Scheme of Examination
B.Sc(Honours) Part-III
(10+2+3 Pattern)

For a pass at each examination a candidate should be required to obtain a minimum of 36% marks in each subsidiary subjects and 40% marks in the Honours subjects, passing separately in the practicals, wherever prescribed, shall be necessary.

Successful candidates will be classified as under:

<table>
<thead>
<tr>
<th>Division</th>
<th>Percentage</th>
<th>Qualification</th>
</tr>
</thead>
<tbody>
<tr>
<td>First Division</td>
<td>60%</td>
<td>of the aggregate marks prescribed both in Honours and subsidiary subject of Part I, II, &amp; III Examination taken together.</td>
</tr>
<tr>
<td>Second Division</td>
<td>50%</td>
<td></td>
</tr>
</tbody>
</table>

All the rest will be declared to have passed the examination if they obtain a minimum of 40% marks in the aggregate.

The number of papers and practicals, wherever prescribed the duration of examination, maximum marks and minimum pass marks shall be shown in the relevant syllabus.

A candidate shall be required to offer one Honours subjects and one subsidiary subject out of the following subjects to the condition that the same were offered by him as optional subjects at the First Year T.D.C. Examinations of the University or an examination recognized by the Universities equivalent thereto:

Honours Subjects:
1. Physics
2. Chemistry
3. Zoology
4. Botany
5. Mathematics
6. Psychology
7. Geography

N.B. Candidates shall be required to offer Four papers and practicals (wherever prescribed) of the Honours subject offered by him.

Dy. Registrar (Academic-I)
University of Rajasthan
Jaipur
## CONTENTS

**Syllabus (Subsidiary Subjects) (Same Courses of Study as prescribed for Part-II T.D.C. Pass Course)**

**Subjects (Honours Subjects):**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Physics</td>
</tr>
<tr>
<td>2.</td>
<td>Chemistry</td>
</tr>
<tr>
<td>3.</td>
<td>Zoology</td>
</tr>
<tr>
<td>4.</td>
<td>Botany</td>
</tr>
<tr>
<td>5.</td>
<td>Mathematics</td>
</tr>
<tr>
<td>6.</td>
<td>Psychology</td>
</tr>
<tr>
<td>7.</td>
<td>Geography</td>
</tr>
</tbody>
</table>
1. **PHYSICS**

B. Sc Honors PART III

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, Laguerre'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:

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)
Syllabus : B.Sc. (Hons.) Part-III

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, noncentral forces, p-p and n-n scattering at low energy, charge independence of nuclear forces and concept of isospin 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 Weissskopf 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.

[Signature]

Dy. Registrar
(Academic)
University of Rajasthan
Jaipur
University of Rajasthan

(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
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/ψ 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 accelerators, 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.
Syllabus: B.Sc. (Hons.) Part-III

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: David Kaplan
2. Concepts of Nuclear Physics: B.L. 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.


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


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

Unit-III

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

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


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.


Qualitative discussion of pyroelectric and piezoelectricity.

Unit V


Reference Books:

Dy. Registrar
(Academic)
University of Rajasthan
Jodhpur
Syllabus: B.Sc. (Hons.) Part-III

4. Introduction to Solid by L. Azaroff.

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% weighting will be given to problem 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, Landé g factor, strong and weak field effects, illustrative cases of H, Na, Ca, and Hg. X-ray spectra: The continuous X-ray spectrum; Dauna 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 H₂ ion, H₂ molecule, Electronic levels and quantum numbers for electronic states of diatomic molecules: singlet and triplet.
University of Rajasthan


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 \( \text{H}_2\text{O}, \text{CO}_2 \) and \( \text{N}_2\text{O} \) 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".
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."

\[ \text{Dy. Registrar} \\
(Academic) \\
University of Rajasthan \\
\]
Syllabus: B.Sc. (Hons.) Part-III

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 experiments 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 filters, 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 form a glass plate with the help of Nicol Prism, and photo cell and verification of Brewster's Maho's law.
7. e/m measurement by Helical 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.
12. Study of gamma ray spectra using scintillation spectrometer.
13. Study of Bremsstrahlung by electrons of 100 KeV to 2 MeV energy using scintillation spectrometer.
15. Study of excitation of characteristic X-rays by electron.
17. Study of parametric amplifier.

Dy. Registrar
(Academic)
University of Rajasthan
JAIPUR
2. CHEMISTRY

Max Marks: 40

<table>
<thead>
<tr>
<th>Duration (hrs)</th>
<th>Max. Marks</th>
<th>Min. Pass Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paper IX</td>
<td>3</td>
<td>75</td>
</tr>
<tr>
<td>Paper-X</td>
<td>3</td>
<td>75</td>
</tr>
<tr>
<td>Paper-XI</td>
<td>3</td>
<td>75</td>
</tr>
<tr>
<td>Paper-XII</td>
<td>3</td>
<td>75</td>
</tr>
<tr>
<td>Practical</td>
<td>10</td>
<td>100</td>
</tr>
</tbody>
</table>

Note: Each paper will contain ten (10) questions having two (02) questions from each unit. Candidates are required to attempt five (05) questions in all selecting one (01) question from each unit.

**Paper-IX Inorganic Chemistry**

(4 hrs. / Week)

**Unit-I**

Metal-Ligand bonding:
(a) Limitations of crystal field theory, molecular orbital theory of octahedral, tetrahedral and square planar complexes, π-bonding and molecular orbital theory.
(b) Organometallic Compounds: definition and classification of organometallic compounds, synthesis, properties and structures of organometallic compounds of magnesium, aluminium, tin and lead.
(c) Metal Carbonyls: preparation, properties and bonding of transition metal carbonyls. Detailed study of mononuclear and polynuclear carbonyls.

**Unit-II**

Inorganic Polymers:
(a) Types of inorganic polymers, comparison with organic polymers, synthesis, structural aspects and applications of silicones, phosphonitrillic halides and condensed phosphates.
(b) Metal Clusters: Higher boranes, carboranes, metallocboranes and metallocarboranes, metal carbonyl and halide clusters, compounds with metal-metal multiple bonds.

**Unit-III**

Nuclear Chemistry:
(a) 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).
(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, spallations, 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

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

Books Suggested:

1. Manfred Bochmann, Organometallics 1: Complexes with transition Metal-Carbon σ-bonds (Oxford Chemistry Primers).
3. R.C. Mehrotra and A. Singh, Organometallic Chemistry.
5. J.E. Huheey, Inorganic Chemistry.
8. R. Sarkar and Nityanand Saha, General and Inorganic Chemistry (Hon. Consulting Editor).

Paper-X: Organic Chemistry
(4 Hrs. / Week)

Unit-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 effects of:
Analgesics: Aspirin, Phenacetin, Paracetamol.
Antimalarials: Chloroquine, Plasmoquine.
Antibiotics: Chloramphenicol (Chloromycetin).
Sulpha drugs and their mechanism of action, Synthesis of sulphadiazine, sulfnpyridine, sulphathiazole, sulphaguanidine and sulphamethazole.

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 α-amino acids.
Nucleic acids: Introduction, constitution 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 Spectrometry: Introduction, instrumentation, factors affecting fragmentation, ion analysis, ion abundance, fragmentation modes, mass spectral fragmentation of simple organic compounds:

[Signature]

Dy. Registrar
(Academic)
University of Rajasthan
JAIPUR
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.

Reference Books:
3. Jonathan Clayden, Nick Greeves, Stuart Warren and Peter Woters; Organic Chemistry; First Edition; Oxford University Press, USA.
6. William Kemp; Application of Spectroscopy; Third Edition; Palgrave Publisher Ltd., New York.

Paper XI: Physical Chemistry
(4 Hrs. / Week)

Unit – I

Quantum Mechanics:
Schrödinger’s wave equation for particle in three dimensional box, H-atom, quantum number and their importance, H-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–H2+ ion, calculation of energy levels from wave functions from energy levels from wave functions, physical picture of bonding and anti-bonding wave functions, concept of σ, σ*, and π, π* orbitals and their characteristics. Hybrid orbitals- sp, sp2, sp3, calculation of coefficient of A.O.’s used in these hybrid orbitals. Introduction to Valence bond model of H2, comparison of M.O. and V.B model.

Unit – II

(a) Photochemistry:
Interaction of radiation with matter, difference between thermal and photochemical processes. Laws of photochemistry: Grothus-Draper law, Stark-Einstein law, Jablonski diagram depicting various processes occurring in the exited state, qualitative description of fluorescence, phosphorescence, non-radiative processes (internal conversion, intersystem crossing), quantum yield, photosensitized reactions-energy transfer processes (simplex examples).

(b) Physical Properties and Molecular Structure
Optical activity, polarization (Calusius-Mossotti equation), orientation of dipoles in an 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 ferromagnetic.
Unit – III

Electrochemistry:
Electrolyte and galvanic cells - Reversible and irreversible cells, conventional representation of electrochemical cells. E.M.F. of a cell and its measurements. Computation of cell e.m.f.
Classification of electrochemical cells, requirement of power source, lead storage cell and fuel cell.
Corrosion: types, theories and method of combating corrosion.

Unit – IV

Macromolecules: Linear branches network and homopolymer. Polymer classification-condensation polymer and addition polymers, number average and weight average, molecular weight determination methods of polymers by (1) osmotic pressure, (2) viscosity, (3) light scattering. Properties of macromolecules.

Unit – V

Phase Equilibrium:
Solid solutions: Compound formation with congruent melting point (Mg-Zn) and benzophenone-dimethylamine, incongruent melting point NaCl-H₂O, picric acid and benzene, FeCl₃ – H₂O and CuSO₄ – H₂O system.
Liquid-Liquid Mixtures: Ideal liquid mixtures, Raoult’s law and Henry's law, non – ideal system, Azeotropes HCl-H₂O 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 phenomenon, Micelles: surface active agents, classification of surface active agents, micellization, hydrophilic interaction, critical micellar concentration (CMC), factors affecting 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 phenomenon), catalytic activity at surface, electrode/electrolyte interface.
Suggested Books:
1. Physical Chemistry by S. Glasston.
5. Physical Chemistry, Behl & Tuli, S. Chand Publication, Delhi.
6. Introduction to Polarographic and Allied Techniques, K Zutshi, New Age International Publication.

Paper XII: Analytical Chemistry
(4 Hrs./Week)

Unit-I
Electrogravimetry: Theory, electrode reactions, overpotential, completeness of deposition, electrolytic separation of metals, character of the deposit and 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.
Coulometry: Coulometry at controlled potential, separation of Ni and Co by coulometric analysis at controlled potential, coulometry at constant current, coulometry titrations.

Unit-II
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.
Amperometry: Amperometric titrations, technique of amperometric titrations with the dropping mercury electrode, titration with the rotating platinum micro electrode, biamperimetric titrations.
Modified Voltammetric methods: Current sampled (TAST) Polarography, Pulse polarography, Differential pulse polarography, Cyclic Voltammetry, Sinusoidal Alternating current polarography, Stripping Voltammetry.

Unit-III
Mass spectrometry: Instrumentation and technique, Elementary idea about electron impact, chemical ionization and matrix 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.
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
NMR Spectroscopy: Theory of nuclear magnetic resonance, experimental methods of NMR spectroscopy, applications of proton NMR including applications in MRI technique.

Suggested Books:
2. A.I. Vogel, Analytical Chemistry.
5. I.M. Kolthop, Analytical Chemistry.

B.Sc.(Hons.) PART-III CHEMISTRY PRACTICALS
(8 hrs or 12 periods /week) (Spread in four days)

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
   d) Silver-Nickel
   e) Silver-Zinc
   f) Copper-Nickel
3. Inorganic Preparations and its characterization (any four) and characterization of coordination compounds:
   a) Bis (dimethylglyoximato) nickel (II) complex
   b) Tetraaminecopper (II) sulphate
   c) Potassium cis-diaquabis(oxalato)chromate (III) dihydrate
   d) Hexamminenickel (II) chloride
   e) Persian 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) MnO₂ in pyrolusite.

ORGANIC CHEMISTRY
1. Qualitative 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, NaHCO₃ and NaOH for separation and preparation of suitable derivatives.

3. Two step preparations 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 acetonilide.
   c) Preparation of syn-tribromobenzene from aniline.
   d) Preparation of m-nitroaniline from nitrobenzene.
   e) Preparation of acetonilide from acetophenone (Beckmann rearrangement).
   f) Preparation of anthranilic acid from phthalic anhydride.
   g) Preparation of eosin from phthalic anhydride.

PHYSICAL CHEMISTRY
(A) Potentiometry (Multimeters may be used)
   1. To find out the strength of acid by titrating it against alkali.
   2. Determination of dissociation constant of weak acids.
   3. Determination of number 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.

(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 CH₃COOH in a mixture of both by titrating it against NaOH.

(C) Spectrophotometer experiment or Colourimetric experiment
   a) Verify Lambert Beer Law & determine the concentration of the given aqueous solution of unknown concentration of salt.

(D) Kinetics:
   1. Determine the effect of ionic strength on the rate of persulphate iodide reaction.
   2. Determination of molecular weight by Rast Camphor method.
   3. Determination of concentration of given solution of H₂SO₄ acid by measuring heat changes during dilution.
   4. Compare cleaning power of two samples of detergents by surface tension measurement.
(Instructions to the Examiner)
B.Sc. (HONS) Pt.-III CHEMISTRY PRACTICAL EXAMINATION

Max. Marks: 100  Duration of Exam: 10 hrs.  (Complete in Two days)

1. Qualitative analysis of inorganic mixture for six radicals (including interfering, rare and insolubes)

   OR

2. Quantitative estimations (gravimetric and volumetric).
3. Separation and identification of two compounds in the given organic mixture and preparation of their suitable derivative.

   OR

4. Organic two step preparations.
5. Quantitative estimations
6. Physical Chemistry
   (a) Perform one major exercise
   (b) Perform one minor exercise
7. Record
8. Viva-voce

---

Dy. Registrar
(Academic)
University of Rajasthan
TAIPUR
3. ZOOLOGY (HONS.)
B.Sc. (Hons.) Part – III – 2020

Scheme

<table>
<thead>
<tr>
<th>Paper</th>
<th>Subject</th>
<th>Max. marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>XIII</td>
<td>Ecology</td>
<td>50</td>
</tr>
<tr>
<td>XIV</td>
<td>Environment Biology</td>
<td>50</td>
</tr>
<tr>
<td>XV</td>
<td>Development Biology</td>
<td>50</td>
</tr>
<tr>
<td>XVI</td>
<td>Evolution</td>
<td>50</td>
</tr>
<tr>
<td>XVII</td>
<td>Applied Zoology-1</td>
<td>50</td>
</tr>
<tr>
<td>XVIII</td>
<td>Applied Zoology-2</td>
<td>50</td>
</tr>
<tr>
<td>Practicals</td>
<td>2 days (8 hrs.)</td>
<td>100</td>
</tr>
</tbody>
</table>

Scheme of Examination

Max. Marks: 50

1. There will be 5 Question in each paper. All questions will be compulsory and carry equal marks.
2. Question number 1 will comprise 10 very short answer (maximum 25 words) type questions, each of 1 mark. Questions should be evenly distributed covering entire syllabus.
3. Each paper is divided into four units/sections. There will be one question from each unit/section. The question number 2 to 5 will have internal choice.

Seminars, posters, models, educational tour reports, practical record etc. will carry internal marking which will be added in the practicals.

Paper XIII: Ecology

Section - A

1. Aim and scope of Ecology.
3. Ecosystem: Abiotic and biotic factors.

Dy. Registrar (Academic-I)
University of Rajasthan
Jaipur
Section - B


Section - C


Section - D

11. Major biomes of the world: Desert, grassland, tundra, temperate, tropical moist forest and seasonal forest.


Paper-XIV: Environmental Biology

Section – A

1. Environmental and its concept, 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. Environmental pollution II: Sources and remedies for thermal, noise, radiation industrial chemicals, agrochemicals, insecticides & pesticides and household pollutants. Solid waste Management.
Section - C

6. Green house effect, ozone layer depletion, El Nino and La Nina effects.
7. Radiation and environment: Types of radiation, fall effects and effects of nuclear radiation accidents.
8. Basic concepts of bioaccumulation, biomagnifications and biodegradation of pollutants.

Section - D

11. Space ecology: Space problems and their solutions, space ecosystem and space colonization.
12. Sustainable environment.

Paper-XV: Development Biology

Section - A

1. Gametogenesis: Spermatogenesis, oogenesis, vitellogenesis and egg membranes.
2. Fertilization: Sperm-egg interactions, biochemical events and 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 and induction process.

Section - C

7. Organogenesis of heart, kidney, nervous system and sense organs.
9. Regeneration in invertebrates and vertebrates.
Section - D
10. Various types of stem cells and applications (with special reference to embryonic stem cells).
11. Cloning of animals: Nuclear embryonic transfer techniques, nuclear transfer techniques and embryonic or therapeutic cloning.
12. Teratological effects of xenobiotics.

Paper-XVI: Evolution

Section - A
1. Concept of evolution.
3. Origin of prokaryotic and eukaryotic cells.

Section - B
5. Concept of species and speciation.
7. Molecular drive.

Section - C

Section - D
11. Zoogeography: Principles and concepts of parallelism, endemism etc and factors influencing animal distribution.
Paper-XVIII: Applied Zoology-1

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 & growth, pure culture and characteristics.
5. Bacterial nucleic acids.

Section - C
6. The world of bacteria- Classification, morphology and characteristics: Gram negative bacteria (Pseudomonas, E.coli, Acetobacter, Nitrobacter & Thiobacter), Gram positive bacteria (Lactobacillus & Enterococcus), bacteria with unusual properties and Gram positive filamentous bacteria (Actinomycetes).
7. Microorganisms: General characteristics of fungi (molds and yeast), algae, protozoa and viruses.
8. Medical Zoology: Role of normal flora, Normal flora as pathogens, brief introduction to pathogenic microbes, viruses (Pox virus, Herpes virus, Adenovirus, Hepatitis virus, HIV & AIDS virus), rickettsia, spirochetes, staphylococcus, streptococcus, pneumococcus, haemophilus, Mycobacterium tuberculosis and clostridium.

Section - D
10. Arthropods as vectors of human diseases: Malaria, Dengue, Filarisis, Japanese encephalitis and Plague.


Section - A
2. Enzymology of genetic engineering: Restriction enzymes, DNA ligase and polymerase.

26
4. Analysis and expression of cloned gene in the host cells: Southern blotting, Northern blotting, In-situ hybridization, PCR (Polymerase chain reaction) and DNA finger printing.

Section - B

5. Protoplast fusion in prokaryotes and eukaryotes.
7. Introduction of cloned genes into the host cells: Transformation and transduction.
8. Medical biotechnology: Gene therapy.

Section - C

9. Transgenic animals and their uses.
10. Brief account of cloning: Genomic research, its advantages and disadavantages.
11. Biotechnology in medicine (outline idea only): Antibiotics, vaccines, enzymes, vitamins, steroids and artificial blood.

Section - D

13. Food, drinks and dairy biotechnology (outline idea only): Microbial spoilage and food preservation, fermented food production: dairy products, alcoholic beverage and vinegar.

University of Rajasthan

Syllabus: B.Sc. Zoology (Hons.) Part-III

Min. Marks 40 8 hrs. /week Max. Marks: 100

Practicals

I. Analysis of environmental components
1. Soil pH.
2. Water analysis: pH, alkalinity, acidity dissolved oxygen, free CO₂ and salinity (chlorides).
4. Quatitative estimation of zooplanktons in the given water sample
5. Simple methods to measure population density.
6. Field study of any one of the following habitats: Freshwater/lake/pond/ river or desert.

27
II. Development Biology (with the help of models /charts/CD-ROM's/ high resolution picture/video's etc.)

Study of frog/toad development:
1. Egg, cleavage, blastula, gastrula, neurula, tail bud, mature tadpole larva, metamorphic stages and froglet/toadlet.
2. Histological slides: Cleavage, blastula, gastrula, neurula and tail bud.

Study of Chick development:
1. Whole mounts: 18 hrs, 21 hrs, 24 hrs, 33 hrs 48hrs, 72 hrs and 98 hrs of incubation.
2. Study of chick development through window and blastoderm mounting.
3. Study of various foetal envelopes in a 10-12 day chick embryos (amnion, chorion, allantois and yolk sac).

III. Evolution
1. Study of evolution of man with help of models.
2. Numerical problems based on population genetics.

IV. Applied Zoology-1
1. Preparation and use of culture media for microbes.
2. Study of microbes in food material (curd and milk).
3. Preparation of bacterial culture (water, air, soil/sludge)-Spread plate and streaking method.
5. Preparation of culture media for fungus and its identification.
7. Visit to Dairy/wine processing unit. Submit a report.

V. Applied Zoology-2
1. Isolation of DNA from onion.
2. Genomic DNA isolation from eukaryotic cells (cheek and yeast).
3. Small scale preparation of plasmid DNA.
4. Restriction digestion and agarose gel electrophoresis of genomic DNA and plasmid DNA.

28

Dy. Registrar (Academic-I)
University of Rajasthan
Jaipur
B.Sc. Zoology (Hons.) Part-III

Scheme of practical examination and Distribution of marks

8 Hrs. (2 days, 4hrs/day)

Min. marks: 40

Ist day

1. Environmental Biology 10
2. Biotechnology (Applied Zoology) 10/15
   (Marks of the observation and result=05 to be given the next day if required)
3. Evolution 10
4. Viva voce 05
5. Class Record 05
6. Seminar/Project Report/Collection 05

IInd day

1. Development Biology 09
2. Biotechnology 05
   (Observations and results of the 1st day experiment if any)
3. Microbiology 10
4. Identifications and Comments on spots (1 to 8) 16
5. Viva voce 05
6. Class Record 05
7. Seminar/Project Report/Collection 05

Notes:

1. With reference to whole mounts and museum specimens the animal types may be substituted with diagrams/photographs/models etc.
2. Students will keep records of all work done in the practical records.
3. It should be ensured that animals used in the practical exercises are not covered under the wildlife act 1972 and amendments made subsequently.
4. The details methodology may be asked to be written where ever is necessary.

Syllabus B.Sc. (Hons.) Part-III

Dy. Registrar (Academic-I)
University of Rajasthan
Jaipur
Recommended Books


30

Dy. Registrar (Academic-I) 
University of Rajasthan
Jaipur
4. **BOTANY**

**B.Sc. Part I (Honors)**

Maximum Marks: 400

<table>
<thead>
<tr>
<th>Subject</th>
<th>Min. Pass Marks: 160</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paper-I Cytology, Genetics and Plant Breeding</td>
<td>75 marks</td>
</tr>
<tr>
<td>Paper-II Algae, Fungi and Bryophyta</td>
<td>75 marks</td>
</tr>
<tr>
<td>Paper-III Plant Physiology and Biochemistry</td>
<td>75 marks</td>
</tr>
<tr>
<td>Paper-IV Ecology and environmental science</td>
<td>75 marks</td>
</tr>
<tr>
<td>Practical (6 hrs.)</td>
<td>100 marks</td>
</tr>
</tbody>
</table>

**B.Sc. Part II (Honors)**

Maximum Marks: 400

<table>
<thead>
<tr>
<th>Subject</th>
<th>Min. Pass Marks: 160</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paper-I Molecular biology</td>
<td>75 marks</td>
</tr>
<tr>
<td>Paper-II Pteridophyta, Gymnosperm and Paleobotany</td>
<td>75 marks</td>
</tr>
<tr>
<td>Paper-III Morphology and Anatomy of angiosperms</td>
<td>75 marks</td>
</tr>
<tr>
<td>Paper-IV Microbiology and plant pathology</td>
<td>75 marks</td>
</tr>
<tr>
<td>Practical (6 hrs.)</td>
<td>100 marks</td>
</tr>
</tbody>
</table>

**B.Sc. Part III (Honors)**

Maximum Marks: 400

<table>
<thead>
<tr>
<th>Subject</th>
<th>Min. Pass Marks: 160</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paper-I Plant Biotechnology</td>
<td>75 marks</td>
</tr>
<tr>
<td>Paper-II Systematics of angiosperms</td>
<td>75 marks</td>
</tr>
<tr>
<td>Paper-III Plant utilization and Ethanobotany</td>
<td>75 marks</td>
</tr>
<tr>
<td>Paper-IV Embryology of angiosperms and Seed science</td>
<td>75 marks</td>
</tr>
<tr>
<td>Practical (6 hrs.)</td>
<td>100 marks</td>
</tr>
</tbody>
</table>
UNIT I

Plant Tissue culture
Historical perspective; composition of media; nutrient and hormone requirement; methods of sterilization; totipotency; concept of differentiation, dedifferentiation and redifferentiation; physical-chemical conditions for propagation of plant cells and tissues; Plant regeneration routes: micropropagation, organogenesis and somatic embryogenesis; Anther culture, production of androgenic haploids; protoplast isolation culture and fusion; somatic hybrids & cybrids. Application of Plant Tissue culture.

UNIT II

Recombinant DNA Technology
Introduction, Restriction endonucleases (history, types and role); Other enzymes, Cloning vectors, plasmids, bacteriophages, cosmids. Introduction of recombinant DNA into E. coli cells, methods for identification of recombinants, Gel Electrophoresis, RFLP; DNA Sequencing (Sanger's method and Maxam Gilbert's method); Southern, Northern and Western blotting; construction of genomic and cDNA library; Introduction to Bioinformatics.

UNIT III

Plant Transformation Technology
Obtaining gene of interest by different methods; Gene constructs; Gene transfer methods; Agrobacterium-mediated transformation; Direct gene transfer methods—Electroporation, Microinjection, Gene-gun; Selection of transgenics - marker and reporter genes

Role of Plant Biotechnology in Agriculture, Environment and Industry

Pest resistant plants (Bt-cotton); herbicide resistance; disease and stress resistant plants; transgenic crops with improved quality traits (Flavr Savr tomato, Golden rice); Plants as bioreactors. Biosafety regulations in India.

Suggested laboratory exercises:

1. Preparation of media MS (1962)
2. Aseptic culture of different explants, methods of in vitro sterilization, inoculation and subculture methods
4. Demonstration of Southern, Northern and Western Blotting (Photographs)
5. Study of steps of genetic engineering techniques from photographs (Bt cotton, Golden rice, Flavr Savr tomato)
6. Demonstration of technique of Gel Electrophoresis
8. Restriction Digestion of DNA

SUGGESTED READINGS


X Paper Systematics of Angiosperms

Unit I

Taxonomy: introduction, definition, components.
Herbarium specimen preparation, methods and importance.
Important herbaria (National, international and digital herbaria).
Taxonomic literature- botanical gardens, monograph, icons, manuals, journals,
abstracts, index and library
Keys constructed with their types for plant identification.
Taxonomic novelty: taxonomic categories, concept of species, genus and family.
ICBN: Principles and rules of nomenclature; nomenclature of hybrids and cultivars.
Phylogeny of angiosperms: Time and place of origin and evolution of angiosperms; primitive living angiosperms.

Unit II

Types of classification – Linnaeus, Benthum and Hooker, Engler and Prantl, Thakurjan and A.G.
Tools of taxonomy: anatomy, embryology, palynology, ecology, cytology and chemotaxonomy.
Numerical taxonomy - concept, characters, OTU's, coding, cluster analysis and cladistics.

Unit III

Diversity of flowering plants illustrated by members and economic importance of the following families: Ranunculaceae, Brassicaceae, Papaveraceae, Malvaceae.

35
Fabaceae, Caryophyllaceae, Apiaceae, Rubiaceae, Asteraceae, Apocynaceae, Acanthaceae, Lamiaceae, Chenopodiaceae, Urophiaceae, Liliaceae, Arecaceae and Poaceae.

Suggested laboratory exercises:

Systematics of Angiosperms
Description of the locally available species of the following families & genera.

- Ranunculaceae: Ranunculus, Delphinium.
- Brassicaceae: Brassica, Alyssum, Iberis, Coronopus.
- Capparidaceae: Capparis, Cleome.
- Caryophyllaceae: Dianthus, Stellaria, Spergula.
- Rutaceae: Citrus, Murraya.
- Fabaceae: faboideae: Lathyrus, Clitoria, Melilotus, Cajanus.
- Caesalpiniaceae: Cassia, Caesalpinia.
- Mimosaceae: Prosopis, Mimosa, Acacia.
- Myrtaceae: Eucalypthin, Eucalyptus.
- Cucurbitaceae: Luffa, Coccinia.
- Apiaceae: Anisum, Anethum.
- Rubiaceae: Hamelia, Mussaenda.
- Apocynaceae: Thevetia, Nerium, Tabernaemontana.
- Asclepiadaceae: Calotropis, Asclepias.
- Solanaceae: Solanum.
- Acanthaceae: Adhatoda.
- Lamiaceae: Ocimum.
- Euphorbiaceae: Euphorbia, Pyllanthus, Jatropha.
- Liliaceae: Alstroemeria, Asparagus.
- Poaceae: Tritium, Hordeum, Poa.

*Visit a Local Botanical Garden, Herbarium, National Park. Study of Local Flora & Flora and Biodiversity (candidates are expected to submit a detailed report of such visit).

Suggested Readings:

New Delhi

- Introduction to Systematics of Plant Taxonomy V.V. Sivarajan (1984)
  Oxford


Dy. Registrar (Academic)
University of Rajasthan
A general account of plants: Primary and secondary centers of diversity plant introduction. A general account of wheat, rice, maize, sorghum, bajra, sweet potato, beet root, and sugarcane. Legumes; Chickpea (Bengal gram), red gram (arhar) Black gram and fodder legumes; barseem, alhagi, vegetable plants; potato, tomato, breadfruit, and cluster bean.

UNIT-II

Vegetable oilseeds: Mustard, groundnut, soybean and coconut a brief account.

Plant fibers: Jute and cori.

Timber and Tree species: A general account distribution and uses of shishum, babool.

Weaver Plant used in leg.
Medicinal plants: A brief account of ten important plant drugs and their chief constituents used in indigenous and allopathic system of medicine, with special reference to *Azadirachta indica*, *Embelica officinalis*, *Aloe vera*, *Ocimum sanctum*, *Rauvolfia serpentina*, *Lantana camara*, *Datura stramonium*, *Withania somnifera*, *Curcuma longa*, *Natural rubber* (*Hevea brasiliensis*), *Ficus elastica*. Essential oil, dyes - a concise account. Ornamental plants Familiarity with seasonals and perennials grown in your locality.

Suggested laboratory exercises:

Economic botany

- World Map of Vavilov's Centres of origin of cultivated plants and Zhukovskys concept of megacentre.
- Study of starch grains in wheat and potato.
- Cereals: wheat, rice, maize, sorghum, bajra.
- Legumes: Chickpea, Bengal gram, red gram (arhar), black gram.
- Vegetable plants: tomato, round gourd, cluster bean.
- Sudan III test for groundnut and coconut oil Rajasthan.
- Economic Botany: Spices, Beverages (Tea & Coffee), Sugar, Oil Seeds (Mustard, Groundnut).
- Medicinal plants: *Azadirachta indica*, *Embelica officinalis*, *Aloe vera*, *Ocimum sanctum*, *Rauvolfia serpentina*, *Datura stramonium*, *Withania somnifera*.

Suggested Books:


**Papers: Embryology of Angiosperms and Seed science**

**UNIT III**

**Dy. Registrar (Academic)**

**University of Rajasthan**

**JAIPOUR**
Structure of flower: Anther - microsporogenesis; formation of pollen grains (male gametophyte); pollen germination, pollen tube growth.

Structure of pistil - megasporogenesis, development of embryo sac (female gametophyte).

Mechanisms and agencies of pollination: Pollen - s - interaction: self-incompatibility; double fertilization; apomixis.

Seed and fruit: Development of endosperm and embryo in monocotyledons and dicotyledons; storage of reserve materials and desiccation in seeds; fruit maturation, ripening and dispersal.

UNIT-II

Morphology and anatomy of seed: Development and structure in dicotyledons and monocotyledons (Fabaceae and Poaceae). Exomorphic features, gross internal morphology and seed coat anatomy.

Physiology of seed dormancy - significance, types and release of dormancy; Longevity - life span of seed and factors affecting longevity.

Seed testing procedures: Introduction, History of Seed Technology, Aims and importance of seed testing, sampling - types of samples, sampling equipments, methods of testing physical purity and genetic purity (seedling and plant stages), moisture content (oven method, moisture meter); Germination-TTC test, embryo excise method, blotter method, roll towel; sand or pot experiment; seeding evaluation.

UNIT-III

Seed storage: Importance and methods of safe seed storage, types of storage structures, detection of seed storage and its control.

Seed Health: Presence of seed-borne inoculum of pathogens; location of seed-borne inoculum. Methods of seed health testing (Dry seed examination, seed washing test, incubation method, opheliter's method).
Seed Certification: Concept, minimum certification standards, general and crop standards, Field inspection and ISTA certificates.

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

Suggested laboratory exercises:

**Embryology**

- 1 S. of microsporangia.
- Types of ovules and placentation.
- Pollen germination and viability.
- Seed germination and seed viability in monocot and dicot plants.
- Diversity in structure of stigma and style.
- Different stages of Embryo-Raphanus sativus.
- Monocot and dicot embryo dissection and study of its structure.

**Seed science**

- Chemical test of Carbohydrates, Protein and Lipids.
- Study of surface microflora of different seeds (wheat, sorghum, bajra and millet).
- Seed viability test (TTC test).
- Calculate seed purity percentage.
- Study seed coat anatomy of different seeds (Cicer, pea and maize).
- ISTA certificates.
- Seed health testing by different methods.

**Suggested Readings:**


MATHEMATICS (HONS.)

5. B.Sc. (Hons.) Part –III – 2020

Teaching : 3 Hours per Week per Theory Paper.

Examination :

<table>
<thead>
<tr>
<th>Scheme</th>
<th>Min. Pass Marks</th>
<th>Max. Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science – 160</td>
<td></td>
<td>400</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Paper</th>
<th>Duration</th>
<th>Max. Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paper – IX Algebra</td>
<td>3 hrs.</td>
<td>85</td>
</tr>
<tr>
<td>Paper – X Complex Analysis</td>
<td>3 hrs.</td>
<td>85</td>
</tr>
<tr>
<td>Paper – XI Mechanics</td>
<td>3 hrs.</td>
<td>85</td>
</tr>
<tr>
<td>Paper – XII Any one of the following</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Statistics</td>
<td>3 hrs.</td>
<td>85</td>
</tr>
<tr>
<td>2. Integral Equations and Calculus of Variations</td>
<td>3 hrs.</td>
<td>85</td>
</tr>
<tr>
<td>3. Calculus of Several Variables</td>
<td>3 hrs.</td>
<td>85</td>
</tr>
<tr>
<td>Practical</td>
<td>2 hrs.</td>
<td>60</td>
</tr>
</tbody>
</table>

Note:

1. 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.

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

3. An Internal/external examiner can conduct Practical Examination not more than 100 (Hundred) candidates.

4. Each candidate has to pass in Theory and Practical examinations separately.

Dy. Registrar (Academic-I)
University of Rajasthan
Jaipur
Paper - IX : Algebra

Teaching : 3 Hours per Week

Duration of Examination : 3 Hours

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.


Reference Books:

Paper – X: Complex Analysis

Teaching: 3 Hours per Week

Duration of Examination: 3 Hours

Max. Marks: 85

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 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.


Unit 5: Conformal mapping. Bilinear transformation and its properties. Elementary mappings: \( w(z) = \frac{1}{2} \left( z + \frac{1}{z} \right), z^2, e^z, \sin z, \cos z, \text{ and } \log z. \)


Reference Books:


Dy. Registrar (Academic-I)
University of Rajasthan
Jaipur
3. S. Ponnuswamy, Introduction to Complex Analysis, Narosa Pub., New Delhi

Paper – XI: Mechanics

Teaching : 3 Hours per Week
Duration of Examination : 3 Hours

Max. Marks: 85

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: 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. Projectile.


Unit 4: Equilibrium of coplanar force, moments and friction.

Unit-5: Virtual work and Catenary.

Reference Books :


Paper – XII: Any One of the Following:

Paper – XII(I): Statistics

Teaching : 3 Hours per Week

Duration of Examination : 3 Hours

Max. Marks: 85

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.

Reference Books :


Dy. Registrar (Academic-I)
University of Rajasthan
Jaipur
Paper- XII(II): Integral Equations and Calculus of Variations

Teaching : 3 Hours per Week

Duration of Examination : 3 Hours

Max. Marks: 85

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: 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 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- Variation and its properties. Euler’s equation. Functionals. Functionals dependent on Higher order derivatives and functions of several independent variables.

Unit 5: Variational problems in parametric form. The moving boundary value problem for a function of the form \( \int_{x_1}^{x_2} f(x,y,z) \, dx \). Euler’s finite difference method. Ritz method for variational problem.

Reference Books:

3. Abdul J. Jerry, Introduction to Integral Equations with applications, Marcel Dekkar Inc. NY.

Dy. Registrar (Academic-I)
University of Rajasthan
Jaipur

Paper – XII(III): Calculus of Several Variables

**Teaching :** 3 Hours per Week

**Duration of Examination :** 3 Hours

**Max. Marks:** 85

**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 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.

**Reference Books :**

Practical

Teaching: 2 hours per week per batch not more than 20 students.

Examination: 

Duration: 2 Hours

Scheme

Max.Marks 60
Min.Pass Marks 22

Distribution of Marks:

Two Practicals one from each group

<table>
<thead>
<tr>
<th>Marks Type</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 Marks each</td>
<td>40 Marks</td>
</tr>
<tr>
<td>Practical Record</td>
<td>10 Marks</td>
</tr>
<tr>
<td>Viva-voce</td>
<td>10 Marks</td>
</tr>
<tr>
<td>Total Marks</td>
<td>60 Marks</td>
</tr>
</tbody>
</table>

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

Practicals with Computer Programming in C Language.

Group A:


2. Solution of Initial value problems by Euler’s method and Runga-Kutta(third and fourth order) method.

Group B:

1. Matrix operations: addition, subtraction, multiplication, Rank of a matrix, inverse of a matrix.


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.

Dy. Registrar (Academic-I)  
University of Rajasthan  
Jaipur
6. PSYCHOLOGY (HONS.)
B.Sc. (Hons.) Part –III – 2020

SCHEME OF EXAMINATION:

<table>
<thead>
<tr>
<th>Papers</th>
<th>Nomenclature</th>
<th>Duration</th>
<th>Max. Marks</th>
<th>Min. Pass Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paper-IX</td>
<td>Applied Psychology</td>
<td>3 Hrs.</td>
<td>75</td>
<td></td>
</tr>
<tr>
<td>Paper-X</td>
<td>Positive Psychology</td>
<td>3 Hrs.</td>
<td>75</td>
<td></td>
</tr>
<tr>
<td>Paper-XI</td>
<td>Theories of Personality</td>
<td>3 Hrs.</td>
<td>75</td>
<td></td>
</tr>
<tr>
<td>Paper-XII</td>
<td>Psychological Testing</td>
<td>3 Hrs.</td>
<td>75</td>
<td></td>
</tr>
<tr>
<td>Practical</td>
<td></td>
<td>3 Hrs.</td>
<td>100</td>
<td>40</td>
</tr>
</tbody>
</table>

NOTE:-
1. There will be 4 Theory Papers in Psychology in B.A. Honours Part-III. Each paper will be of 3 hours. There will be a common paper for Arts and Science. There will be 3 Sections A, B and C in all the papers and will cover the entire course content of the paper.

Section-A will contain 10 questions of 20 words consisting of 1.5 marks each. Thus, Part-A will be of 15 marks.

Section-B will contain 7 questions of 50 words each, out of which students are required to attempt 5 questions. Each question will be of 3 marks. Thus, Part-B will be of 15 marks.

Section-C will contain 3 long questions each with internal choice. Each question will be of 15 marks.

Thus, Part-C will be of 45 marks.

For clarification the distribution of marks is tabulated as below:-

<table>
<thead>
<tr>
<th>B.A. Honours(Psychology)Part-III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Section</td>
</tr>
<tr>
<td>---------</td>
</tr>
<tr>
<td>A</td>
</tr>
<tr>
<td>B</td>
</tr>
<tr>
<td>C</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

Dy. Registrar (Academic-I)
University of Rajasthan
Jaipur
Paper IX - Applied Psychology

Section-A

2. Personal Assessment Techniques: Development and Training; Attitude and Motivation.

Section-B

5. Stress Management: Psychological Determinants and Stress Management.

Section-C

8. Community Psychology: Concept and Goals; Social Change and Social Action, Arousing Community Consciousness.

Books Recommended:


Dy. Registrar (Academic-I)  
University of Rajasthan  
Jaipur
Paper X - Positive Psychology

Section A
1. Introduction: Definition, Goals, Assumptions and Historical Perspective; Relationships with other Branches of Psychology.
2. Eastern and Western Perspectives on Positive Psychology.
3. Virtues and Strengths of Characters: Classification and Measures of Human Strength-Gallup’s Clifton Strength Finder. The VIA Classification. Identifying Personal Strengths.

Section B
4. Happiness and Wellbeing: Definition; Hedonic and Eudaimonic basis of Happiness; Subjective Wellbeing, Psychological Wellbeing and Social Wellbeing.
5. Resilience: Meaning, Developmental and Clinical Perspective, Sources of Resilience, Successful Aging and Growth through Trauma.
6. Pro-Social Behavior: Empathy, Altruism, Gratitude and Forgiveness

Section C
7. Self-Regulation and Self Control: Theories and Planning for Self-Regulation Success, Self-Regulations Problems – Goal Conflict, Goal Difficulty and Goal Disengagement
9. Positive Emotional States and Processes: Meaning, Theories and Resources of Positive Emotions; Emotional Intelligence; Emotional Focused Coping.

Books Recommended:

Paper XI - Theories of Personality

Section-A
1. Introduction: Definition, History and Basic Issues. Biological and Cultural Determinants of Personality.
2. Psychoanalytic Theories: Freud and Modern Developments.

Dy. Registrar (Academic-I)
University of Rajasthan
Jaipur

52
Section-B

4. Biological Theories: Genetic Effects and Temperament; Sociobiological and Evolutionary Factors.

Section-C

7. Trait Theories: Cattell, Allport and Big Five Model.
8. Humanistic and Existential Theories: Fromm, Rogers and Maslow.

Books Recommended:

Paper XII - Psychological Testing

Section-A


Section-B


53.

Dy. Registrar (Academic-I)
University of Rajasthan
Jaipur
Section-C

Tests of Intelligence: Nature and Types- Verbal Tests, Non-language Tests, Performance Test, Test for Measuring Adult Intelligence, Special Tests; Culture Fair Tests.

8. Tests of Interest and Aptitude: Interest Tests- Educational and Vocational; Attitude Tests; Aptitude Tests; Academic Tests - Achievement Tests.


Books Recommended:


Practical

1. Reaction Time
2. Saving Method
3. Two Point Threshold
4. Work and Fatigue
5. Picture Frustration Study
6. Career Interest Checklist by Holland
7. NEOPI - R
8. Differential Aptitude Test
9. Rorschach Test
10. Assessment of Altruism
11. Assessment of Emotional Intelligence
12. Assessment of Need Achievement (Projective Method)
Scheme of Examination

Min. Pass Marks 160 (40%)  Max. Marks 400
Paper -IX 3 hour duration  Geography of India  Max. Marks 80
Paper -X 3 hour duration  Evolution of Geographical Thoughts  Max. Marks 80
Paper -XI 3 hour duration  Fundamentals of Agricultural Geography  Max. Marks 80
Paper XII 3 hour duration  Applied Geography  Max. Marks 80
Practical

Notes

1. Students are permitted to use the stencils, simple calculator and log tables wherever needed in both theory and practical examinations.
2. There will be a common paper for Arts and Science.
3. Q.1 will be compulsory and will cover the entire course of the paper. Q.No. 1 of 20% marks of the total marks be set in two parts.
   (a) Part (a) will have ten items for locating on a map (to be supplied by examination centre) carrying 10% marks of the maximum marks and candidates shall attempt any five items.
   (b) Part (b) will have 10 short answer questions carrying 10% marks of the maximum marks and candidates shall attempt any five items.
4. Remaining 9 questions will be set with three questions from each section of the syllabus carrying equal marks.
5. Candidate will attempt 5 questions in all including question No. 1 selecting at least one question from each section.
6. Practical examination will be conducted by the board of examiners.
7. The candidate will have to pass in theory and practical separately.

Dy. Registrar
University of Rajasthan
Jaipur
SYLLABUS

Paper IX: Geography of India

Section A

India in the context of South and Southeast Asia, geological structure, physiographic divisions, climate: seasons, mechanism of Indian monsoon, major climatic regions; vegetation, major soils and regions; drainage system, water resources and irrigation projects; forests, mineral and power resources: their utilization policy and conservation strategies.

Section B

Agriculture: typology, major crops, changing pattern of crops, agricultural growth during plan period and green revolution, livestock resources and their development, industrial growth and development; industrial localization with reference to iron and steel, cotton textile, cement and chemical industries, industrial regions; population growth, distribution, problems, policy implication, trends of urbanization and human resource development.

Section C

Regional disparities in economic development, planning and economic regions of India, multilevel planning, problems and prospects of linking of rivers, environmental issues in India, transport development: rail, road, air and waterways, foreign trade: challenges and prospects.

Recommended Readings:


Gopal Kishan, R. 2001: Geography of India, Jawaher Publishers & Distributions, New Delhi, 2nd Edition

Khullar, L.R. 2006. India a comprehensive Geography; Kalyani Publishers, New Delhi

मानविकीय, ती. 1999: आज्ञातिक भाषा का ज्ञान पूरे हो। साहित्य न्याय पालिका. आयरा।


Paper X: Evolution of Geographical Thought

Section A

The scope and nature of geography in the ancient classical period, contributions of Herodotus, Eratosthenes, Strabo and Ptolemy, dark age, development of Geography during medieval period with special reference to Al-Biruni, Al-Masudi, Ibn Batutta and Ibn Khaldun.

Section B

The revival of geography from the 14th to the 18th century, works of Varenius and Kant; foundation of modern of geography, contributions of Humboldt and Ritter, Ratzel, Mackinder, dualism and its implication in the development of geography: physical versus human geography, regional versus systematic, determinism versus possibilism, qualitative versus quantitative geography.

Section C

Basic concepts in geography: geography as the study of areal differentiation and landscape morphology, regions: concept and types, geography as human ecology and environmental science, quantitative revolution, development of Geography in India.

Recommended Readings:

Jain, P. R. 2005: भौगोलिक धिक्तन एवं विधि तंत्र। साहित्य चवन पुस्तकशाला, आगरा।
5th edition,
Mistry, E. 2007. भौगोलिक धिक्तन का इतिहास। प्रयाग गुस्ताक भवन, इलाहाबाद।
Paper XI: Fundamentals of Agricultural Geography

Section A

Meaning, nature, scope and approaches (systemic and regional) of agricultural geography, determinants of agricultural land use: physical, social, economic and cultural.

Section B

Concept of agricultural region: Whittlesey’s classification of agricultural regions, agricultural typology, land use and land capability classification: methods and applications.

Section C

Agro-climatic regions of India and their characteristics, green revolutions: its impact and consequences, agricultural policy in India and contemporary issues: nutrition, hunger and food security.

Recommended Readings:

कुरुबर, पी. एवं सर्व, एस. 1986: कृषि पृथ्वी। भारत प्रदेश हिंदी प्रत्यावर्ती, गोवाला।
शाफी, आर.सी. एवं चिह, बी.एच. 1994: कृषि पृथ्वी। प्रयाग पुस्तक प्रेस भवन इंदिरापुराण।

Paper XII: Applied Geography

Section A

Nature, scope and content of applied geography, identification of problems of interdisciplinary nature like environments resource base, resource utilization sustainable development, issues related to spatial variations in physical environments, land capability, agricultural productivity, environmental degradation, environmental challenges and environmental management.

Section B

Issues related to human resource development: quality versus numbers, social and demographic issues: diversity and disparity, carrying capacity of the earth, man power planning and employment, issues related to economy: spatial organization of economic activities (like agriculture, industry, transport, trade etc.).
Section C

Environment and sustainable development with a focus on man-environment relationship: regional and interregional stresses, review of policies and multiple planning: local, regional and national level with special reference to India.

Recommended Readings:

श्रीपाला, श्री.मे. 1997: प्रदेशिक नियोजन और समुदायित विकास। पशुपति प्रकाशन, कोलकाता.

Practicals

Scheme of examination

<table>
<thead>
<tr>
<th>Min. Pass Marks: 32</th>
<th>Max. Marks: 80</th>
</tr>
</thead>
<tbody>
<tr>
<td>Written test:</td>
<td>Marks 30</td>
</tr>
<tr>
<td>Field survey and viva voce:</td>
<td>10+05</td>
</tr>
<tr>
<td>Report of socio-economic survey and viva voce:</td>
<td>10+05</td>
</tr>
<tr>
<td>Record and viva voce:</td>
<td>12+08</td>
</tr>
<tr>
<td>Total Marks:</td>
<td>80</td>
</tr>
</tbody>
</table>

N B. 1. There shall be 6 questions in written paper selecting at least two questions from each section. Candidates are required to attempt 3 questions selecting 1 question from each section. All question carry equal marks.

59

Dy. Registrar
(Academic)
University of Rajasthan
Jaipur
SYLLABUS

Section A

Map projections: bases of classification, uses and choice of projections.
Mathematical construction of map projections: cylindrical—simple, equal area and Mercator’s

Section B

Conical: one standard partial two standard parallels, Bonne’s, polyconic and modified
polyconic (international).
Zenithal: equidistant and equal area (Polar cases only), gnomonic, stereographic,
orthographic.

Section C

Conventional: sinusoidal and Mollwede’s (normal cases only).
Dump level: survey and contouring.
Socio-economic survey of a town/village: survey planning, data collection, compilation,
analysis and interpretation, report writing

Recommended Reading:

चौहान, पी.आर. 2005: प्रयोगात्मक भूगोल। वक्रशेष्ठ प्रकाशन, गोरखपुर।
Jalandhar.


Rampal, K.K. 1993: Mapping and Compilation: Methods and Techniques Concept.

सारंग, जे.पी. 2012: प्रयोगिक भूगोल।सत्तागी पब्लिकेशन्स, नेपाल।
Delhi.

लिखार, आर.सी. एवं सुधाकर, त्रिपाठी 2008: प्रयोगात्मक भूगोल। प्रयाग पुस्तक भवन, इलाहाबाद।

Dy. Registrar
(Academic)
University of Rajasthan
Jaipur