Sunbeam Women's College Varuna

Affiliated to M.G.K. Vidyapith Varanasi

VISION

Sunbeam College envisions to develop culturally rooted, globally oriented, self reliant women committed to achieve excellence through duty, devotion and discipline.

MISSION

- To reinforce duty, devotion towards the society and the Nation, thereafter keeping with the essence of discipline in one's life.
- To make students sensitive about social concerns, human rights and thus help them being an eco conscious individual.
- To educate the women of tomorrow, through teaching- learning exchange programmes, researches and extension activities.
- To pursue student centric learning for self- development & skill development.
- To equip and empower students with relevant knowledge, competence, value and creativity to face global challenges.
- To facilitate young women to come up with leadership, self-pride and identity in order to become the change makers of the society.
- To inculcate skills and practices that help students become culturally rooted, globally oriented and self reliant.

DEPARTMENT OF SCIENCE

VISION

To achieve overall excellence in education by continuously upgrading the teaching learning methodology and incorporating latest scientific aptitude which are currently happening in the worldwide with ethical responsibility and commitment towards humanity.

MISSION

- To provide excellent environment for faculty and students.
- To impart sound scientific quality education and competency.
- Design and implement curriculum that equips student with professional and life skills.
- Promote and undertake quality work in thrust area of science.
- Collaborate with academia to meet the changing needs of society.
- Foster innovation and cultivate the spirit of scientific aptitude amongst students.
- To realize full potential enabling the students to contribute towards the cause of the society.
- To foster and develop scientific temper among new generation.

Program Outcomes (POs):

The B.Sc. undergraduate programme is designed to intend the following outcomes:

PO1	**Critical Thinking**	Take informed actions after identifying the assumptions that frame our thinking and actions, checking out the degree to which these assumptions are accurate and valid, and looking at our ideas and decisions (intellectual, organizational, and personal) from different perspectives.
PO2	**Effective Communication**	Speak, read, write and listen clearly in person and through electronic media in English and in one Indian language, and make meaning of the world by connecting people, ideas, books, media and technology.
PO3	**Social Interaction**	Elicit views of others, mediate disagreements and help reach conclusions in group settings.
PO4	**Effective Citizenship**	Demonstrate empathetic social concern and equity centered national development, and the ability to act with an informed awareness of issues and participate in civic life through volunteering.
PO5	**Ethics**	Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them.
PO6	**Environment and Sustainability**	Understand the issue of environmental contexts and sustainable development
PO7	**Self-directed and Life-long learning**	Acquire the ability to engage in independent and life-long learning in the broadest context of socio-technological changes

PROGRAM: BACHELOR OF BACHELOR OF SCIENCE (B.Sc.) BZC
COURSE STRUCTURE FOR
Session 2025-26

SEMESTER- III

Paper	**Name of Paper**	**Semester Examination Marks**	**Internal Examination Marks**	**Credit (Theory +Practical)**
Major /Minor	Botany	75	25	4+2
Major /Minor	Zoology	75	25	4+2
Major /Minor	Chemistry	75	25	4+2
Vocational (Any one)	1. Psychological testing 2. Marketing & Salesmanship	75	25	3
Co- Curricular	Analytical ability and Digital awareness	100	-	2

SEMESTER- IV

Paper	**Name of Paper**	**Semester Examination Marks**	**Internal Examination Marks**	**Credit (Theory +Practical)**
Major /Minor	Botany	75	25	4+2
Major /Minor	Zoology	75	25	4+2
Major /Minor	Chemistry	75	25	4+2
Co- Curricular	General Hindi	100	-	2

Academic Calendar for the Session 2025-26

Date sheet for **Internal Assessment**

SEMESTER- III

Mid Term

Name of Subjects	**Date**	**Shift**
Co-Curricular: Analytical ability and digital awareness	17/11/2025	Shift 1
Vocational: Psychological Testing / Marketing and salesmanship	17/11/2025	Shift 2
Major: Botany – I	18/11/2025	Shift 1
Major: Botany – II	18/11/2025	Shift 2
Major: Zoology –I	19/11/2025	Shift 1
Major: Zoology –II	19/11/2025	Shift 2
Major: Chemistry –I	20/11/2025	Shift 1
Major: Chemistry –II	20/11/2025	Shift 2

SEMESTER- IV

Name of Subjects	**Mid Term I**	**Shift**
Co-Curricular: General Hindi	23/03/2026	Shift 1
Major/Minor: Botany – I	24/03/2026	Shift 1
Major/Minor: Botany – II	24/03/2026	Shift 2
Major/Minor: Zoology –I	25/03/2026	Shift 1
Major/Minor: Zoology –II	25/03/2026	Shift 2
Major/Minor: Chemistry –I	27/03/2026	Shift 1
Major/Minor: Chemistry –II	27/03/2026	Shift 2

Important Dates

SEMESTER- III

- 17.11.25 to 20.11.25: Mid Term begins.
- 29.11.25: PPM & Report Card Distribution.

SEMESTER- IV

- 23.03.26 to 27.03.26: Mid Term begins.
- 04.04.26: PPM & Report Card Distribution.

"All the Best"

SEMESTER- III

MAJOR: BOTANY
Course code: B040301T
Paper I (Theory)
Course Title: Flowering Plants Identification & Aesthetic Characteristics
Credits: 4 **Max. Marks: 75+25**

Course outcomes:
After the completion of the course the students will be able:

1. To gain an understanding of the history and concepts underlying various approaches to plant taxonomy and classification.
2. To learn the major patterns of diversity among plants, and the characters and types of data used to classify plants.
3. To compare the different approaches to classification with regard to the analysis of data.
4. To become familiar with major taxa and their identifying characteristics, and to develop in depth knowledge of the current taxonomy of a major plant family.
5. To discover and use diverse taxonomic resources, reference materials, herbarium collections, publications.
6. For the entrepreneur career in plants, one can establish a nursery, Start a landscaping business,
7. Set up a farm Or Run a plantation consultancy firm

Month	Working Days	Topics to be covered
July'25	**21**	**Unit I- Taxonomic Resources & Nomenclature** Components of taxonomy (identification, nomenclature, classification); Taxonomic resources: Herbarium- functions& important herbaria, Botanical gardens, Flora, Keys- single access and multi-access. Botanical Nomenclature- Principles and rules of ICN (ranks and names; principle of priority, binomial system; type method, author citation, valid-publication). **Unit II- Types of classification & Evidences** Artificial, natural and phylogenetic. Bentham and Hooker (upto series), Engler and Prantl (upto series) angiosperm phylogeny group (APG III) classification. Taxonomic evidences from palynology, cytology, phyto chemistry &Molecular biology data (Protein and Nucleic acid homology).
August'25	**24**	**Unit III- Identification of Angiospermic families -I: (Families can be chosen University wise as per 8local available flora)** A study of the following families with emphasis on the morphological peculiarities and economic importance of its members (based on Bentham & Hooker's system) --Ranunculaceae, Malvaceae, Rutaceae, Fabaceae, Myrtaceae , Cucurbitaceae, Rubiaceae,Asteraceae, Apocynaceae, Acanthacea, Asclepiadiaceae, Solanaceae **Unit IV- Identification of Angiospermic families -II: (Families can be chosen University wise as per local available flora)** A study of the following families with emphasis on the morphological peculiarities and economic importance of its members (based on Bentham & Hooker's system)-Amaranthaceae, Euphorbiaceae, Papaveraceae, Scrophulariaceae, Orchidaceae, Liliaceae, Arecaceae, Poaceae.
September'25	**22**	**Unit V- Modern trends in Plant taxonomy:**

		Phenetics and Cladistics: Brief idea on Phenetics, Numerical taxonomy- methods, Operational Taxonomic Units, Cladistics- construction of dendrogram and primary analysis; Monophyletic, polyphyletic and paraphyletic groups; Plesiomorphy and apomorphy . **Unit VI- TOOLS & SOFTWARES IN PLANT IDENTIFICATIONGIS** GIS Mapping of (i)Patterns (ii)Features (iii)Quantities, 0P02.010H11YLIP- Free Phylogenetic Software, Digital Taxonomy, Description Language for Taxonomy – DELTA Internet directory for botany
October'25	**18**	**Unit VII- Computer Applications** Introduction to Computers – classification, computer generation, low, medium and high level languages, software and hardware, operating systems, compilers and interpreters, personal, mini, main frame and super computers, characteristics and application, computer memory and its types, data representation and storage. Microsoft excel, data entry, graphs, aggregate functions, formulas and functions, number systems, conversion devices, secondary storage media. **Unit VIII- Aesthetic Characteristics of Plants:** Aesthetic characteristics of plants, English, Italian, French, Persian, Mughal and Japanese gardens; Features of a garden (Garden wall, Fencing, Steps, Hedge, Edging, Lawn, Trees, shrubs and shrubberies, climbers and creepers, rockery, Flower beds, Shrubbery, Borders, Water garden). Some Famous gardens of India. Conservatory, greenhouses, Indoor garden, Roof garden, Topiary, Bonsai.
November'25	**24**	**Revision & Internal Examination**

Activity I*: *Project on Comparative analysis of classification systems given in syllabus.
***Objective:** To understand concepts underlying various approaches to plant taxonomy and classification.*
***Methodology:** Inquiry based learning.*
Activity III*: *Class Interaction on aesthetic characters of plants.
***Objective:** To develop the entrepreneur career in plants, one can establish a nursery, Start a landscaping business, set up a farm or Run a plantation consultancy firm.*
***Methodology:** Individual learning.*

Suggested readings:

1. Pandey, B.P. 2007. Botany for Degree Students: Diversity of Seed Plants and their Systematics, Structure, Development and Reproduction in Flowering Plants. S. Chand & Company Ltd,New Delhi.
2. Stace, C. A. 1989. Plant Taxonomy and Biostatistics (2nd Ed.). Edward Arnold, London.
3. Singh, G. 1999. Plant Systematics: Theory and Practice. Oxford and IBH, New Delhi.
4. DuttaA.C. 2016. Botany for Degree Students. Oxford University Press
5. https://www.naace.co.uk/school-improvement/ict-mark/

Suggested equivalent online courses:

1. https://www.easybiologyclass.com/topic-botany/
2. http://egyankosh.ac.in/handle/123456789/53530
3. https://www.delta-intkey.com/www/desc.htm
4. https://milneorchid.weebly.com/plant-id-for-beginners.html

5. https://plants.usda.gov/classification.html
6. https://www.senecahs.org/pages/uploaded_files/Plant%20Classification.pdf
7. https://www.ladykeanecollege.edu.in/files/userfiles/file/Dr_%20S_%20Nongbri%20III%20Sem%20ppt.pdf
8. https://www.brainkart.com/article/Bentham-and-Hooker-s-classification-of-plants-Dicotyledonae,-Gymnospermae- and-Monocotyledonae_1000/
9. https://libguides.rutgers.edu/c.php?g=336690&p=2267037 https://www.delta-intkey.com/

MAJOR: BOTANY
Course Code: B040302P
Paper-II (Practical)
Course Title: Plant Identification technology

Credit:2 **Max. Marks: 75+25**

Course outcomes:
After the completion of the course the students will be able:

1. To learn how plant specimens are collected, documented, and curated for a permanent record.
2. To observe, record, and employ plant morphological variation and the accompanying descriptive terminology.
3. To gain experience with the various tools and means available to identify plants.
4. To develop observational skills and field experience.
5. To identify a taxonomically diverse array of native plants.
6. To recognize common and major plant families.
7. To understand aesthetic characters of flowering plants by making landscapes, gardens, bonsai miniatures
8. Comprehend the concepts of plant taxonomy and classification of Angiosperms

Month	Working Days	Topics to be covered
July'25	**21**	**Unit I- Herbarium: Plant Collecting, Preservation And Documentation:** Stepwise Practicing Herbarium techniques: a. Demonstration of FIELD EQUIPMENTS, Global Positioning System (GPS) instrument & Collection of any wild 25 plant specimens. b. Learn to handle Herbarium making tools c. Pressing and Drying of collected plant specimens d. Mount on standard herbarium sheets and labelling **Unit II- Taxonomic Identification Using Plant Structure** a. Classify 25 plants on the basis of Taxonomic description (Plant Morphology, Anatomy, Reproductive parts, Habit, adaptation anomalies) according to Bentham Hooker system of classification for locally present families.
August'25	**24**	**Unit III- Identification During Excursions** a. Conducting Spot identification (Binomial, Family) of common wild plants from families included in the theoretical syllabus (list to be provided) and making FIELD NOTE BOOK as per slandered of Botanical Survey of India. b. Describe/compare flowers in semi-technical language giving V.S. of flowers, T.S. of ovaries, floral diagrams and Floral Formulae. Identify and assign them to their respective families giving reasons. **Unit IV- Collection, Preservation And Storage Of Algae, Fungi, Bryophytes, Pteridophytes (Two Each)**
September'25	**22**	**Unit V- Botanical Nomenclature & Reporting Method:** a. Give nomenclature to collected plants as per ICN rules and prepare labels as per BSI. b. **Author Citation, Effective Publication and Principle of**

		Priority: To show a specimen paper on Basic structure of a taxonomic Research published on a new species in taxonomic journal **Unit VI- COMPUTERS** a. Learning to use EXCEL Microsoft PowerPoint and Word, WORKING WITH FOLDER AND WINDOWS UTILITY., CREATE AND MANAGE, FILES AND FOLDER TREE. b. Create and Participate in virtual conferencing in an interactive Zoom Meeting.
October'25	**18**	**Unit VII- Computer Application In Taxonomy** 1. Use Taxonomic Software (Dichotomous Key) 2. Practicals on Phylogenetic analysis 3. Make line drawing of Plants for description 4. Using of plant identification apps on android phones **Unit VIII-** 1. Create a Bonsai of any plant 2. Develop a miniature garden 3. Plant Propagation methods practice.
November'25	**24**	**Revision & Internal Examination**

Activity I**:** *Plant specimen collection and their preservation.*

Objective: *To develop the skill of plant specimen preservation for their identification and taxonomical studies.*

Methodology: *Expeditionary learning.*

Suggested readings:

1. Day, S.C. (2003)A Art of Miniature Plant Culture. - Agrobias. Jodhpur, India.
2. Practical Taxonomy of Angiosperms By: R K Sinha ISBN: 9789386768520 I.K International Publishing House Pvt. Ltd.

Suggested equivalent online courses:

1. http://egyankosh.ac.in/bitstream/123456789/13096/1/Unit5.pdf
2. https://www.for.gov.bc.ca/hfd/pubs/docs/wp/wp18.pdf
3. https://www.researchgate.net/publication/267510854_The_ Flowering_Plants_Handbook

MAJOR: CHEMISTRY
Course Code: B020301T
Paper I (Theory)
Course Title: Chemical Dynamics & Coordination Chemistry

Credits: 4 **Max. Marks: 75 +25**

Course outcomes:

Upon successful completion of this course students should be able to

1. Describe the characteristic of the three states of matter and the different physical properties of each state of matter.
2. Describe the kinetic theory of gases.
3. Describe the laws of crystallography.
4. Describe the liquid state and liquid crystals.
5. Describe the conductometric, potentiometric, optical methods, polarimetry and spectrophotometer technique to study Chemical kinetics and chemical equilibrium.
6. Understand metal- ligand bonding in transition metal complexes, thermodynamic and kinetic aspects of metal complexes.

Month	Working Days	Topics to be covered
July'25	**21**	**Unit I: Chemical Kinetics:** Rate of a reaction, molecularity and order of reaction, concentration dependence of rates, mathematical characteristic of simple chemical reactions – zero order, first order, second order, pseudo order, half-life and mean life. **Unit II: Chemical Equilibrium:** Equilibrium constant and free energy, thermodynamic derivation of law of mass action. Le-Chatelier's principle. Reaction isotherm and reaction isochore – ClapeyronClausius equation and its applications.
August'25	**24**	**Unit I: Chemical Kinetics:**Determination of the order of reaction – differential method, method of integration, half-life method and isolation method. Brief outline of experimental methods of studying chemical kinetics: Conductometric, potentiometric, optical methods, polarimetry and spectrophotometer. **Theories of chemical kinetics:** Effect of temperature on rate of reaction, Arrhenius equation, concept of activation energy. Simple collision theory based on hard sphere model, transition state theory (equilibrium hypothesis). Expression for the rate constant based on equilibrium constant and thermodynamic aspects (no derivation). **Unit III: Phase Equilibrium:** Statement and meaning of the terms-phase, component and degree of freedom, derivation of Gibbs phase rule, phase equilibria of one component system– water, CO_2 and systems. Phase equilibria of two component systems – Solid - liquid equilibria , simple eutectic – Bi-Cd, Pb-Ag systems.

September'25	**22**	**Unit IV: Kinetic theories of gases: Gaseous State:** Postulates of kinetic theory of gases, deviation from ideal behavior, van der Waals equation of state. **Critical phenomena:** PV isotherms of real gases, continuity of states, the isotherms of Van der Waals equation, relationship between critical constants and Van der Waals constants, the law of corresponding states, reduced equation of state. **Molecular Velocities:** Qualitative discussions of the Maxwell's distribution of molecular velocities, collision number, mean free path and collision diameter. Liquefaction of gases (based on JouleThomson effect). **Unit VI: Coordination Chemistry:** Coordinate bonding: double and complex salts. Werner's theory of coordination complexes, classification of ligands, ambidentate ligands, chelates, coordination numbers, IUPAC nomenclature of coordination complexes (up to two metal centers), Isomerism in coordination compounds, constitutional and stereo isomerism, geometrical and optical isomerism in square planar and octahedral complexes. **Unit VII: Theories of Coordination Chemistry:** **I:**Metal- ligand bonding in transition metal complexes, limitations of valance bond theory, an elementary idea of crystal field theory, crystal field splitting in octahedral, tetrahedral and square planner complexes, factors affecting the crystal-field parameters.
October'25	**18**	**II:** Thermodynamic and kinetic aspects of metal complexes: A brief outline of thermodynamic stability of metal complexes and factors affecting the stability, stability constants of complexes and their determination, substitution reactions of square planar complexes **Unit V: Liquid State:** Intermolecular forces, structure of liquids (a qualitative description). Structural differences between solids, liquids and gases. Liquid crystals: Difference between liquid crystal, solid and liquid. Classification, structure of nematic and cholesterol phases. Thermography and seven segment cell. **Liquids in solids (gels):** Classification, preparation and properties, inhibition, general application**.** **Unit VIII: Inorganic Spectroscopy and Magnetism** **I)** Electronic spectra of Transition Metal Complexes, Types of electronic transitions, selection rules for d-d transitions, spectroscopic ground states, spectrochemical series, Orgel-energy level diagram for d1 and d9 states, discussion of the electronic spectrum of $[Ti(H_2O)_6]^{3+}$ complex ion. **II)** Magnetic properties of transition metal complexes, types of magnetic behaviour, methods of determining magnetic susceptibility, spin-only formula, L-S coupling, correlation of μ_s and μ_{eff} values, orbital contribution to magnetic moments, application of magnetic moment data for 3d-metal complexes. **Physical properties and molecular structure:** Optical activity,

		polarization – (Clausius - 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 ferromagnetism, magnetic susceptibility, its measurements and its importance.
November'25	**24**	**Revision & Internal Examination**

Activity: *Analysis of 3 D model of inorganic crystal using CIF data. (CCDC data).*
Objective: *To analyze the 3D structure of coordination complexes.*
Methodology: *Individual learning.*

Suggested Readings:

1. Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry Ed., Oxford University Press 13 (2006).
2. Ball, D. W. Physical Chemistry Thomson Press, India (2007).
3. Castellan, G. W. Physical Chemistry 4th Ed. Narosa (2004).
4. Cotton,F.A, Wilkinson,G and Gaus,P. L ,Basic Inorganic Chemistry,3rd Edition ,Wiley 1995
5. Lee,J.D, Concise Inorganic Chemistry 4th Edition ELBS,1977
6. Douglas,B, McDaniel ,D and Alexander,J ,Concepts of Models of Inorganic Chemistry, John Wiley & Sons; 3rd edition , 1994
7. Shriver,D.EAtkins,P.W and Langford,C .H , Inorganic Chemistry ,Oxford University Press, 1994.
8. Porterfield ,W.W, Inorganic Chemistry ,Addison Wesley 1984.
9. Sharpe,A .G, Inorganic Chemistry, ELBS,3RD edition ,1993
10. Miessler,G.L,Tarr,D.A, Inorganic Chemistry, 2nd edition , Prentice Hall,2001

Suggestive digital platforms web links:

1. https://swayam.gov.in/
2. https://www.coursera.org/learn/physical-chemistry
3. https://www.mooc-list.com/tags/physical-chemistry
4. https://www.openlearning.com/courses/introduction-to-physical-chemistry/
5. https://www.my-mooc.com/en/categorie/chemistry
6. https://onlinecourses.swayam2.ac.in/nce19_sc15/preview
7. https://swayam.gov.in/
8. https://www.coursera.org/browse/physical-science-and-engineering/chemistry

MAJOR CHEMISTRY
Course Code: B020302P
Paper II (Practical)
Course Title: Physical Analysis

Credits: 2 **Max. Marks: 75 +25**

Course outcomes:

Upon successful completion of this course students should be able to

1. Calibrate apparatus and prepare solutions of various concentrations.
2. Estimation of components through volumetric analysis.
3. Perform dilatometric experiments: one and two component phase equilibrium experiments.

Month	Working Days	Topics to be covered
July'25	**21**	**Strengths of Solution** Calibration of fractional weights, pipettes and burettes. Preparation of standards solutions. Dilution – 0.1 M to 0.001 M solutions. Mole Concept and Concentration Units:Mole Concept, molecular weight, formula weight, and equivalent weight. Concentration units: Molarity, Formality, Normality, Molality, Mole fraction, Percent by weight, Percent by volume, Parts per thousand, Parts per million, Parts per billion, pH, pOH, milli equivalents, Milli moles
August'25	**24**	**Surface Tension and Viscosity** 1. Determination of surface tension of pure liquid or solution 2. Determination of viscosity of liquid pure liquid or solution
September'25	**22**	**Boiling point and Transition Temperature** 1. Boiling point of common organic liquid compounds ANY FIVE]nbutylalcohol, cyclohexanol, ethyl methyl ketone, cyclohexanone, acetylacetone, isobutyl methyl ketone, isobutyl alcohol, acetonitrile, benzaldehyde and acetophenone. [Boiling points of the chosen organic compounds should preferably be within 1800C]. 2. Transition Temperature, Determination of the transition temperature of the given substance by thermometric /dialometric method (e.g. MnCl2.4H2O/SrBr2.2H2O
October'25	**18**	**Phase Equilibrium** 1. To study the effect of a solute (e.g. NaCl, succinic acid) on the critical solution temperature of two partially miscible liquids (e.g. phenolwater system) and to determine the concentration of that solute in the given phenol-water system 2. To construct the phase diagram of two component (e.g. diphenylamine – benzophenone) system by cooling curve method.
November'25	**24**	**Revision & Internal Examination**

Activity: *Visit to Department of Biomedical Engineering, IIT, BHU for Hands on training for the determination of BOD and COD.*

Objective: *To understand the instruments, techniques and lab etiquettes for working in laboratory and practical demonstration of above practical.*

Methodology: *Expeditionary learning.*

Suggested Readings:

1. Skoog .D.A., West.D.M and Holler .F.J., "Analytical Chemistry: An Introduction", 7th edition, Saunders college publishing, Philadelphia,(2010).
2. Larry Hargis.G" Analytical Chemistry: Principles and Techniques" Pearson©(1988) Note: For the promotion of Hindi language, course books published in Hindi may be prescribed by the University

Suggestive digital platforms web links:

1. https://www.labster.com/chemistry-virtual-labs/
2. https://www.vlab.co.in/broad-area-chemical-sciences
3. http://chemcollective.org/vlab

MAJOR: ZOOLOGY
Course Code: B050301T
Paper I (Theory)
Course Title: Molecular Biology, Bioinstrumentation &Biotechniques

Credits: 4 **Max. Marks: 75 +25**

Course outcomes:

The student at the completion of the course will be able to:

1. A detailed and conceptual understanding of molecular processes *viz.* DNA to trait.
2. A clear understanding of the processes of central dogma *viz.* transcription, translation *etc.* underlying survival and propagation of life at molecular level.
3. Understanding of how genes are ultimately expressed as proteins which are responsible for the structure and function of all organisms.
4. Learn how four sequences (3 letter codons) generate the transcripts of life and determine the phenotypes of organisms.
5. How genes are regulated differently at different time and place in prokaryotes and eukaryotes.

Month	Working Days	Topics to be covered
July'25	**21**	**Unit I: Process of Transcription** • Fine structure of gene • RNA polymerases • Transcription factors and machinery • Formation of initiation complex • Initiation, elongation and termination of transcriptionin prokaryotes and eukaryotes **Unit II: Process of Translation** • The Genetic code • Ribosome • Factors involved in translation • Aminoacylation of tRNA, tRNA-identity,aminoacyltRNAsynthetase • Initiation, elongation and termination of translation in prokaryotes and eukaryotes **Unit III: Regulation of Gene Expression I** • Regulation of gene expression in prokaryotes: *lac* and *trp*operons in *E. coli* • Regulation of gene expression in eukaryotes: Role of chromatin in gene expression • Regulation at transcriptional level, Post-transcriptional modifications: Capping, Splicing, Polyadenylation • RNA editing.
August'25	**24**	**Unit IV: Regulation of Gene Expression II** • Regulation of gene expression in eukaryotes: • Regulation at translational level, Post- translational modifications: protein folding etc. • Intracellular protein degradation • Gene silencing, RNA interference (RNAi) **Unit V: Principle and Types of Microscopes** • Principle of Microscopy and Applications • Types of Microscopes: light microscopy, dark field

		microscopy, phase-contrast microscopy, Fluorescence microscopy, confocal microscopy, electron microscopy
September'25	**22**	**Unit VI: Centrifugation and Chromatography** • Principle of Centrifugation • Types of Centrifuges: high speed and ultracentrifuge • Types of rotors: Vertical, Swing-out, Fixed-angle etc. • Principle and Types of Chromatography: paper, ion exchange, gel filtration, HPLC, affinity **Unit VII: Spectrophotometry and Biochemical Techniques** • Biochemical techniques: Measurement of pH, Preparation of buffers and solutions • Principle of Colorimetry/Spectrophotometry: Beer-Lambert law • Measurement, applications and safety measures of radio-tracer techniques
October'25	**18**	**Unit VIII: Molecular Techniques** • Detection of nucleic acid by gel electrophoresis • DNA sequencing DNA fingerprinting, RFLP • Polymerase Chain Reaction (PCR) • Detection of proteins, PAGE, ELISA, Western blotting
November'25	**24**	**Revision & Internal Examination**

Activity I: *PowerPoint Presentation on Central dogma of Molecular biology.*
Objective: *To understand the events leading to successful gene expression.*
Methodology: *Individual learning.*

Activity II: *Group Discussion on various Tools and Techniques of biological sciences.*
Objective: *To understand and explore the proper functioning of instrumental techniques required to accomplish different experimental procedures.*
Methodology: *Group learning.*

Suggested Readings:

1. Lodish et al: Molecular Cell Biology: Freeman & Co, USA (2004).
2. Alberts et al: Molecular Biology of the Cell: Garland (2002).
3. Cooper: Cell: A Molecular Approach: ASM Press (2000).
4. Karp: Cell and Molecular Biology: Wiley (2002).
5. Watson et al. Molecular Biology of the Gene. Pearson (2004).
6. Lewin. Genes VIII. Pearson (2004).
7. Pierce B. Genetics. Freeman (2004).
8. Sambrooket al .Molecular Cloning Vols I, II, III. CSHL (2001).
9. Primrose. Molecular Biotechnology.Panima (2001).
10. Clark & Switzer. Experimental Biochemistry. Freeman (2000)

MAJOR: ZOOLOGY

Course Code: B050302P

Paper II (Practical)

Course Title: Bioinstrumentation & Molecular Biology Lab

Credits: 2 **Max. Marks: 75 +25**

Course outcomes:

At the completion of the course students will learn Hands-on:

1. Understand the basic principles of microscopy, working of different types of microscopes.
2. Understand the basic techniques of centrifugation and chromatography for studying cells and separation of biomolecules
3. Understand the principle of measuring the concentrations of macromolecules in solutions by colorimeter and spectrophotometer and use them in Biochemistry.
4. Learn about some of the commonly used advance DNA testing methods.

Month	Working Days	Topics to be covered
July'25	**21**	**Unit I:** 1. To study the working principle and Simple, Compound and Binocular microscopes. 2. To study the working principle of various lab equipments such as pH Meter, Electronic balance, use of glass and micropipettes, Laminar flow, Incubator, Waterbath, Centrifuge, Chromatography apparatus, etc.
August'25	**24**	**Unit II:** 1. To prepare solutions and buffers. 2. To measure absorbance in Colorimeter or Spectrphotometer. 1. Demonstration of differential centrifugation to fractionate different components in a mixture.
September'25	**22**	**Unit III:** 1. To prepare dilutions of Riboflavin and verify the principle of spectrophotometry. 2. To identify different amino acids in a mixture using paper chromatography. 3. Demonstration of DNA extraction from blood or tissue samples. 4. To estimate amount of DNA using spectrophotometer.
October'25	**18**	**Unit IV: Virtual Labs (Suggestive sites)** www.labinapp.com www.uwlax.edu www.labster.com www.onlinelabs.in www.powershow.in https://vlab.amrita.edu info@premiereducationaltechnologyies.com https://li.wsu.edu **Revision & Internal Examination**
November'25	**24**	

Suggested Readings:

1. Sambrooket al .Molecular Cloning Vols I, II, III. CSHL (2001).
2. Primrose. Molecular Biotechnology. Panima (2001).
3. Clark & Switzer. Experimental Biochemistry. Freeman (2000)

Course Name-III: VOCATIONAL/ SKILL DEVELOPMENT

Any one subject:

1. Marketing & Salesmanship
2. Psychological Testing

MARKETING & SALESMANSHIP

Credits: 3 **Max. Marks:25+75**

Course Outcomes:

After the completion of the course, the students will

CO 1: Understand about the concept of Marketing and Market segmentation.

CO 2: Understand concept of Marketing Mix.

CO 3: Apply art of Salesmanship.

CO 4: Understand Personal Selling concepts.

Month	W. Days	Topics to be covered
July' 25	22	**Unit I** Introduction to Market & Marketing: Meaning & Definition of Market, Classification of Markets. Marketing Concepts: Traditional & Modern, Importance & Functions of Marketing
		Activity*: Presentation on various forms of market* ***Objective****: To create an understanding about various existing classifications of markets in the economy.* ***Methodology:*** *Group of 4 student's PPT Presentation*
August' 25	24	**Unit II** Market Segmentation: Meaning & Definition of Market Segmentation, Importance, Limitation & bases for Segmentation.
September' 25	22	Marketing Mix: Meaning & Definition of Marketing Mix, Importance & Elements of Marketing Mix- Product, price, Promotion and Place.
October' 25	18	**Unit III** Salesmanship: Meaning & Definition of Salesmanship, Features, Scope, Utility & Elements of Salesmanship.
November' 25	24	**Unit III** Selling Process: Stages of Selling Process & approaches. **Unit IV** *Personal Selling: Meaning & Definition, Selling as a Career, Classification of Successful Salesperson, Functions & Qualities of Salesperson*
		Activity*: Assignment on Steps of Selling Process* ***Objective****: To create an understanding about selling process.* **Methodology:** Written Assignment
December'25		**Revision & University Examination**

Suggested Readings:

1. *Cundiff, Still & Govani: Basic Marketing, Decisions and Strategies*
2. *Philip Kotler: Marketing Management*
3. *Philip Kotler: Principles of Marketing*
4. *Ramaswami & Nama Kumari: Viparan Prabandh*
5. *Ajit Kumar Shukla: Marketing Management*
6. *Ajit Kumar Shukla: Services Marketing*
7. *Tapan K. Panda: Sales & Distribution Management*
8. *PK Sahu & KC Raut: Salesmanship & Sales Management*

Latest edition of the text books should be used.

PSYCHOLOGICAL TESTING

Credits: 3 **Max. Marks :25+75**

Course Outcomes:

After completion of the course the students will be able to-

CO1: Understand test construction, standardization, reliability, and validity.

CO2: Administer, score, and interpret various psychological tests.

CO3: Recognize and address ethical and cultural issues in testing.

CO4: Analyze and critique the strengths and limitations of psychological tests.

Month	W. Days	Topics to be covered
July' 25	22	**UNIT-I** Introduction to Psychological testing Definition, meaning and nature of testing, Differences between testing and measurement, Difference between testing and experiment.
		Activity*: Flip class on the topic "Types of Psychological Testing".* ***Objective****: To develop the capabilities of learning and understanding over the topic.* ***Methodology:*** *Flip class*
August' 25	24	**UNIT-I** Objective of psychological testing, Utility of psychological testing. **UNIT-II** Intelligence test: Introduction and utility of intelligence test.
		Activity: *Workshop on Intelligence test, Interest test, Personality Test, Attitude test & Achievement test* ***Objective:*** *To develop the skill of demonstrating & analyzing the psychological tests.* ***Methodology****: Practical learning*
September' 25	22	**UNIT-II** Personality test, Interest test, Attitude test, Achievement test **UNIT-III** Objective test: Definition, nature, characteristics and utility. M.M.P.I.-2, E.P.Q.,
October'25	18	**UNIT-IV** Projective test: Nature, characteristics and utility. T.A.T., Type – A Behaviour, Alienation, Adjustment.
November' 25	24	**Revision & University Examination**

Suggested Readings:

- *Anastasi , A. and Rubina, S.: Psychological Testing (7th Ed.). Pearson Education.*
- *Hall ,C.S.: Lindzey , G.L. and Campbell, J.B.: Theories of Personality, John Wily and Sons.*
- *Freeman, F.S.: Theories and Practice of Psychological Testing (3rd Ed.). Oxford Press, New Delhi.*
- *Weiner, J.B.: Clinical Methods in Psychology. John Wiley's Sons.*

Course Name IV: Co- Curricular

Course Title: Analytical Ability and Digital Awareness

Max. Marks: 100

Course outcomes:

CO 1: Familiarize with analogy, number system, set theory and its applications, number system and puzzles.

CO 2: To understand the basics of Syllogism, figure problems, critical and analytical reasoning.

CO 3: Familiarize with word processing application and worksheet.

CO 4: To understand the basics of web surfing and cyber security.

Month	W. Days	Topics to be covered
July' 25	22	**Unit I** Alphabet test, Analogy, Arithmetic Reasoning, Blood relations, Coding and Decoding, Inequalities, Logical Venn diagram, Seating Arrangements, Puzzles and Missing numbers
August' 25	24	**Unit II** Syllogism, Pattern completion and figure series, Embeded Figure and counting of figures, Cube & Dice, Paper cutting and folding, Data sufficiency, Course of Action, Critical Reasoning, Analytical and decision making
September' 25	**22**	**Unit III** **Computer Basics:** Block diagram of Digital Computer, Classification of Computers, Memory System, Primary storage, Auxiliary memory, Cache memory, Computer Software (System/Application Software), **MS Word Basics:** The word screen, getting to word documents, typing and Revising text, Finding and Replacing, Editing and Proofing tools, Formatting text characters, Formatting Paragraph, Document templates., Page set up, tables, Mail Merge, Macros, protecting documents, printing a document.
October'25	**18**	**Unit III** **MS-Excel** Introduction, Worksheet basics, Creating worksheet, Heading information, Data & Text, Date & Time, Alphanumeric values, Saving & quitting worksheet, Opening and moving around in an existing worksheet, Toolbars and Menus, Excel shortcut and function keys, Working with single and multiple workbook, Working with formulae & cell referencing, Auto sum, coping formulae, Absolute & relative addressing, Worksheet with ranges, Formatting of worksheet, Previewing & Printing worksheet, Graphs and charts, Database, Creating and using macros, Multiple worksheets- concepts **Introduction of Open-Source Applications:** LibreOffice, OpenOffice and Google Docs etc
November' 25	24	**Unit IV** **Web Surfing:**

		An Overview: working of Internet, Browsing the Internet, E-Mail, Components of E-Mail, Address Book, Troubleshooting in E-Mail, Browsers: Netscape Navigator, Microsoft Internet Explorer, Google Chrome, Mozilla Firefox, Tor, Search Engines lik Google, DuckDuckGo etc, Visiting web sites: Downloading. **Cyber Security:** Introduction to Information System, Type of information system, CIA model of Information Characteristics, Introduction to Information Security, Need of Information Security, Cyber Security, phishing, spamming, fake news, general issues related to cyber security, Business need, Ethical and Professional issues of security.
		Activity*: Implementation of ANOVA Analysis, Z-Test & T-Test of data through Data Analysis Module in Advance Excel* ***Objective:*** *Student will learn Real-time implementation of data manipulation & calculations* ***Methodology:*** *Presentation*
December'25		**Revision & University Examination**

Suggested readings:

1. Sharma, A., "How to prepare for Data Interpretation and Logical Reasoning for the CAT" McGraw Hill Education Pvt. Ltd., New Delhi, India, ISBN 978 2007 070 481.
2. Aggarwal, R.S., "A Modern Approach to Verbal and Non-verbal Reasoning" S. Chand Publishers New Delhi, India, ISBN 10: 8121905516.
3. Madan , Sushila, Introduction to Essential tools, Jain Book Agency, New Delhi/India, 5th ed..
4. Goel, Anita, Computer Fundamentals, Pearson Education, India.
5. Michael E. Whitman and Herbert J. Mattord, "Principles of Information Security," Sixth Edition, Cengage Learning.

SEMESTER- IV

MAJOR/MINOR: BOTANY
Course Code: B040401T
Paper I (Theory)
Course Title: Economic Botany, Ethnomedicine and Phytochemistry
Credit:4 **Max. Marks: 75+25**

Course outcomes:

After the completion of the course the students will be able to:
1. Understand about the uses of plants –will know one plant-one employment
2. Understand phytochemical analysis related to medicinally important plants and economic products produced by the plants
3. know about the importance of Medicinal plants and its useful parts, economically important plants in our daily life and also about the traditional medicines and herbs, and its relevance in modern
times.

Month	Working Days	Topics to be covered
January' 26	**19**	**Unit I: Origin and domestication of cultivated plants** Centers of diversity of plants, origin of crop plants. Domestication and introduction of crop plants. Concepts of sustainable development; cultivation, production and uses of Cereals, legumes, Spices & beverages. **Unit II: Botany of oils, Fibers, timber yielding plants & dyes** Study of the plants with Botanical names, Family, part used, and economic uses yielding Edible& essential oils; Sugar, Starch; Fibers; Paper, Fumitories & Masticatories, Rubber, Dyes, Timber,biofuel crops.
February'26	**23**	**Unit III: Commercial production of Flowers, Vegetables, and fruits (To be Chosen area wise)** Commercial greenhouse cultivation of rose, Gerbera, Gladiolus, Anthurium/lilium/lily, tomato, bell pepper, cucumber, strawberry & Exotic leafy vegetables using Hydroponics. **Unit IV: IPR & Traditional Knowledge** IPR and WTO (TRIPS, WIPO), Patent Act 1970 and its amendments,TIFAC,NRDC,Rights, Procedure of obtaining patents, Working of patents, Infringement, Copyrights, Trademarks, Geographical Indications, Traditional Knowledge Digital Library, Protection of Traditional Knowledge & Protection of Plant Varieties and Biotech inventions.
March' 26	**20**	**Unit V: Ethnobotany** Methodologies of ethnobotanical research: Field work, Literature, Herbaria and Musea and other aspects of ethnobotany. Importance of ethnobotany in Indian systems of medicine (Siddha, Ayurveda and Unani), Role of AYUSH, NMPB, CIMAP and CARI. Tribal knowledge towards disease diagnosis, treatment, medicinal plants, plant conservationand

		cultivation. **Unit VI: Medicinal aspects** Study of common plants used by tribes (*Aeglemarmelos, Ficusreligiosa, Cynadondactylon, Eclipta alba, Oxalis, Ocimum sanctum* and *Trichopuszeylanicus)* Ethnobotanical aspect ofconservation and management of plant resources, Preservation of primeval forests in the formof sacred groves of individual species and Botanical uses depicted in our epics.Plants in primary health care*:* common medicinal plants*: Tinospora, Acorus, Ocimum,*Turmeric and Aloe. Indian Pharmacopeia, Quality Evaluation of crude drugs & adulteration
April' 26	**24**	**Unit VII: Pharmacognosy** Preparation of drugs for commercial market - Organoleptic evaluation of drugs – Microscopic evaluation of drugs - Physical evaluation of drugs - Active and inert constituents of drugs - Classification of drug plants - individual drugs - drug adulteration. Sources of crude drugs –roots, rhizome, bulb, corm, leaves, stems, flowers, fruits and seeds ;organoleptic study of *Adhatodavasica, Andrographispaniculata, Azadirachtaindica,Coriandrumsativum, Datura metal, Eclipta alba, Emblicaofficinalis, Ocimumsanctum,Phyllanthusamarus, Ricinuscommunis, Vincarosea and Zingiberofficinale.* **Unit VIII: Herbal Preparations &Phytochemistry:** Collection of wild herbs - Capsules - compresses - Elixirs - Glycerites - Hydrotherapy or Herbal bath - Herbal oils - Liquid extracts or Tincture - Poultices - Salves - Slippery elm slurry and gruel - Suppositories - Teas. Plant natural products, general detection, extraction and characterization procedures. Glycosides and Flavonoids and therapeutic applications. Anthocyanins and Coumarins and therapeutic applications, Lignans, Terpenes, Volatile oilsandSaponins, Carotenoids and Alkaloids Carotenoids and pharmacological activities. **Revision & Internal Examination**

Activity I*: *Project on economically important plants and their collection from local market.

Objective: *To know the sustainable use of plants resources.*

Methodology: *Inquiry based learning.*

Suggested readings:

1. Kochhar, S.L. (2011). Economic Botany in the Tropics, MacMillan Publishers India Ltd., New Delhi.4th edition.
2. Sambamurthy, AVSS&Subrahmanyam, NS (2000). Economic Botany of Crop Plants.Asiatech Publishers. NewDelhi.
3. Singh, D.K and K.V. Peter. 2014. Protected cultivation of horticultural crops. New India Publishing Agency, India.
4. Reddy P. Parvatha. 2016. Sustainable crop protection under protected cultivation. Springer, Singapore.
5. Singh, B., B. Singh, N. Sabir and M Hasan. 2014. Advances in protected cultivation. New India Publishing Agency,India

MAJOR/MINOR: BOTANY
Course Code: B040402P
Paper II (Practical)
Course Title: Commercial Botany & Phytochemical Analysis
Credit: 2 **Max. Marks: 75 +25**

Course outcomes:
After the completion of the course the students will be able to:

1. Know about the commercial products produced from plants.
2. Gain the knowledge about cultivation practices of some economic crops.
3. Understand about the ethnobotanical details of plants.
4. Learn about the chemistry of plants &herbal preparations
5. Can become a protected cultivator, aromatic oil producer, Pharmacologist or quality analyst in drug company.

Month	Working Days	Topics to be covered
January' 26	**19**	**Unit I: Economic Botany &Microtechniques:** 1. Cereals: Wheat/Rice (habit sketch, L.S./T.S. of grain, starch grains, micro-chemical tests); 2. Legume: Pea or ground nut (habit, fruit, seed structure, micro-chemical tests) 3. Source of sugars and starches: Sugarcane (habit sketch; cane juice- micro-chemical tests); potato (habit sketch, tuber morphology, T.S. of tuber to show localization of starch grains, W.M. of starch) grains, micro-chemical tests. 4. Tea- tea leaves, tests for tannin. 5. Mustard- plant specimen, seeds, tests for fat in crushed seeds 6. Timbers and Jute- specimen **Unit II: Commercial Cultivation** 1. Field visit to Green houses for understanding Floriculture & vegetables production 2. Development of hydroponics nutrient solutions & running models for cultivation of vegetables/Fodder.
February'26	**23**	**Unit III: Cultivating Medicinal and aromatic plants & Essential oil extraction** a. Lemon grass/ Neem/ Zinger /Rose/Mint **Unit IV: Documentation from** 1. Traditional Knowledge Digital Library, 2. Mark the Geographic Indications on Map, 3. Understand –NakshtraVatika, Navgrahvatika and develop in your college. 4. To extract the names of the plants and Botanical uses depicted in our epics.
March' 26	**20**	**Unit V: Ethnobotany**

		1. Study of common plants used by tribes. *Aeglemarmelos, Ficusreligiosa, Cynadondactylon.,* 2. Visit a tribal area and collect information on their traditional method of treatment using crude drugs **or** 1. Visit to an Ayurveda college or Ayurvedic Research Institute / Hospital 2. Familiarize with at least 5 folk medicines and study the cultivation, extraction and its medicinal application. **Unit VI: Instrumentation and herbal Preparations** Analyze some active ingredients using chromatography /Spectrophotometry
April' 26	**24**	**Unit VII: Pharmacognosy** Organoleptic studies of plants mentioned in the theory : 1. Morphological studies of vegetative and floral parts. 2. Microscopic preparations of root, stem and leaf. 3. Stomatal number and stomatal index. 4. Starch test 2. Proteins and lipid test **Unit VIII: Phytochemistry** 1. Project on "Dimensions of Calcium oxalate crystals in powdered crude drug". 2. Preliminary phytochemical tests for alkaloids, terpenoids, glycosides, volatile oils, tannins& resins. Any 5 herbal preparations. **Revision & Internal Examination**

Activity I: *Visit to Department of Ayurveda Science, BHU / Visit to tribal area & collect information on their traditional method of treatment using crude drug.*

Objective: *To identify and know the characteristics of medicinal plants.*

Methodology: *Expeditionary learning*

Suggested Readings:

1. KhasimS.M Botanical Microtechniques: Principles and Practice-
2. Sambamurthy, AVSS&Subrahmanyam, NS (2000). Economic Botany of Crop Plants. Asiatech Publishers. New Delhi.
3. Datta&Mukerji, 1952. Pharmacognosy of Indian roots of Rhizome drugs. Bulletin No.1 Ministry of Health,Govt. of India.
4. Young Ken, H.W., 1948. Text Book of Pharmacognosy. Blakiston C., Philadelphia.
5. Shukla, R.S., 2000. Forestry for tribal development. A.H. Wheeler & Co. Ltd., India.
6. Raychudhuri, S.P., 1991. (Ed.) Recent advances in Medicinal aromatic and spice crops. Vol.1,Today&Tomorrow's printers and publishers, New Delhi.
7. Practical Botany Part-2 by Bendre and Kumar. Rastogi Publication Merut.

MAJOR/MINOR: CHEMISTRY

Course Code: B020401T

Paper I (Theory)

Course Title: Quantum Mechanics and Analytical Techniques

Credits: 4 **Max. Marks: 75 +25**

Course outcomes:

Analytical chemistry plays an enormous role in our society, such as in drug manufacturing, process control in industry, environmental monitoring, medical diagnostics, food production, and forensic surveys. It is also of great importance in different research areas. Analytical chemistry is a science that is directed towards creating new knowledge so that chemical analysis can be improved to respond to increasing or new demands.

Upon successful completion of this course students should be able to

1. Describe atomic structure, elementary quantum mechanics,wave function and its significance; Schrodinger wave equation and its applications.
2. Describe the Molecular orbital theory and develop basic ideas&Criteria for forming molecular orbital from atomic orbitals.
3. Understand Molecular Spectroscopy, Rotational Spectrum,vibrational Electronic Spectrum.
4. Understand Photo chemistry and kinetics of photo chemical reaction.
5. Explore new areas of research in both chemistry and allied fields of science and technology.
6. Function as a member of an interdisciplinary problem-solving team.
7. Solve scientific problems by critical thinking and analytical reasoning.
8. Understandthe method for determining structure of organic molecules using IR and NMR spectroscopic techniques.
9. Develop basic skills required for purification, solvent extraction, TLC and column chromatography.

Month	Working Days	Topics to be covered
January' 26	**19**	**Unit I: Atomic Structure**: Idea of de-Broglie matter waves, Heisenberg uncertainty principle, atomic orbitals, Schrödinger wave equation, significance of Ψ and $\Psi^{2,}$ quantum numbers, radial and angular wave functions and probability distribution curves, shapes of s, p, d, orbitals. Aufbau and Pauli exclusion principles, Hund's multiplicity rule. **Unit II: Elementary Quantum Mechanics:** Black-body radiation, Planck's radiation law, photoelectric effect, heat capacity of solids, Bohr's model of hydrogen atom (no derivation) and its defects, Compton effect. de-Broglie hypothesis. Heisenberg uncertainty principle. Hamiltonian Operator.Schrödinger wave equation (time dependent and time independent) and its importance, physical interpretation of the wave function, postulates of quantum mechanics, particle in a one dimensional box. Schrödinger wave equation for H-atom, separation into three equations (without derivation), quantum numbers and their importance, hydrogen like wave functions, radial wave functions, angular wave functions. Molecular orbital theory, basic ideas – Criteria for forming MO from AO, construction of MO by LCAO – H2 + ion, calculation of energy levels from wave functions, physical picture of bonding and anti-bonding wave functions, concept of σ, σ^*, π, π^* orbitals and

		their characteristics.
February'26	**23**	**<u>Unit III: Molecular Spectroscopy:</u>**Introduction: Electromagnetic radiation, regions of the spectrum, basic features of different spectrometers, statement of the Born-Oppenheimer approximation, degrees of freedom **Rotational Spectrum:**Diatomic molecules. Energy levels of a rigid rotor (semi-classical principles), selection rules, spectral intensity, distribution using population distribution (MaxwellBoltzmann distribution) determination of bond length, qualitative description of non-rigid rotor, isotope effect. **Vibrational Spectrum:** Energy levels of simple harmonic oscillator, selection rules, pure vibrational spectrum, intensity, determination of force constant and qualitative relation of force constant and bond energies, effect of anharmonic motion and isotope on the spectrum, idea of vibrational frequencies of different functional groups. **Raman spectrum:**Concept of polarizability , pure rotational and pure vibrational, Raman spectra of diatomic molecules, selection rules. Electronic Spectrum: Concept of potential energy curves for bonding and antibonding molecular orbitals, qualitative description of selection rules and Franck-Condon principle. **<u>Unit IV: UV-Visible Spectroscopy:</u>** Origin of spectra, interaction of radiation with matter, fundamental laws of spectroscopy and selection rules. Types of electronic transitions, λmax, chromophores and auxochromes, Bathochromic and Hypsochromic shifts, Intensity of absorption; application of Woodward Rules for calculation of λmax for the conjugated dienes: alicyclic, homoannular and heteroannular; extended conjugated systems distinction between cis and trans isomers (Cis and trans stilbene).
March' 26	**20**	**<u>Unit V: Infrared Spectroscopy:</u>**IR Spectroscopy: Fundamental and non-fundamental molecular vibrations; Hooke's law selection rule, IR absorption positions of various functional groups (C=O, OH, NH, COOH and nitile) , Effect of H-bonding, conjugation, resonance and ring size of cyclic ketones and lactones on IR absorptions; Fingerprint region and its significance; application in functional group analysis and and interpretation of I.R. spectra of simple organic compounds **<u>Unit VI: ^{1}H-NMR Spectroscopy (PMR):</u>**NMR Spectroscopy: introduction; nuclear spin; NMR active molecules; basic principles of Proton Magnetic Resonance; choice of solvent and internal standard; equivalent and non-equivalent protons; chemical shift and factors influencing it; ring current effect; significance of the terms: up-/downfield, shielded and deshielded protons; spin coupling and coupling constant (1st order spectra); relative intensities of first-order multiplets: Pascal's triangle; chemical and magnetic equivalence in NMR ; anisotropic effects in alkene, alkyne, aldehydes and aromatics; NMR peak area, integration; relative peak positions with coupling patterns of common organic compounds; interpretation of NMR spectra of simple compounds. Applications of IR, UV and NMR spectroscopy for identification of simple organic molecules.
April' 26	**24**	**<u>Unit VII: Introduction to Mass Spectrometry:</u>** Principle of mass spectrometry, the mass spectrum, mass spectrometry diagram,

		molecular ion, metastable ion, fragmentation process, McLafferty rearrangement. **Unit VIII: Separation Techniques:** Solvent extraction: Classification, principle and efficiency of the technique. Mechanism of extraction: extraction by solvation and chelation. Technique of extraction: batch, continuous and counter current extractions. Qualitative and quantitative aspects of solvent extraction: extraction of metal ions from aqueous solution, extraction of organic species from the aqueous and non-aqueous media. Chromatography: Classification, principle and efficiency of the technique. Mechanism of separation: adsorption, partition & ion exchange. Development of chromatograms: frontal, elution and displacement methods. **Revision & Internal Examination**

Activity: *Two days Hands on training for identification of Organic compounds using IR, UV, NMR spectroscopy techniques at Department of Chemistry, BHU.*

Objective: *To understand how to use spectroscopic techniques for analyzing organic compounds.*

Methodology: *Expeditionary learning*

Suggested Readings:

1. Alberty,R A, Physical Chemistry,4theditionWiley Eastern Ltd ,2001.
2. Atkins, PW, The elements of physical chemistry,Oxford ,1991
3. Barrow,G .M,International student Edition .McGraw Hill, McGraw-Hill,1973.
4. Cotton,F.A, Wilkinson,G and Gaus,P. L ,Basic Inorganic Chemistry,3rd Edition ,Wiley 1995
5. Lee,J.D, Concise Inorganic Chemistry 4th Edition ELBS,1977
6. Clayden, J., Greeves, N., Warren, S., Organic Chemistry, Second edition, Oxford University Press 2012.
7. Silverstein, R. M., Bassler, G. C., Morrill, T. C. Spectrometric Identification of Organic Compounds, John Wiley and Sons, INC, Fifth edition.
8. Harris, D.C.: Exploring Chemical Analysis, 9th Ed. New York, W.H. Freeman, 2016.
9. Khopkar, S.M. Basic Concepts of Analytical Chemistry. New Age International Publisher, 2009.

Suggestive digital platforms web links:

1. https://www.coursera.org/courses?query=chemistry&languages=en
2. https://www.mooc-list.com/tags/physical-chemistry
3. https://www.coursera.org/learn/physical-chemistry
4. https://ocw.mit.edu/courses/chemistry/5-61-physical-chemistry-fall-2017/
5. http://heecontent.upsdc.gov.in/Home.aspx
6. https://nptel.ac.in/courses/104/108/104108078/
7. https://nptel.ac.in/courses/104/108/104108124/
8. https://nptel.ac.in/courses/104/106/104106122/

MAJOR/MINOR: CHEMISTRY
Course Code: B020402P
Paper II (Practical)
Course Title: Instrumental Analysis

Credits: 2 **Max. Marks: 75 +25**

Course outcomes:

Upon completion of this course,

1. Chemistry majors are able to employ critical thinking and scientific inquiry in the performance, design, interpretation and documentation of laboratory experiments, at a level suitable to succeed at an entry-level position in chemical industry or a chemistry graduate program.
2. Students will be able to explore new areas of research in both chemistry and allied fields of science and technology.
3. Students will be able to function as a member of an interdisciplinary problem solving team.
4. Students will be skilled in problem solving, critical thinking and analytical reasoning as applied to scientific problems
5. Students will gain an understanding of how to determine the structure of organic molecules using IR and NMR spectroscopic techniques
6. To develop basic skills required for purification, solvent extraction, TLC and column chromatography

Month	Working Days	Topics to be covered
January' 26	**19**	**Unit I: Molecular Weight Determination** 1. Determination of molecular weight of a non-volatile solute by Rast method/ Beckmann freezing point method. 2. Determination of the apparent degree of dissociation of an electrolyte (e.g., NaCl) in aqueous solution at different concentrations by ebullioscopy.
February'26	**23**	**Unit II-Spectrophotometry:** 1. To verify Beer – Lambert Law for KMnO4/K2Cr2O7 and determining the concentration of the given solution of the substance from absorption measurement 2. Determination of pKa values of indicator using spectrophotometry. 3. Determination of chemical oxygen demand (COD). 4. Determination of Biological oxygen demand (BOD).
March' 26	**20**	**Unit III- Spectroscopy:** 1. Assignment of labelled peaks in the IR spectrum of the same compound explaining the relative frequencies of the absorptions (C-H, O-H, N-H, C-O, C-N, C-X, C=C, C=O, N=O, C≡C, C≡N stretching frequencies; characteristic bending vibrations are included. Spectra to be provided). 2. Assignment of labelled peaks in the 1HNMR spectra of the known organic compounds explaining the relative δ-values and splitting pattern. 3. 3. Identification of simple organic compounds by IR spectroscopy and NMR spectroscopy (Spectra to be provided).
April' 26	**24**	**Unit IV- Chromatographic Separations:** 1. Paper chromatographic separation of following metal ions: i. Ni (II) and Co (II) ii. Cu(II) and Cd(II) 2. Separation of a mixture of o-and p-nitrophenol or o-and p-

		aminophenol by thin layer Chromatography (TLC) 3. Separation and identification of the amino acids present in the given mixture by paper chromatography. Reporting the Rf values 4. TLC separation of a mixture of dyes (fluorescein and methylene blue) **Revision & Internal Examination**

Suggested Readings:

1. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009.
2. Willard, H.H. et al.: Instrumental Methods of Analysis, 7th Ed. Wardsworth Publishing Company, Belmont, California, USA, 1988.
3. Christian, G.D. Analytical Chemistry, 6th Ed. John Wiley & Sons, New York, 2004.
4. Harris, D.C.Exploring Chemical Analysis, 9th Ed. New York, W.H. Freeman, 2016.
5. Khopkar, S.M. Basic Concepts of Analytical Chemistry. New Age International Publisher, 2009.
6. Skoog, D.A. Holler F.J. and Nieman, T.A. Principles of Instrumental Analysis, Cengage Learning India Edition.
7. Mikes, O. &Chalmes, R.A. Laboratory Handbook of Chromatographic &AlliedMethods, Elles Harwood Ltd. London.
8. Ditts, R.V. Analytical Chemistry: Methods of separation. Van Nostrand, New York, 1974.

Suggestive digital platforms web links:

1. https://www.labster.com/chemistry-virtual-labs/
2. https://www.vlab.co.in/broad-area-chemical-sciences
3. http://chemcollective.org/vlabs

MAJOR/MINOR: ZOOLOGY
Course Code: B050401T
Paper I (Theory)
Course Title: Gene Technology, Immunology and Computational Biology
Credits: 4 **Max. Marks: 75 +25**

Course outcomes:
The student at the completion of the course will:

1. Understand the principles of genetic engineering, how genes can be cloned in bacteria and the various technologies involved in it.
2. Know the applications of biotechnology in various fields like agriculture, industry and human health.
3. To have an in depth understanding about Immune System & its mechanisms.
4. Get introduced to DNA testing and utility of genetic engineering in forensic sciences.
5. Get introduced to computers and use of bioinformatics tools.
6. Enable students to get employment in pathology/Hospital.
7. Take up research in biological sciences.

Month	Working Days	Topics to be covered
January' 26	**19**	**Unit I: Principles of Gene Manipulation** • Recombinant DNA Technology • Selection and identification of recombinant cells • Restriction Enzymes, DNA modifying enzymes, Cloning Vectors, Ligation • Gene transfer techniques, Gene therapy **Unit II: Applications of Genetic Engineering** • Single cell proteins • Biosensors, Biochips • Crop and live stock improvement, development of transgenics • Development of DNA drugs and vaccines
February'26	**23**	**Unit III: DNA Diagnostics** • Genetic analysis of human diseases, detection of known and unknown mutations • Concept of pharmacogenomics and pharmacogenetics **Unit IV: Immune System and its Components** • Historical perspective of Immunology, Innate and Adaptive Immunity, clonal selection, complement system • Structure and functions of different classes of immunoglobulins, Hypersensitivity • Humoral immunity and cell mediated immunity • HLA complex: organization, class I and II HLA molecules

March' 26	**20**	**Unit V: Biostatistics I** • Calculations of mean, median, mode, variance, standard deviation • Concepts of coefficient of variation, Skewness, Kurtosis • Elementary idea of probability and application **Unit VI: Biostatistics II** • Data summarizing: frequency distribution, graphical presentation—bar, pie diagram, histogram • Tests of significance: one and two sample tests, t-test and Chi square Test
April' 26	**24**	**Unit VII: Basics of Computers** • Basics (CPU, I/O units) and operating systems • Concept of homepages and websites, World Wide Web, URLs, using search engines **Unit VIII: Bioinformatics** • Databases: nucleic acids, genomes, protein sequences and structures, Bibliography • Sequence analysis (homology): pairwise and multiple sequence alignments-BLAST, CLUSTALW • Phylogenetic analysis **Revision & Internal Examination**

Activity: *Visit to Indian Institute of Vegetable Research, Varanasi*
Objective: *To see Apiculture as an Economic Zoology procedure.*
Methodology: *Expeditionary learning.*

Suggested Readings:

1. Primrose &Twyman. Principles of Genome Analysis and Genomics. Blackwell (2003).
2. Hartl& Jones. Genetics: principles &Analsysis of Genes & Genomes. Jones & Bartlett (1998).
3. S6mbrooket al .Molecular Cloning Vols I, II, III. CSHL (2001).
4. Primrose. Molecular Biotechnology. Panima (2001).
5. Clark & Switzer. Experimental Biochemistry. Freeman (2000)
6. Sudbery. Human Molecular Genetics. Prentice-Hall (2002).
7. Wilson. Clinical Genetics-A Short Course, Wiley (2000).
8. Pasternak. An Introduction to Molecular Human Genetics. Fritzgerald (2000).
9. Biostatistical Analysis (Fourth Edition) by Jerrold H. Zarr, Pearson Education Inc., Delhi.
10. Statistical Methods (Eighth Edition) by G. W. Snecdecor and W. G. Cochran, Willey Blackwell
11. Biostatistics (Tenth Edition) by W.W. Daniel and C. L. Cross, Wiley
12. Introductory Biological Statistics (Fourth Edition) by John E. Havel, Raymond E. Hampton and Scott J.Meiners
13. Westheadet al Bioinformatics: Instant Notes. Viva Books (2003).

MAJOR/MINOR: ZOOLOGY
Course Code: B050402P/R
Paper II (Practical)
Course Title: Genetic Engineering and Counselling Lab
Credits: 2 **Max. Marks: 75 + 25**

Course outcomes:
The student at the completion of the course will be able to:

1. Understand the principles of genetic engineering with hands-on experiments in mutation detection, testing of infectious diseases like Covid 19.
2. Get introduced to DNA testing and utility of genetic engineering in forensic sciences.
3. Apply knowledge and awareness of the basic principles and concepts of biology, computer science and mathematics existing software effectively to extract information from large databases and to use this information in computer modeling.
4. Use bioinformatics tools to find out evolutionary/phylogenetic relationship of organisms using gene sequences.
5. Get employment in Hospitals/Diagnostic and forensic labs/Counsel families with genetic disorders.
6. Enable students to take up research in biological sciences.

Month	Working Days	Topics to be covered
January' 26	**19**	**Unit I:** 1. Measure the pre and post clitellar lengths of earthworms and calculate mean, median, mode, standard deviation etc. 2. Measure the height and weight of all students in the class and apply statistical measures.
February'26	**23**	**Unit II:** 1. Determination of ABO Blood group 2. To perform bacterial culture and calculate generation time of bacteria. 3. To study Restriction enzyme digestion using teaching kits. 4. To detect genetic mutations by Polymerase Chain Reaction (PCR) using teaching kits. 5. Demonstration of agarose gel electrophoresis for detection of DNA. 6. Demonstration of Polyacrylamide Gel Electrophoresis (PAGE) for detection of proteins. 7. To calculate molecular weight of unknown DNA and protein fragments from gel pictures.

March' 26	**20**	**Unit III:** 1. To learn the basics of computer applications 2. To learn sequence analysis using BLAST 3. To learn Multiple sequence alignment using CLUSTALW 4. To learn about Phylogenetic analysis using the programme PHYLIP. 5. To learn how to perform Primer designing for PCR using available softwares etc.
April' 26	**24**	**Unit IV:** **Virtual Labs (Suggestive sites)** 1. Gel Documentation Systemhttps://youtu.be/WPpt3-FanNE 2. Colorimeter- https://youtu.be/v4aK6G0bGuU 3. PCR Part 1- https://youtu.be/CpGX1UFSl4A 4. PCR Part 2- https://youtu.be/6IcHAYPTAEw 5. DNA isolation Part 1-https://youtu.be/QE7Ul0JnY9A 6. DNA isolation part 2- https://youtu.be/-efr_HFeHxM 7. DNA curve- https://youtu.be/ubL8QxTeuG4 8. Spectrophotometerhttps://youtu.be/ubL8QxTeuG4 9. Agarose Part 1- https://youtu.be/7gvHPFww--g 10. Agarose part 2- https://youtu.be/j_bOZCHNsSg 11. Use softwares like Primer3, NEB cutter 12. NCBI, BLAST, CLUSTAL W, PHYLIP **Revision & Internal Examination**

Suggested Readings:

1. Primrose &Twyman. Principles of Genome Analysis and Genomics. Blackwell (2003).
2. Hartl& Jones. Genetics: principles &Analsysis of Genes & Genomes. Jones & Bartlett (1998).
3. Sambrooket al .Molecular Cloning Vols I, II, III. CSHL (2001).
4. Primrose. Molecular Biotechnology. Panima (2001).

Course Name V: Co- Curricular

Course Title: GENERAL HINDI

Course Code: UGHINCOCR401

Credits: 2 **Max. Marks: 100**

पाठ्यक्रम का उद्देश्य–

इकाई 01– हिंदी भाषा के निर्माण की प्रक्रिया को समझना, हिन्दी की कोटियों को जानना, हिन्दी भाषा के वाक्य गठन एवं संज्ञा, सर्वनाम, विशेषण, समास आदि की संरचना को समझना।

इकाई 02– मुहावरे , लोकोक्तियां और कहावतें ,पर्यायवाची एवं विलोम शब्द समानर्थी शब्द आदि द्वारा हिन्दी के भाषिक व्यवहार को समझना।

प्रतिफल(Outcome)– 1. इस इकाई के अध्ययन के उपरान्त विद्यार्थी हिंदी भाषा के निर्माण की प्रक्रिया को समझ सकेंगे, हिन्दी की कोटियों को जान सकेंगे, हिन्दी भाषा के वाक्य गठन एवं संज्ञा, सर्वनाम, विशेषण, समास आदि की संरचना को समझ सकेंगे।

2. इस इकाई के अध्ययन के उपरान्त विद्यार्थी मुहावरे , लोकोक्तियों , कहावतों ,पर्यायवाची, विलोम शब्द एवं समानर्थी शब्द आदि के बोध द्वारा हिन्दी के भाषिक व्यवहार को समझ सकेंगे।

इकाई 01– 15 घंटा

1. हिंदी भाषा एवं देवनागरी लिपि का परिचय।
2. हिन्दी की प्रमुख बोलियां।
3. संज्ञा, सर्वनाम, विशेषण और क्रिया: पहचान एवं प्रयोग।
4. शब्द संपदा (तद्भव ,तत्सम, देशज, विदेशज)।

इकाई 02– 15 घंटा

1. मुहावरे , लोकोक्तियाँ और कहावतें ।
2. पर्यायवाची एवं विलोम शब्द।
3. समोच्चारी शब्द एवं शब्द समूह के लिए एक शब्द।
4. समास

Details of Activities/Field Visit/Outreach Program
Department of Science
2024-25

Class	Subject	Field Work/Visit	Faculty In-Charge
B.Sc. I/III/V SEM	Botany	Field Plant Collection & CSIR Institute Visit	Dr. Rishi & Dr. Ritu
	Zoology	In-situ or Ex-situ conservation site	Dr. Soumik
	Chemistry	Department of Material Science, IIT BHU	Dr. Ragini & Dr. Anju
	Physics	Department of Physics, IIT BHU	Dr. Ragini
	Mathematics	Department of Mathematics, IIT BHU	Dr. Anju
Activity			
Date	**Events/ Outreach Program**		**Faculty In-Charge**
11.03.2025	Organic color preparation & distribution (In collaboration with BHUMI)		Dr. Soumik
14.04.2025	Mosquito awareness rally & cleaning (World Malaria Day), in collaboration with BHUMI & NSS		Dr. Soumik & Dr. Ritu
16.05.2025	International Day of Light		Dr. Ragini & Dr. Bhupendra
Aug'2025	Outreach Program of Mathematics		Dr. Anju
16.09.2025	World Ozone Day (Lecture) in collaboration with BHUMI & APEIRON		Dr. Soumik
Oct'2025	DAAN Utsav (World Food day) in collaboration with BHUMI		Dr. Soumik
10.11.2025	Presentation on world Science Day for peace & Development		Dr. Rishi & Dr. Ritu
01.12.2025	Blood Donation on World AIDS Day		Dr. Ragini & Dr. Soumik
22.12.2025	Role Play on National Mathematics Day		Dr. Anju
22.04.2026	Special assembly on the occasion of Earth Day		Dr. Ragini & Dr. Bhupendra