
- Smith, L.R. 1996. Ecology and Field Biology (6th Edition). Harper Collins College Publishers, USA.
- Smith, L.A. and Smith, T.M. 199B. Elements of Ecology (4th Edition) An Imprint of Addison Wesley, Longman Ink., California.
- Tyler, M.G. Jr. 1997. Environmental Science : Working with Earth (6th Edition). Wadsworth Publishing Co.
- Weaver, J.E. and Clements, S.E. 1966. Plant Ecology. Tata McGraw Publishing Co. Ltd., Bombay.

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**Systematics of Angiosperms**

1. Description of the locally available species of the following families & genera.
2. Ranunculaceae : *Ranunculus, Delphinium*.
3. Brassicaceae : *Brassica, Alyssum, Iberis, Coronopus*
4. Capparidaceae : *Capparis, Cleome*
5. Caryophyllaceae : *Dianthus, Stellaria, Sparganium*.
6. Rutaceae : *Citrus, Murraya*.
7. Tiliaceae : *Corchorus, Grewia*.
8. Fabaceae : Faboideae : *Lathyrus, Clitoria, Melilotus, Cajanus*; Caesalpiniopideae : *Cassia, Caesalpinia*; Mimosoideae : *Prosopis, Mimosa, Acacia*.
9. Myrtaceae : *Callistemon, Eucalyptus*.
10. Cucurbitaceae : *Luffa, Coccinia*.
11. Apiaceae: *Coriandrum, Anethum*.
12. Rubiaceae : *Hamelia, Mussaenda*.
13. Asteraceae : *Tridax, Helianthus, Calendula, Ageratum, Vernonia, Sonchus, Launaea*.
14. Apocyanaceae : *Vinca, Thevetia, Nerium, Tabernaemontana*.
15. Asclepiadaceae : *Calotropis, Asclepias*.
16. Solanaceae: *Solanum, Withania*.
17. Acanthaceae : *Adhatoda, Peristrophe*.
18. Lamiaceae : *Ocimum, Salvia*.
19. Chenopodiaceae : *Chenopodium, Beta*.
20. Euphorbiaceae : *Euphorbia, Phyllanthus, Jatropha*.
21. Moraceae : *Morus, Ficus*.
22. Cannaceae : *Canna*.
23. Liliaceae : *Asphodelus, Asparagus*.
24. Commelinaceae : *Tradescantia, Commelina*.
25. Poaceae : *Avena, Triticum, Hordeum, Poa*.

**Environmental Biology**

1. Mechanical analysis of soils by sieve method.
2. Determination of soil porosity and density (sand and pit method)

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3. Determination of water holding capacity and field capacity of soil.
4. Determination of permeability (capillarity and percolation) of different types of soils.
5. Titrimetric estimation of total carbonates of soil samples.
6. Quantitative determination of soil organic matter by Walkley and Black's rapid titration method.
7. Determination of species area curve by minimal quadrat size.
8. Analysis of the herbaceous vegetation for frequency, density and abundance.
9. Study the height spectrum of herbaceous vegetation by line transect method.
10. Effect of tree canopy on the distribution of herbaceous vegetation.
11. Estimation of biomass of aerial parts of herbaceous plants (fresh weight and dry weight).
12. Analysis of different water samples for pH, oxygen, carbon-dioxide (titrimetric estimation), turbidity and temperature.
13. Demonstration of desert and aquatic ecosystems with the help of models.
14. Field visit : students should be taken for field visits to places of ecological/environmental interest. They should submit detailed report of the visit in the form of project report in the final practical examination for evaluation. The report shall carry marks.

*Suggested Readings (for Environmental Biology laboratory exercises)*

- Ambasht, R.S. 1990. Environment and Pollution Student Friend and Co. Varanasi, India.
- Kapur, P. and Govil, S.R. 2000. Experimental Plant Ecology. S.K. Jain for CBS Publisher and Distributors, New Delhi.
- Misra, R. 1968. Ecology Work Book, Oxford and IBH, New Delhi.
- Moore, P.W. and Chapman, S.B. 1986. Methods in Plant Ecology. Blackwell Scientific Publication.

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Piper, C.S. 1950. Soil and Plant Analysis, University of Adelaide, Australia.

Smith, R.L. 1966. Ecology and Field Biology. Harper Collins, New York.

Smith, R.L. 1990 (4th Edition). Ecology and Field Biology. Harper Collins, New York.

**Note to Teachers :**

The students are to be familiarized with the families listed above in the practical classes with representative species or any other that may be available locally. However, questions pertaining to these may be asked in the theory examinations.

The teachers should prevent the students from collecting plants and submitting them for the practical examinations. Instead, the students should be asked to prepare field reports.

**Paper-XI : Biotechnology**

***Unit-I***

1. Introduction, historical developments, scope, terminology and perspectives.
2. Genetic manipulation through tissue culture techniques, concept of differentiation, dedifferentiation, re-differentiation, Media : composition, preparation, sterilization, Callus growth patterns, organogenesis and plant regeneration. Cell culture techniques, screening of cell lines, selection for nutritional quality, disease resistance, salt and drought tolerance ; anther culture and production of haploids, uses of haploids.

***Unit-II***

3. Gene manipulation through protoplast culture : isolation of protoplasts, fusion of isolated protoplast, culture of protoplasts, somatic hybrid; direct DNA uptake by protoplast, Agrobacterium-mediated gene transfer and electroporation.

***Unit-III***

4. Recombinant DNA technology : isolation and purification of DNA from plant cells, DNA sequencing, gene isolation, cutting and joining DNA molecules, restriction endonucleases, ligases; cloning vehicles; plasmids and bacteriophages; cloning strategies- enzymatic synthesis of genes, selection of vehicle/vector,

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attachment to the vehicle, transfer of recombinant DNA to the host, expression of the transferred plant genes in bacteria; genomic DNA libraries.

5. Application of biotechnology in agriculture and medicine.

**Practicals**

1. Callus induction, organogenesis and plant regeneration (Tobacco, Petunia or any other suitable material).
2. Protoplast isolation, fusion.
3. Isolation, purification of DNA from plant material.
4. Plant tumors—induction through Agrobacterium.

**Paper-XII Seed Science**

***Unit-I***

**Introduction :** Importance and History of Seed Technology, Development of seed testing in India.

**Seed Testing Procedures :** Aim, Sampling, types of samples, sampling equipment, method of testing physical purity, genetic purity (seedling and plant stages), moisture content, (oven method, moisture meter); Germination-3, STTC test, embryo excise methods; blotter methods, roll towel; sand or pot; seedling evaluation.

**Morphology and anatomy of Seed :** Development and structure in dicotyledons and monocotyledons (Leguminosae, Poaceae), exomonomorphic feature, gross internal morphology, seed coat anatomy (basic types in contest's classification).

***Unit-II***

**Seed Storage :** Principles and methods of safe seed storage, types of storage structures, deterioration in storage and its control.

**Physiology of Seed :** Dormancy—Significance, types and release of dormancy : Longevity—Life span of seed, factors affecting longevity.

***Unit-III***

**Seed Health :** Kinds of seed borne inoculum; location of seed borne inoculum; effects of the inoculum. Methods of seed health testing (Dry seed examination, washing test, blotter method, Hiltner's methods).

**Seed Certification :** Concept, minimum certification standards, general and crop standards, Field inspection ISTA certificates.

The seeds Act of India, National Seeds Corporation, State seed corporation, Central Seed Testing Laboratory.

**Practicals :** Based on theory syllabus.

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## 5 MATHEMATICS

### B.A./B.Sc. (Hons) Part III-2010

Teaching : 3 Hours per Week per Theory Paper.

Examination :

Min. Pass Marks

Max. Marks. 400

Science 160

	Duration	Max. Marks
Paper – IX Algebra	3 hrs.	100
Paper – X Complex Analysis	3 hrs.	100
Paper – XI Dynamics and Computer Programming inc	Theory : 2½ hrs. Practical : 2 hrs.	68 32
— Paper – XII Any one of the following		
1. Statistics	3 hrs.	100
2. Spherical Triognometry and Astronomy	3 hrs.	100
3. Integral Equations and Calculus of Variations	3 hrs.	100
4. Calculus of Several Variables	3 hrs.	100

Note :

1. Papers IX, X and XII will be divided into FIVE Units. Two questions will be set from each Unit. Candidates are required to attempt FIVE questions in all taking ONE question from each Unit. All questions carry equal marks.
2. Paper XI is divided into FOUR Units. TWO questions will be set from each Unit. Candidates are Required to attempt FOUR questions in all taking ONE question from each Unit. All questions carry equal marks.
3. Common paper will be set for both the Faculties of Social Science and Science. However, the marks obtained by the candidate in the case of Faculty of Social Science will be converted according to the ratio of the Maximum marks of the papers in the two Faculties.
4. Each candidate is required to appear in the Practical examination to be conducted by internal and external examiners. External examiner will be appointed by the

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University and internal examiner will be appointed by the Principal in consultation with Local Head/Head, Department of Mathematics in the college.

5. An Internal/external examiner can conduct practical Examination not more than 100 (Hundred) candidates (20 Candidates in one batch).
6. Each Candidate has to pass in Theory and Practical examinations separately.

**Paper – IX : Algebra**

**Teaching : 3 Hours per Week**

**Duration of Examination : 3 Hours**

**Max. Marks : 100**

**Note :** This Paper is divided into FIVE Units. TWO questions will be set from each Unit. Candidates are required to attempt FIVE questions in all taking ONE question from each Unit. All questions carry equal marks.

- Unit 1 :** Definition and simple properties of Groups and Subgroups. Permutation group, Cyclic group. Cosets, Lagrange's theorem on the order of subgroups of a finite order group.
- Unit 2 :** Morphism of groups, Cayley's theorem. Normal subgroups and Quotient groups. Fundamental theorems of Isomorphism.
- Unit 3 :** Definition and simple properties of Rings and Subrings. Morphism of rings. Embedding of a ring, Integral domain and field. Characteristics of a Ring and Field.
- Unit 4 :** Ideals and Quotient Ring. Maximal ideal and Prime ideal. Principal Ideal domain. Field of quotients of an integral domain. Prime fields. Definition, Examples and Simple properties of Vector spaces and Subspaces.
- Unit 5 :** Linear combination, linear dependence and Linear independence of vectors. Basis and Dimension. Generation of subspaces. Sum of subspaces. Direct sum and Complement of subspaces. Quotient space and its dimension.

**Paper – X : Complex Analysis**

**Teaching : 3 Hours per Week**

**Duration of Examination : 3 Hours**

**Max. Marks : 100**

**Note :** This paper is divided into FIVE Units. TWO questions will be

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set from each Unit. Candidates are required to attempt FIVE questions in all taking ONE question from each Unit. All questions carry equal marks.

**Unit 1 :** Complex plane. Connected and Compact sets. Curves and Regions in complex plane. Jordan curve theorem (statement only). Extended complex plane. Stereographic projection. Complex valued function – Limits, Continuity and Differentiability. Analytic functions, Cauchy-Riemann equations (Cartesian and polar form). Harmonic functions, Construction of an analytic function.

**Unit 2 :** Complex integration, Complex line integrals, Cauchy integral theorem, Indefinite integral, Fundamental theorem of integral calculus for complex functions. Cauchy integral formula, Analyticity of the derivative of an analytic function, Morera's theorem, Poisson integral formula, Liouville's theorem.

**Unit 3 :** Taylor's theorem. Laurent's theorem. Maximum modulus theorem.

**Power series** – Absolute convergence, Abel's theorem, Cauchy-Hadamard theorem, Circle and Radius of convergence, Analyticity of the sum function of a power series.

**Unit 4 :** Singularities of an analytic function, Branch point, Meromorphic and Entire functions, Riemann's theorem, Casorati-Weierstrass theorem.

Residue at a singularity, Cauchy's residue theorem. Argument principle. Rouché's theorem. Fundamental theorem of Algebra.

**Unit 5 :** Conformal mapping. Bilinear transformation and its properties.

Elementary mappings :  $w(z) = \frac{1}{2} \left( z + \frac{1}{z} \right)$ ,  $z^2$ ,  $e^z$ ,  $\sin z$ ,  $\cos z$ , and  $\log z$ .

Evaluation of a real definite integral by contour integration. Analytic continuation. Power series method of analytic continuation.

**Paper – XI : Dynamics and Computer Programming in C**

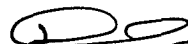
**Teaching : 3 Hours per Week**

**Duration of Examination : 2½ Hours**

**Max. Marks : 68**

**Note :** This paper is divided into FOUR Units. TWO questions will be set from each Unit. Candidates are required to attempt FOUR questions in all taking ONE question from each Unit. All questions carry equal marks.

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**Unit 1 :** Velocity and acceleration – along radial and transverse directions, along tangential and normal directions. S.H.M., Hooke's law, motion along horizontal and vertical elastic strings.

**Unit 2 :** Motion in resisting medium – Resistance varies as velocity and square of velocity. Work and Energy. Motion on a smooth curve in a vertical plane. Motion on the inside and outside of a smooth vertical circle.

**Unit 3 :** Central orbits – p-r equations, Apses, Time in an orbit, Kepler's law of planetary motion. Moment of inertia – M.I. of rods, Circular rings, Circular disks, Solid and Hollow spheres, Rectangular lamina, Ellipse and Triangle. Theorem of parallel axis. Product of inertia.

**Unit 4:** Programming languages and problem solving on computers, Algorithm, Flow chart, Programming in C-Constants, Variables, Arithmetic and logical expressions, Input-Output, Conditional statements, Implementing loops in Programs, Defining and manipulating arrays and functions.

**Practical :**

**Teaching : 2 Hours per Week per Batch  
(20 Candidates in each Batch)**

**Examination :**

**Duration : 2 Hours**

**Scheme**

Max. Marks 32

Min. Pass Marks 13

**Distribution of Marks :**

Two Practicals of

10 Marks each = 20 Marks

Practical Record = 06 Marks

Viva-voce = 06 Marks

Total Marks = 32 Marks

The paper will contain TWO practicals. The candidates are required to attempt both practicals.

Programming in C and execution for the result of

1. Solution of linear algebraic equations by Gauss elimination method
2. Solution of algebraic and transcendental equations by Bisection, False position and Newton – Raphson Methods

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3. Solution of ordinary differential equations by Euler's and Runge-Kutta 4th order method
4. Numerical integration by Trapezoidal and Simpson's one third rule

Note :

1. Each Candidate (Regular/non-Collegiate) has to prepare his/her practical record.
2. Each Candidate has to pass in Practical and Theory examinations separately.

Paper – XII : Any One of the Following :

Paper – XII (I) : Statistics

Teaching : 3 Hours per Week

Duration of Examination : 3 Hours

Max. Marks : 100

Note : This paper is divided into FIVE Units. TWO questions will be set from each Unit. The candidates are required to attempt FIVE questions in all taking ONE question from each Unit. All questions carry equal marks.

Unit 1 : Frequency distributions and measures of location, Measures of dispersion, Skewness and Kurtosis, Moments of frequency distributions.

Unit 2 : Mathematical expectation, Moment generating and Cumulative functions. Discrete probability distributions (Binomial, poisson, Geometric and Hypergeometric).

Unit 3 : Continuous probability distributions (Rectangular and Normal distributions).

Unit 4 : Methods of least squares and curve fitting. Correlation and Regression, Multiple and partial correlation.

Unit 5 : Theory of probability.

Paper – XII (II) : Spherical Trigonometry and Astronomy

Teaching : 3 Hours per week

Duration of Examination : 3 Hours

Max. Marks: 100

Note : This paper is divided into FIVE Units. TWO questions will be set from each Unit. The candidates are required to attempt FIVE question in all taking ONE question from each Unit. All questions carry equal marks.

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**Unit 1 :** Spherical triangles. Relation between sides and angles. Right angled triangles.

**Unit 2 :** Celestial sphere. Astronomical coordinate system, Diurnal motion, Twilight.

**Unit 3 :** Atmospheric Refraction. Time.

**Unit 4 :** Precession and Mutation.

**Unit 5 :** Aberration Parallax and Eclipses.

**Paper – XII (III) : Integral equations and Calculus of Variations**  
Teaching : 3 Hours per Week

Duration of Examination : 3 Hours

Max. Marks : 100

Note : This paper is divided into FIVE Unit. TWO question will be set from each Unit. The candidates are required to attempt FIVE questions in all taking ONE question from each Unit. All questions carry equal marks.

**Unit 1 :** Linear Integral Equations - Definition and classification, Conversion of initial and boundary value problems to an integral equation, Eigen values and Eigen functions and their properties for symmetric kernels. Solution of homogeneous and general Fredholm integral equations of second kind with degenerate kernels.

**Unit 2 :** Iterated kernels and their properties. Construction of resolvent kernel with the aid of iterated kernels. Solution of Fredholm and Volterra integral equations of second kind by using resolvent kernel method. Fredholm determinants. Solution of Fredholm integral equation of second kind by using Fredholm determinants.

**Unit 3 :** Laplace transform - Definition and its properties. Rules of manipulation. Laplace transform of derivatives and integrals. Properties of inverse Laplace transform. Convolution theorem.

**Unit 4 :** Abel's integral equation and its generalizations. Application of Laplace Transform to solve the Volterra integral equations with convolution type kernels.

Calculus of Variations - Variations and its properties. Euler's equation. Functionals. Functionals dependent on Higher order derivatives and functions of several independent variables.

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Unit 5 : Variational problems in parametric form. The moving boundary

value problem for a function of the form  $\int_{x_1}^{x_2} f(z,y,z) dx$ .

Euler's finite difference method. Ritz method for variational problem.

Paper-XII (IV) : Calculus of Several Variables

Teaching : 3 Hours per Week

Duration of Examination : 3 Hours Max. Marks : 100

Note : This paper is divided into FIVE Units. TWO questions will be set from each Unit. The candidates are required to attempt FIVE questions in all taking ONE question from each Unit. All questions carry equal marks.

Unit 1 : Normed vector space, Distance, Inner product. Open and Closed sets. Compactness, Connectedness. Sequence and series. Continuous functions.

Unit 2 : Calculus in vector space - Functions on n-space, Space of continuous functions, Differentiability and the chain rule, Properties of derivative. Partial derivatives, Jacobian, Differentiation under integral sign.

Unit 3 : Mean value theorem and its applications. Higher derivatives and Taylor's formula. Invertible and implicit functions. Continuously differentiable functions. Maxima and minima.

Unit 4 : Multiple integral on  $R^n$  Closed n-rectangle. Lower and upper Riemann sums. Lower and upper Riemann integrals. Riemann integral. Characteristic function. Admissible function. Admissible set. Criteria for admissibility. Repeated integral. Change of variables.

Unit 5 : Ordinary Differential Equations - Integral and Approximate solutions. Lipschitz's property. Comparison of two approximate solutions. Existence and Uniqueness theorem (statement only). Linear differential equation.

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## 6. GEOGRAPHY (HONS.)

Scheme :

Minimum Marks : 160 (40%)

Maximum Marks : 400

Four Papers	Maxi.Marks
Paper-IX India : A Systematic Geography	80
Paper-X Evolution of Geographical Thought	80
Paper-XI Agricultural Geography : An Introductory Course	80
Paper-XII Applied Geography	80
Practical	80

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Notes :

1. Students are permitted to use stencils, simple calculator and Log tables wherever needed in the examinations.
2. One question (Question No. 1) of 20% marks of the total. Question No. 1 will be compulsory and will cover the entire course contents of the paper. Question be set in two Parts :
  - (a) Question on Map (to be supplied) of 10% marks.
  - (b) Question on objective type (Multiple choice and very short answer) of 10% marks.
3. Nine questions will be set with three questions from each section.
4. The Candidate will attempt five questions selecting at least one from each section.
5. The students are required to pass both in theory and practical separately.
6. The theory paper will be of 3 hours duration.

Paper-IX : India : A Systematic Geography*Section A*

India in the context of Asia and the world.

Systematic Geography :

Land—Major terrain units of India and their characteristics. Drainage systems and their functional significance to the country. The Indian monsoon-regional and seasonal variations in climate and climatic

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division : soil types, their characteristics and distribution and the problems of soil conservation, vegetation cover-vegetation types and their distribution. Forest resources and their conservation.

Mineral and power resources—reserves, production and problems of conservation, Resource regions of India.

*Section B*

People—Numbers, distribution density and growth, with special reference to the post-independence period. Socio-economic implications of explosive growth of population literacy and education-spatial patterns, urbanisation-its relation with economy and ecology.

Economy—Changing nature, Indian economy and over-view.

Agriculture—Main characteristics and problems of Indian agriculture, spatial aspects of irrigation developments, technological developments in Indian agriculture, green revolution and its spatial dimension, regionalisation of agriculture in India, food production and population growth.

*Section C*

Industry—Industrial development and the Indian economy-an overview. Locational factors and spatial pattern of major industries in India-iron and steel, engineering goods, textiles, chemicals, cement, sugar, paper etc. industrial regions of India.

Transport and Trade—Development of transport network, different modes and their functional significance. Internal and international trade-composition and change (both in spatial and temporal terms).

*Recommended Books :*

1. Bose, A. (ed.)—Pattern of population change in India, 1951-61, Allied Publishers, Bombay, 1967.
2. Davis, K—Population of India and Pakistan, Princeton University Press, Princeton, 1951.
3. Farmer, B.H.—An Introduction to South Asia, Methuen, London, 1983.
4. Government of India—The Gazetteer of India, Publication, Division, Ministry of Information and Broadcasting, New Delhi, 1965.
5. Mitra, Ashok—Levels of Regional Development of India, Vol.I-Part I-A(i) and (ii) Census of India Publication, New Delhi, 1967.

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Dr.

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6. NATMO (G.O.I.)—National Atlas of India, NATMO, Calcutta.
7. Puri, G.S.—Indian Forest Ecology, Volumes I & II Oxford Book and Stationary Co., New Delhi, 1960.
8. Sdasyuk, G. and Sengupta—Economic Regionalisation of India, Census of India Publication, New Delhi, 1968.
9. Sharma. T.R.—Location of Industries in India. Hind Kitab, Bombay, 1949.
10. Singh. R.L. (ed). India—Regional Studies, Published for the 21st International Geographical Congress held New Delhi. 1968.
11. Singh, R.L. (ed).—India A Regional Geography. National Geographical Society of India, Varanasi, 1971.
12. Spate, O.H.K. and Learmonth, A.T.A.—India and Pakistan, Land, People and Economy, Methuen & Co., London, 1967.
13. Srivastava, M.A. : Trade of India, S. Chand & Co., Delhi, 1967.
14. Wadia, D.N.—Geology of India, MacMillan & Co., London, 1967.
15. Wadia, Mehar and Wadia, D.N.—Minerals of India, National Book Trust, New Delhi, 1966.

### Paper-X : Evolution of Geographical Thought

#### *Section A*

The nature of Geography is the early classical period with reference to the works of Horodotus, Eratosthenes, Strabo and Ptolemy. Early Medieval Geography.

#### *Section B*

The Revival of Geography from the 16th to the early 19th century.

The Works of Varenius. Humboldt and Ritter.

The Nature of Geographical Thought in the second half of 19th century.

The dualism in Geography.

#### *Section C*

The Works of Peschel and W.M. Davis, Ratzel, Semple Richtnofen,

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Hetter, Herbertson and Saur. Concepts of Areal differentiation and Region.

Natural Regions and Geographical Regions, Concept of Ecology.

**Recommended Books :**

1. Hartshorne, Richard : The Nature of Geography (Annals of American Geographers 1939-1947).
2. Hartshorne, Richard : Perspective on the Nature of Geography, John Murray, London.
3. Taylor, Griffith (Ed) : Geography in the Twentieth Century, New York, 1951.
4. James, Preston E.—American Geography : Inventory and Prospects, Syracuse, 1945.
5. Bowman, Isabiah : Geography in Relation to the Social Science New York, 1934.
6. Mackinder, Halford, J. : On the Scope and Method of Geography. Proceedings of the Royal Geographical Society, 1887.
7. Wooldridge, S.W. and W.G. East : Spirit and Purpose of Geography.
8. Dickinson, R.E. : Makers of Modern Geography.

**Paper-XI : Agricultural Geography  
An Introductory Course**

**Section A**

Nature, Scope and significance of Agricultural Geography.

Approaches to the study of Agricultural Geography—commodity, environmental, systematic and regional.

Determinants of agricultural Land use—Physical, Social, Economic and cultural.

**Section B**

Whittlesey's agricultural types—their characteristics and distribution in the world.

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A critical review of Whittlesey's agricultural classification.

*Section C*

Indian Agriculture—(a) Problems and prospects, (b) regions.

*Recommended Books :*

1. Alexander, J.W. : Economic Geography, Prentice Hall, Inc. Englewood Cliffs, N.J. Latest Edition.
2. Symons, L. : Agricultural Geography, G. Bell & Sons, London, 1964.
3. Husain, M. : Agricultural Geography, Inter-India Publications, New Delhi, 1979.
4. Singh, J. and Dhillon, S.S. : Agricultural Geography, Tata McGraw Hill Publishing Co. Ltd. New Delhi, 1984.
5. Grigg, D.B. : Agricultural Systems of the World and Evolutionary Approach, Cambridge University Press Cambridge, 1978.
6. Whittlesey, Darwent, S. : Major Agricultural Regions of the Earth. Annals of the Association of American Geographers. Vol. 26, 1936.
7. Tewari P.S. (ed) : Contribution to Agricultural Geography, Heritage, Delhi, 1986.

*Reference Books :*

1. Gregor, H.F. : Geography of Agriculture—Themes in Research, Prentice Hall Inc., London, 1970.
2. Morgan, W.B. and Muton, R.J.C.—Agriculture Geography, Methuen, London, 1971.

Paper-XII Applied Geography

*Section A*

Nature, scope and content of applied geography; identification of problems of interdisciplinary nature (like environment resource base, resource-use, development and disparity).

Issues related to variations in physical environment. Variations

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land quality affecting agricultural productivity; environmental degradation, environmental disaster and environmental management.

**Section B**

Issues related to human resource-quality vs numbers; social and demographic issues; diversity and disparity; carrying capacity of the earth; human resources use and manpower planning.

Issues related to economy; spatial organization of economic activities (like agriculture, industry, transport, trade, etc.) spatial inequalities-causes and consequences.

**Section C**

Environment and sustainable development with a focus on man environment relationship. Review of policies related to planning formulated for local, regional and national level with special reference of india.

**Recommended Books :**

1. Dohrs, F.E. and Sommers, L.W. (eds.): Introduction to Geography, Thomas Y. Crowell Co., New York, 1967.
2. Hartshorne Richard; Perspective on the nature of Geography Rand Mc Nally & Co. Chicago, 1959.
3. Harvey, David.: Explanation in Geography, Edward-Arnold, London, 1972.
4. Hold-Lensen, A.: Geography Its History and Concepts, Longmans, 1980.
5. Husain Majid : Evolution of Geographica Thought, Rawat Publications, Jaipur, 1984.
6. James, P.E.: All possible Worlds: A History of Geographical Ideas, Sachin Publication, Jaipur, 1980 (Indian reprint).
7. Johnston, R.J. and Claval, P.(eds.) : Geography since the Second World War, Croom Helm, London/Bernes and Noble, Totowa, N.J., 1984.
8. Jones, P.A.: Fieldwork in Geography, Longmans.

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9. Lownsburg, J.F. and Aldrich, F.T.: Introduction to Geographical Methods and Techniques, Charles Marrill, Columbus, 1979.
10. Minshull, R. : The Changing Nature of Geography, Hutchinson University Library, London, 1970.
11. Worldridge, S.W. : The Geographer as a Scientist, Thomas Nelson and Sons Ltd., London, 1956.
12. Misra, V.V., Ayyar, N.P. et.al. (editors) : Essay in Applied Geography University Printing Press, Saugar, 1976.

**Practicals : Map Projectionis & Surveying**

General Principles, classification, identification, transformation and choice of projections.

Construction, Properties, limitations and uses of the following projection :

Cylindrical : Simple, Equal Area and Mercator's

Conical : One standard, Two standard Boone's, Polyconic and international.

Zenithal : Gnomonic, Stereographic Orthographic, Equidistant and Equal Area (Polar Cases only).

Conventional : Sinusoidal and Mollwede's (normal Cases only).

Dumpy level : Survey and Contouring.

***Recommended Books :***

1. Kellaway, George, P.—Map Projections, Methuen & Co., London.
2. Steers : J.A.—Map Projections, University of London Press, London.
3. Singh, R.L.—Practical Geography, Kalyani Publishers, New Delhi.

***Reference Books :***

1. Gamett. William—Map Projections, George Philip & Sons., London.
2. Jameson, A.H. & Ormsby, M.T.M.—Mathematical Geography, Vol. I, Isaac Pitman & Sons., London.

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Hons Pt III

**137 PSYCHOLOGY (HONS.)****Scheme :**

<b>Four Theory Papers</b>	<b>Duration</b>	<b>Max. Marks</b>	<b>Min. Pass Marks</b>
Paper-IX	3 hrs.	75	
Paper-X	3 hrs.	75	120
Paper-XI	3 hrs.	75	
Paper-XII	3 hrs.	75	
Practicals		100	40

**Note:** There will be 4 theory papers in subject Psychology in BA Hons Part III. There will be common papers for Arts and Science Question No. 1 will be compulsory and will cover the entire course contents of the paper. Question I will contain two parts A & B. A part of I questions will contain 20 questions of multiple choice. Each question will be of 3/4 mark. Thus A part will be of 15 marks. B part will contain 10 questions to be answered in the limit of 20 words. Each question of B part will be of 1½ marks. Thus B part will be of 15 marks. Separate question paper for this objective type will be provided to each student and answers will be given in this question paper only in the space provided for this purpose in the objective type question paper. Candidates will be given one hour to attempt this first compulsory question out of three hours in total time allotted for this paper.

In the second part of the question paper, three questions of essay type will be attempted selecting at least one from each section. Each question will be of 15 marks. This objective type question will be compulsory to attempt in all four theory papers.

**B.A./ B.Sc. Honours Part-III**

**Paper-I: Psychometrics**

**Section-A**

1. **The need of psychological measurement and testing, the origin of psychological measurement and testing.**
2. **Scaling: Kinds of scales, their characteristics and uses of scaling in psychological problems.**
3. **Psychological Tests: Nature and Functions of tests: Current uses of psychological tests. Kinds of Tests: Individual and Group test. Characteristics of a good test.**

**Section-B**

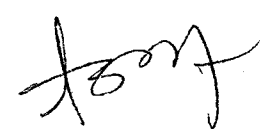

4. **Problems in the Test Administration: Testing programme, professional ethics, controlling the use of psychological tests, problems of report and administration. Guidelines for testing programmes.**
5. **Problems of Testing Construction: Drafting and compilation of test items. Item analysis. Establishing the characteristic of a good test i.e. reliability, validity and need for cross validation.**
6. **Standardization of Tests: Procedure, establishment of norms, interpretation and application of test scores, Prediction value of Test.**

**Section-C**

7. **Tests of intelligence: Nature and Types: Verbal tests, Non-language tests, Performance test, Test for measuring adult intelligence, Special tests; Culture fair tests.**

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8. **Tests of Interest and Aptitude:** Interest test (educational and vocational), Attitude tests, Aptitude tests, Academic tests (achievement tests), Testing in progressions.
9. **Personality tests:** Self-report test inventories, Projective techniques: Verbal, Non-verbal, T.A.T. and Rorschach, Situational tests and Expressive techniques.

**Reference Books:**

1. Anne Anastasi- Psychological Testing. Macmillan company, London, 1988
2. Lee Chronbach-Essentials of Psychological Testing. Tokyo. Harper International Edition, 3<sup>rd</sup> Ed. 1970
3. Freeman-Theory and practice of Psychological Testing, New Delhi, Oxford & IBH, 3<sup>rd</sup> Ed., 1963.
4. Guilford, J.P.- Psychometric Methods, N.D. Tata McGraw Hill 1974.

**Paper-II: Applied Psychology**

**Section-A**

1. **Applications of Psychology in Industry:** Personnel selection and classification.
2. **Personal assessment techniques:** Development and training attitude and motivation.
3. **Organization psychology:** Leadership and supervision, participated management, job design, organizational structure and climate, communication.

**Section-B**

4. **Engineering Psychology:** Human performance.



5. **Human factors in Equipment design**
6. **Stress management: Psychological determinants of stress and its management.**

**Section-C**

7. **Psychology in education: School system, Measurement and Evaluation, Instructional technology, Behaviour modification in school setups.**
8. **Counselling psychology: Nature of guidance and counselling, uses of psychological tests in guidance and counselling, career planning and development, occupational information.**
9. **Scope and methods of consumer psychology.**

**Reference Books:**

1. Anastasi, A-Fields of Applied Psychology, New York, McGraw Hill (International Ed.) Tokyo, 1979
2. Schien-Organizational Psychology, New Delhi, Prentice-Hall, 1967.
3. Korchin, S.- Modern clinical Psychology, Basic Books, Inc. Publications, New York, 1976
4. Bunt-Applied Psychology.
5. Poffenberger-Principles of Applied Psychology
6. Mohan, J. Chaddha, N.K. and Akhtar, S.S. Psychology of Sports Fiends Publications (India), Delhi, 1992.

**Paper-III: Personality and Motivation**

**Section-A**

1. **Personality and Personality Theory: Definition and Nature. Biological and cultural determinants of Personality.**

2. **Personality assessment:** Observational Methods, rating scales, interview, different personality inventories, MMPI, 16 PF, EPI, projective techniques: Rorschach and TAT.
3. **Type and Trait Approach**

**Section-B**

4. **Psychoanalytic theory of personality**
5. **S-R theory of personality**
6. **Factor theories of personality: Cattell and Eysenck.**

**Section-C**

7. **Motivational phenomena and goal direction:** Classification, purpose and direction in motivational activities. Human performance and Motivational variables.
8. **Achievement motivation:** Nature, measurement and research, Maslow's theory of motivation.

**Reference Books:**

1. Hall & Lindzey-Theories of Personality, New York, Wiley, 1978.
2. Mischeli, W.-Theories and Assessment of Personality
3. Maslow A.-Motivation and Personality, New York, Harper & Row, 1970.
4. Atkinson-Personality, Motivation and Achievement.
5. Bindra, Dalbir-Motivation: A Systematic Interpretation Ronald Press Col. New York, 1965.
6. Rrow Judsoa Seise-The Motivation on Behaviour, New York, McGraw Hill Book Col, 1962

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**University of Rajasthan**  
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**Paper-IV: Environmental Psychology**

**Section-A**

1. **Nature and Scope of Environmental Psychology:** Methodological approaches to environmental psychology.
2. **Environmental perception:** Nature and factors.
3. **Attitude toward Environment:** Formation and change.

**Section-A**

4. **Behaviour Theories of Environment.**
5. **Environmental Stress: Pollution and Behaviour.**
6. **Personal Space and Territoriality:** Definition, functions & determinants.

**Section-A**

7. **Crowding and Environment:** Density and social behaviour.
8. **Environment and Community Health:** Urban problems and their solutions.
9. **Save the Environment:** Changing behaviour to save the environment.

**Reference Books:**

1. Fishar, J.D., and Bell. P.A.-Environmental Psychology (2<sup>nd</sup> ed.), Hold, Rinehart & Winston, 1984.
2. Baum, A sunger J.E. and Valins, S.- Advances in Environmental Psychology Vol. 4.

**Practicals**

1. Assessment of Attitude
2. Assessment of Interests
3. MPI
4. Population Density and Mental Stress
5. Need Achievement
6. Vocational Attitude Maturity
7. HSPQ
8. Work Attitude
9. TAT
10. Picture Frustration Study
11. Raven's SPM
12. WAIS

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