Lok Jagruti Kendra University
University with a Difference

LJ School of Applied Sciences

Bachelor of Science Syllabus

Course Structure with Subjects and Credits
(As per NEP-2020 and SOP of KCG)
(w.e.f. A.Y. 2023-24)

TABLE OF CONTENTS

B.Sc. in Chemistry Programme Outcomes (PO)

PO1. Students will demonstrate a solid grasp of basic biological, physical, chemical, and mathematical principles. This foundational knowledge serves as the bedrock for their further studies and applications.

PO2. As budding scientists, students will practice professional ethics in their scientific endeavors. This includes integrity, honesty, and responsible conduct in research and experimentation.

PO3. Chemistry majors will develop strong problem-solving and analytical abilities. Whether it's balancing chemical equations or deciphering complex reactions, they'll tackle challenges with confidence.

PO4. Students will be adept at operating and interpreting data from various scientific instruments. From spectrophotometers to chromatographs, they'll navigate the world of analytical tools.

PO5. Through hands-on methods, students will gain quantitative skills. These skills empower them to analyze data, perform calculations, and make informed decisions in the lab.

PO6. Chemistry majors will delve into the quantum mechanical model of the atom, electronic configurations, and periodic trends. They'll decipher atomic radii, ionization enthalpy, and electron affinity.

PO7. Students will draw plausible structures and understand molecular geometries using VSEPR theory, radius ratio rules, and molecular orbital (MO) diagrams.

PO8. They'll rationalize the conductivity of metals, semiconductors, and insulators based on band theory.

PO9. Chemistry honours students to enhance their ability to write methodical, logical, and precise reports. They'll also learn how to communicate scientific content effectively through oral presentations and posters.

PO10. The program encourages students to work both independently and collaboratively. They'll develop skills needed for problem-solving, numeracy, IT, and organizational competence.

PSO1. Graduates will **apply core principles** of inorganic, organic, physical, and analytical chemistry to comprehend chemical phenomena.

PSO2. Graduates will **skillfully conduct chemical laboratory experiments**, operate analytical instruments, and interpret quantitative and qualitative chemical data.

B.Sc. Chemistry Semester-1

110390101 Major-1 Fundamental Chemistry – 1
Credits: 4

Objective:

The main aim of studying Fundamental of chemistry is for students to:

- Understand atomic structure's role in explaining chemical behaviour.
- Use chemical bonding knowledge to predict properties and reactivity.
- Apply kinetics principles to control reaction rates.
- Analyse catalysis applications in industry and research.
- Explore alkane reactivity as hydrocarbons.
- Grasp essential organic chemistry concepts.
- Use analytical methods for elemental composition.
- Learn tests for halogens, sulphur, and phosphorus.
- Estimate nitrogen content quantitatively.
- Determine molecular weights.
- Solve problems for empirical and molecular formulas.

Course Outcomes:

CO1: Understand atomic structure, quantum mechanics, and chemical bonding principles including VSEPR and hybridization.

CO2: Apply chemical kinetics concepts like reaction rates, order, and Arrhenius equation.

CO3: Explore catalysis mechanisms (homogeneous, heterogeneous, enzyme) and fundamental organic reaction types.

CO4: Perform qualitative and quantitative analysis of organic compounds, including elemental determination and molecular formula calculation.

Unit: 1 (A) Atomic Structure

Recapitulation of Bohr's theory, its limitations and atomic spectrum of hydrogen atom.

de 'Broglie equation, Heisenberg's Uncertainty Principle, and its significance.

Schrödinger's wave equation, significance of ψ and ψ^2. Quantum mechanical treatment of H- atom, Quantum numbers and their significance. Normalized and orthogonal wave functions. Sign of wave functions.

Shapes of s, p, and d orbitals, Relative energies of orbitals.

Pauli's Exclusion Principle, Hund's rule of maximum spin multiplicity, Aufbau principle and its limitations.

(B). Chemical Bonding

Introduction of different types of Bonds

Octet Rule and its limitations with examples

Valence Bond theory (Heitler-London approach)
Molecular orbital theory. Molecular orbital diagrams of diatomic and simple polyatomic molecules N_2, O_2, C_2, B_2, F_2, CO, NO, and their ions.
Valence shell electron pair repulsion theory (VSEPR), shapes of the following simple molecules and ions containing lone pairs and bond pairs of electrons:
H_2O, NH_3, PCl_3, PCl_5, SF_6, ClF_3, I_3^-, BrF_2^+, PCl_6^-, ICl_2^- - ICl_4^-, and SO_4^{2-}.
Types of hybridisation and shapes of molecules with sp , sp^2 , sp^3 sp^3d and sp^3d^2 hybridisation.

Unit: 2 (A) Chemical Kinetics

Basic terms: Rate of Reaction, Average rate of Reaction, Rate constant, Order of reaction
Unit for rate constant.
Derivation of first order rate constant, Second order rate constant for (a = b) and (a ≠ b) with graphical method.
Determination of Half Lifetime for 1^{st}, 2^{nd} and 3^{rd} order reactions.
Pseudo first order reaction.
Numericals based on Rate of reaction 1^{st} order or reactions.
Temperature dependence of rate of a reaction: Energy of activation; Arrhenius equation; Numericals based of Arrhenius equation.
Collision theory of chemical reactions.

(B). Catalysis

Types of catalyst: Homogeneous and Heterogeneous Catalysis
Specificity and selectivity Mechanisms of catalysed reactions at solid surfaces
Enzyme catalysis
Michaelis-Menten mechanism

Unit 3 : (A). Fundamentals of Organic Chemistry

Fission of Covalent Bond: Homolytic & Heterolytic Fission with suitable examples.
Reactive Intermediates (Preparations, Shape, Reactions and Stability) : Carbonium Ion ; Carbanion ; Free radicals ; Carbene ; Nitrene ; Benzyne.
Types of Reagents: Electrophiles; Nucleophiles.
Electronic displacements and their applications: Inductive Effect; Resonance Effect; Electrometric Effect; Mesomeric Effect; Hyperconjugation.
Introduction of organic reactions: Addition Reaction; Elimination Reaction; Substitution Reaction; Rearrangement Reaction.
Types of Nucleophilic Substitution reactions: Unimolecular Nucleophilic Substitution reaction (SN^1) ; Biomolecular Nucleophilic Substitution reaction (SN^2).

Types of Elimination reactions: E1 and E2.

(B).	**Alkanes**
	General methods of preparations of Alkanes: From Reduction of Unsaturated hydrocarbons ; From Aldehydes & Ketones ; Wurtz Reaction ; Corey-House Synthesis ; Kolbe's Electrolysis Carbanion **Physical properties** : Solubility ; Density ; Melting point & Boiling points **Chemical Properties (Reactions)** : Halogenation (with detailed free radical chain mechanism) and its selectivity in halogens ; Cracking or Pyrolysis Electrometric Effect

Unit 4	**Quantitative Analysis and Determination of Molecular Formula**
	Identification of C , H and (O) in organic compounds. Lassaigne's Test for the determination of Halogen, Sulphur and Phosphorus. Estimation of Nitrogen by Kjeldahl' and Duma's Method Molecular weight of organic acid by Ag-salt method and organic base by Chloroplatinate method. Numerical based above all methods Numericals based on empirical and molecular formula.

Reference Books

1. Lee, J.D.; Concise Inorganic Chemistry, Volume 1, Wiley India.
2. Malik, Tuli, Madan; Selected topics of Inorganic Chemistry, S. Chand Publication.
3. G.S. Sodhi; Principles of Inorganic Chemistry, Viva Publication
4. Overton, T.L.; Rourke, J.P.; Weller; Inorganic chemistry,6th edition, Oxford publication.
5. Morrison, R. N.; Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education) 7th edition.
6. Finar, I. L. Organic Chemistry (Volume 1, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education). 6th edition.
7. Mehta Bhupinder; Mehta Manju ; Organic Chemistry , PHL Learning Private Limited ; 2nd edition.
8. Kalsi P S ; Oza R S ; Organic Reactions : Stereochemistry and Mechanism , New Age International Publication; 5th edition.
9. Arun Bahl, B S Bahl and G D Tuli; Essentials of Physical Chemistry; S Chand Publication.
10. B.R. Puri, L.R. Sharma, Madan S. Pathania, Principles of physical chemistry, Vishal publishing-Jalandhar, 44th Edition.
11. Atkins, P.W.; Paula, J.de. (2014), Atkin's Physical Chemistry Ed., 10th Edition, Oxford University Press
12. Ira N. Levine, Physical Chemistry, 6th Edition, Tata McGraw Hill Higher Education.

110390102 Major-2 Chemistry Practical-1
Credits: 4

Course Outcomes:

CO1: Conduct inorganic qualitative analysis for various cations and anions.

CO2: Perform acid-base and redox volumetric titrations.

CO3: Execute limit tests for common impurities like chloride, arsenic, and iron.

CO4: Apply learned techniques to prepare and standardize solutions.

PART – 1

Inorganic Qualitative Analysis (Two Radicals) (Minimum ten Salts):
Water Soluble and Insoluble Inorganic salts of following cations and anions:
Cations: K^+, NH_4^+, Mg^{2+}, Ba^{2+}, Ca^{2+}, Sr^{2+}, Fe^{2+}, Fe^{3+}, Al^{3+}, Cr^{3+}, Zn^{2+}, Mn^{2+}, **CO3:**$^+$, Pb^{2+}, Cu^{2+}.
Anions: S^{2-}, SO_4^{2-}, **CO3:**$^{2-}$, PO_4^{3-}, CrO_4^{2-}, Cl^-, Br^-, I^-, NO_3^-, O^{2-}

PART – 2

Volumetric Analysis and Limit tests

(A). Volumetric Analysis

Acid-Base Titration:

1. Titration of weak acid (Oxalic acid) and strong base.
2. Titration of weak acid (Succinic Acid) and strong base.
3. To prepare 250 mL of approximately 0.1N Hydrochloric acid (HCl) and standardize it with 0.1N NaOH.
4. To determine the Normality, gm/litre and Molarity of X N Na_2**CO3:** by using prepared standard 0.1 N HCl solution.
5. To determine the strength of NaH**CO3:** and Na_2**CO3:** present in the solution.
6. Estimation of free alkali present in different Soaps/detergents

Redox Titration:

1. Prepare 0.05 N Standard solution of $KMnO_4$ and find out Normality, Molarity and gm/lit. of given $FeSO_4(NH_4)_2SO_4$. $6H_2O$ solution.
2. Estimation of Organic Carbon from Soil Sample. ($K_2Cr_2O_7$ → $FeSO_4$ $(NH_4)_2$ SO_4 $6H_2O$)

(B). Limit tests:

Limit Test: Introduction & its importance in Pharmaceutical Industries.

1. Limit Test for Chloride.
2. Limit Test for Arsenic.
3. Limit Test for Iron

Reference Books

1. 'Vogel's Textbook of Quantitative Chemical analysis' Revised by G. H. Jeffery, J. Bassett, J. Mendham & R. C. Denney, ELBS (English Language Book Society) Longman. 5th Ed., New York

2. Vogel's Textbook of Macro and Semi micro–Qualitative Inorganic Analysis, 5/E, Orient Longman Ltd.
3. 'Advanced Practical Inorganic Chemistry' by Gurdeep Raj, 9th Ed., Goel Publishing House, Meerut
4. 'Analytical Chemistry' by Dhruba Charan Dash, 2011, 2nd Ed., PHI Learning Private Ltd, New Delhi.
5. Analytical Chemistry by Gary D. Christian, 4/E, John Wiley & Sons.

110391103 Minor-1 Physics-1
Credits: 2

Objectives

- In present paper, the aim is to include as much of basic physics as possible, while make the student familiar to the applied aspects of physics. We also need to keep in view the role of physics as a training process for the brain. Not all students who study Physics will go on to become professional physicists. Nevertheless, the study of physics is likely to make them good at logical thinking, quantitative argumentation, etc.
- we also need to remember that this is an era of interdisciplinary studies. The physics student will benefit by the study of fields that overlap with other domains of knowledge. The syllabus presented here represents an attempt to balance all these requirements.

Course Outcomes:

CO1: Understand the fundamental concepts of nuclear physics, including radioactivity, nuclear reactions, and their applications in energy and dating techniques.

CO2: Apply the laws of thermodynamics and related mathematical formulations to analyze physical systems and processes involving heat, work, and entropy.

Unit: 1. Nuclear Physics

Radioactivity: The law of radioactive decay (review); Radioactive growth and decay ; Ideal equilibrium; Transient equilibrium and secular equilibrium ; Radioactive series ; Radioactive isotopes of lighter elements ; Artificial radioactivity ; Age of earth, Carbon dating (Archaeological time scale)

The Q Equation : Types of Nuclear Reactions, The balance of mass and Energy in Nuclear reactions, The Q Equation, Solution of the Q Equation.

Constituents of the nucleus properties : Measurement of Nuclear radius ; Constituents of the nucleus and their properties.

Unit: 2. Heat and Thermodynamics

Entropy : Reversible part of the second law (Clausius theorem) ; Entropy, Principle of increase of entropy ; TS diagram ; Application of the Entropy principle.

Pure substances: Volume expansivity; Cubic Expansion coefficient; Compressibility.

Mathematical methods in thermodynamics: Characteristics functions, Enthalpy, Helmholtz & Gibb's functions, two mathematical theorems, Maxwell's relations, TdS equations, Internal energy equations, Heat Energy equations, Heat capacity equations.

Open Systems: Joule-Thomson expansion, Liquefication of gases by the Joule-Thomson expansion

Reference Books

1. Nuclear Physics: An Introduction (Rev. ed., Chapters 2, 3, and 4) by S. B. Patel. New Age International Publishers, 1991.

2. Heat and Thermodynamics (7th ed., Chapters 8–11) by M. W. Zemansky & R. H. Dittman. McGraw-Hill International, 1997.

3. Nuclear Physics (1st ed.) by D. C. Tayal. Himalaya Publishing House, 2003.

4. Thermal Physics by A. B. Gupta & H. P. Roy. New Central Book Agency, 2009.

110391104 Minor-2 Physics Practical-1
Credits: 2

Course Outcomes:

CO1: Perform experiments in optics, mechanics, thermodynamics, and nuclear physics using standard laboratory instruments and techniques.

CO2: Analyze experimental data using graphs, error estimation, and simulations to draw valid scientific conclusions.

List of Practical:

1. To find the prism angle and refractive index of a prism using spectrometer
2. Calibration of spectrometer and find the wavelength of unknown line of a mercury spectrum.
3. To find the wavelength of prominent spectral lines by diffraction grating
4. To verify the Stefan Boltzmann's fourth power law by using dc power source
5. To study the X-ray diffraction.
6. Simple pendulum - Find the relaxation time and quality factor.
7. To obtain the value of 'g' by bar pendulum.
8. Simulation of Nuclear Radioactive decay using Calculator.
9. Plotting of a graph and error estimation on graphical plot
   - Linear (find slope and intercept) and nonlinear graph
   - Logarithmic graph
   - Polar graph
10. To study of travelling microscope - To find distance between two given points, to find diameter of a ring, to find inner and outer diameter of a rubber tube.

Reference Books

1. B.Sc. Practical Physics (5th Edition) by C. L. Arora. S. Chand & Company Ltd., 2012.

2. Practical Physics (18th Edition) by S. L. Gupta & V. Kumar. Pragati Prakashan, 2011.

3. Advanced Practical Physics for Students (9th Edition) by B. L. Worsnop & H. T. Flint. Methuen & Co. Ltd., 1962.

4. Practical Physics (4th Edition) by G. L. Squires. Cambridge University Press, 2001.

110392105 MDC – 1 Mathematics-1
Credits: 2

Objective:

- In this paper, our objective is to develop a positive attitude toward mathematics and to understand its practical applications in life.
- The study of Mathematics is likely to make them good at logical and critical thinking. We also need to remember that this is an era of interdisciplinary studies.
- The mathematics student will benefit by the study of fields that overlap with other branches of science.

Course Outcomes:

CO1: Perform matrix operations and understand linear dependence, rank, and echelon forms.

CO2: Solve systems of linear equations and determine eigenvalues/eigenvectors using matrix theory.

Unit: 1 Matrix Algebra

Linear dependence and independence of row and column of matrix, row rank, column rank and rank of a matrix, row reduced echelon (RRE) form of a matrix.

Application of matrices in solving a system of simultaneous linear equations, Cramer's rule, theorems on consistency of a system of simultaneous linear equations.

Eigenvalues, eigenvectors, and the characteristic equation of a matrix.

Cayley-Hamilton theorem and its use to find the inverse of a matrix.

Unit: 2 Successive Differentiation & Mean Value theorems

Successive Differentiation: Introduction to successive derivatives; n^{th} derivatives of some standard functions ; Leibnitz theorem.

Mean Value theorems: Rolle's mean value theorem ; Lagrange's mean value theorem ; Different forms of Lagrange's mean value theorem ; Cauchy's mean value theorem ; Applications of mean value theorems.

Reference Books

1. Matrix and Linear Algebra - K. B. Dutta, Prentice Hall.
2. A Textbook of Matrices - Shanti Narayan, P. K. Mittal, S. Chand Group.
3. Introduction to Linear Algebra - Serge Lang. Springer (India).
4. Linear Algebra Theory and Applications - Ward Cheney, David Kincaid. Jones and Bartlet India Pvt. Ltd.
5. H. Anton, Elementary linear algebra with applications (8th Edition), John Wiley 1995).
6. Introduction to Linear Algebra- V. Krishnamurthy, Affiliated East-west Press Pvt Ltd.
7. Differential Calculus, Shanti Narayan, S. K. Mittal, S. Chand and Co. Publication.
8. Anton, Biven and Davis, Calculus, 10th edition, Willey Publication.
9. Thomas, Calculus early transcendental, Addison-Wesley person publication.
10. Calculus, James Stewart, sixth edition.
11. Calculus, T. M. Apostol, Volume I.

110392106 MDC – 2
Fundamentals of Biochemistry Credits: 2

Objective:

- To understand the structure, classification, and function of carbohydrates, amino acids, and lipids in biological systems.
- To analyse the chemical properties, reactions, and structural determination of biomolecules.
- To explore the metabolic pathways and biological significance of these biomolecules.
- To familiarize students with biochemical techniques for analysing carbohydrates, amino acids, and lipids.
- To study the synthesis, degradation, and key reactions involved in biomolecule transformations.

Course Outcomes:

CO1: Classify and understand the structure and function of carbohydrates.
CO2: Analyze chemical properties and biological importance of amino acids.

Unit: 1 (A) Carbohydrates

- Introduction and function of Carbohydrate
- **Classification of Carbohydrates:** Monosaccharides, Disachharides and Polysachharides.
- Family of D-aldoses and D-Ketoses
- **Detailed Chemical Structure determination of**
  - Glucose
  - Fructose
  - Osazone formation
- Step-up and step-down rection (Killani Fischer synthesis, Ruff's Degradation & Wohl's Method).
- Importance of Carbohydrates.

(B) Amino Acids

- Introduction
- Classification of Amino acids based on nutritional importance and nature of amino acids
- Types of Amino acids.
- **Physical Properties of Amino acids**
  - Zwitter ion
  - Isoelectronic point
- Biological importance of Amino acids.
- Peptide and Polypeptide bond.

Unit: 2 Lipids

- Classification of lipids (Simple, derived and complex)
- Complex lipids (Phospholipids, Glycolipids and Lipoproteins)

- Nomenclature of fatty acids: Alpha and Omega fatty acids, Essential and Non-essential fatty acids
- Saturated and Unsaturated Fatty Acids (MUFA, PUFA)
- Chemical reactions of fatty acids
- Simple Lipids (Oils and fats, waxes)
  - Introduction
  - Distinction between Oils and Fats.
  - Properties.
  - Classification
- Analysis of Oils, Fats and Waxes
  - Saponification value
  - Acid value
  - Iodine value
  - Reichert – Meissl value
- Biological importance of Lipids

Reference Books

1. Fundamental of Biochemistry by Dr. A C Deb , 4th Edition , New Central Book Agency .
2. Biochemistry by U. Satyanarayan and U. Chakrapani , 6th Edition , Elsevier Health Sciences.
3. Mehta Bhupinder; Mehta Manju; Organic Chemistry, PHL Learning Private Limited; 2nd edition.
4. Organic Chemistry: Volume-2 Stereochemistry and the Chemistry of Natural Products by I. L. Finar

110393107 SEC Environmental Audit
Credits: 2

Objective:

The key objective of an environmental audit is to:

- Determine the performance of the existing environmental management system in place and its instrumentality.
- To identify which environmental management practices are working effectively.
- Verify compliance with the relevant laws and regulations.

Course Outcomes:

CO1: Understand the overview, objectives, and importance of environmental auditing.
CO2: Identify different types of environmental audits and their advantages.

Unit: 1. Environmental Audit Scheme

Introduction to Environmental Audit
Overview of environmental auditing
Importance of an environmental audit
The objective of environmental auditing
Objectives
Performance analysis of available environmental management systems
Compliance measures
Types of Environmental Audits
Types of pollution applicable for environmental auditing
Environmental compliance audits
Environmental management audits
Functional environmental audits
Advantages of Environmental Auditing
Benefits of an environmental audit
Limitations of an environmental audit

Unit: 2. Auditors and their roles and responsibilities

Environmental Auditor Do
Responsible for examining and reviewing the company's environmental policies.
Plan audit methodology and procedures
Requirements to become an Environmental Auditor
Environmental Professional – Compliance Environmental Auditor (EPCEA)
Environmental Professional – Environmental Management Systems Auditor (EPEMSA)
Certified Environmental Auditor (CEA)
Duties of Environmental Auditors
Regular auditing of all environmental policies and procedures
How environmental compliance is being handled.
Steps to carry out Environment Audit

Pre–Audit Phase
Audit Phase
Post Audit Phase

References

1. Guidelines of GPCB
2. Guidelines of CPCB
3. Details Regarding Environment Audit
   https://gpcb.gujarat.gov.in/webcontroller/viewpage/details-regarding-environment-audit
4. Environment Audit Scheme
   https://www.scribd.com/document/332051048/Environment-Audit-Scheme
5. Guide on Environmental Audit:
   http://kb.icai.org/pdfs/PDFFile5b28e322df0fd2.63902464.pdf

110394108 AEC
English and Communication Skills Credits: 2

Objectives

- The course aims at inculcating a proficient level of language competency in English among students of B.Sc.
- The objective is to introduce students to Communication as a subject and its foundational theoretical concepts.
- This knowledge will help them handle various day to day situations, both in personal as well as professional world, proficiently.
- The goal is to introduce them to the basics of reading, writing, listening, and speaking communication skills.
- The main objective is to sensitize them to the nuances of basic English communication and its application for various business communication.

Course Outcomes:

CO1: Demonstrate an understanding of communication processes and apply effective communication and business etiquette in workplace and meeting scenarios.

CO2: Develop core communication skills — listening, reading, writing, and speaking — to effectively interpret, analyze, and convey information in professional and social contexts.

Unit 1 Effective Business Communication

1. Communication Skills
   a. Introduction to communication and its importance
   b. Process of Communication
2. Business Etiquette
   a. Importance of business communication and etiquettes
   b. Learning the critical aspects pertaining to workplace etiquette
3. Note-making:
   a. The ability to comprehend the gist, make drafts and concise content

Unit 2 Developing Communication Skills

1. Listening Skills
   a. Ideal process of listening and types of Listening
   b. Effective or Active Listening and techniques to become an active listener
2. Reading Skills
   a. Introduction to reading skills: Introduction and types of reading skills
   b. Comprehension Passage: Reading purposefully and understanding what is read, drawing conclusions, findings and analysis
3. Writing Skills:
   a. Translation and interpretation from Gujarati to English: Basic grammar including parts of speech and sentence structure

4. Speaking Skills
   a. Social communication: Making a request, seeking permission or information, placing and receiving an order, accepting an invitation, giving direction, lecture discussion

Activities:

1. Bring Stories to life
2. Reading photographs
3. I Spy with Words
4. Role Play

Reference Books

1. Middle School English Grammar and Composition by Wren & Martin
2. Business Communication by Meenakshi Raman, Prakash Singh
3. Business English by Pearson Publications
4. English at Workplace by Macmillan Publications
5. Basic communication skills for Technology, Andreja. J. Ruther Ford, 2nd Edition, ++Pearson Education, 2011
6. The Ace of Soft Skills: Attitude, Communication and Etiquette for success, GopalaSwamy Ramesh, 5th Edition, Pearson, 2013
7. Developing your influencing skills, Deborah Dalley, Lois Burton, Margaret, Greenhall, 1st Edition Universe of Learning LTD, 2010

110395109 VAC National Service Scheme (NSS) Credits: 2

Objectives:

The key objectives of studying NSS is to:

- Sensitize the members of National Service Society (NSS) to advocate the motto of NSS "service before self"
- Encourage the members of NSS to undertake any activity or engage in activities reflecting the motto and spirit of NSS.
- Train members of NSS the importance of offering social service to those in need especially during pandemic crisis
- Generate ideas or ways to offer social services or assistance to those in need.

Course Outcomes:

CO1: Understand the history, objectives, and organizational structure of NSS.

CO2: Sensitize to the NSS motto "service before self" and encourage social service activities.

Unit: 1. Introduction of National Service Scheme

History and its Objectives.

Organizational structure of N.S.S. at National, State, University and College Levels.

Advisory committee and their functions with special reference to college principal, Programme officer, N.S.S. group leader and N.S.S. volunteers in the implementation.

Unit: 2. National Integration & Special Programme

Need of National integration.

Various obstacles in the way of National Integration; such as caste, religion, language and provisional problems etc.

- Legal awareness
- Health awareness
- First-aid
- Career guidance
- Leadership training - cum - Cultural Programme
- Globalization and its Economic Social Political and Cultural impacts.

References

1. National Service Scheme Manual, Government of India
2. Training Programme on National Programme scheme, TISS.
3. Orientation Courses for N.S.S. Programme officers, TISS.
4. Case material as Training Aid for field workers, Gurmeet Hans.
5. Social service opportunities in Hospitals, Kapil K. Krishan, TISS.
6. Social Problems in India, Ram Ahuja.

B.Sc. Chemistry Semester-2

110390201 Major-1 Fundamental Chemistry – 2
Credit: 4

Objective:

- Understand coordination chemistry principles, explore structures, bonding, and examine magnetic and spectral properties of coordination compounds.
- Gain a comprehensive understanding of f-block elements, explore electronic configurations and periodic trends, and study properties/applications of lanthanides and actinides, including their importance in nuclear reactions.
- Grasp fundamental thermodynamic concepts, understand laws, and apply principles to chemical reactions and physical processes.
- Understand adsorption phenomenon, explore types, factors affecting it, and examine adsorption isotherms and kinetics, along with applications in various fields.
- Study the structure, nomenclature, and properties of alkenes, alkynes, and cycloalkanes. Explore preparation methods, reactions, and understand resonance's role in stability.
- Understand three-dimensional arrangement of atoms in organic molecules, explore stereoisomerism, including geometric and optical isomerism, and study principles of chirality's importance in organic reactions.
- Understand principles of dye chemistry, study classification/properties of synthetic dyes, explore dyeing methods and applications, and understand the role of synthetic dyes in industries like textiles and pharmaceuticals.

Course Outcomes:

CO1: Comprehend coordination chemistry, including structure, bonding, magnetic, and spectral properties.

CO2: Understand f-block elements, their electronic configurations, periodic trends, and applications.

CO3: Grasp fundamental thermodynamic concepts and apply them to chemical processes.

CO4: Understand adsorption phenomena, types, influencing factors, and industrial applications.

Unit: 1 (A) Co – Ordination Chemistry – 1

Simple inorganic molecules and coordination complexes.

IUPAC nomenclature of coordination complexes.

Brief review of Werner's theory

Sidgwick's electronic interpretation and EAN rule and their limitations.

Labile and inert complexes; Stability of complex compounds; Factors influencing the stability of complexes.

Valence bond theory (VBT) – postulates and application to

tetrahedral complexes $[Ni(NH_3)_4]^{2+}$, $[NiCl_4]^{2-}$ and $[Ni(CO)_4]$

square planar complexes $[Ni(CN)_4]^{2-}$, $[Cu(NH3)_4]^{2+}$, $[PtCl_4]^{2-}$

octahedral complexes $[Fe(CN)_6]^{4-}$, $[Fe(CN)_6]^{-3}$, $[FeF_6]^{4-}$, $[Co(NH3)_6]^{3+}$, $[CoF_6]^{3-}$

Limitations of VBT

(B).	**Inner Transition Elements**

Lanthanides

Electron configuration
Oxidation states
Magnetic properties
Colour and absorption spectra of lanthanide ions
Lanthanide contraction
Separation of Lanthanides
Ion-exchange and solvent extraction methods

Actinides

Electron configuration, Oxidation states
Magnetic properties
Colour and absorption spectra of actinide ions
Actinide contraction
Trans uranic elements
importance of Uranium
Comparison with lanthanide

Unit: 2 (A)	**Chemical Thermodynamics**

Thermodynamic Terms: System, Boundary, Surroundings
Types of Thermodynamic Systems: Homogeneous and Heterogeneous Systems
Intensive and Extensive Properties
Thermodynamic Processes: Reversible and Irreversible Processes
Thermodynamic equation of state
Nature of Heat and Work
Internal Energy & Units of Internal Energy
First Law of Thermodynamics
Concept of entropy
Entropy and Statement of the second law of thermodynamics
Carnot cycle
Gibbs-Helmholtz equation: variation of S, G, A with T, V, P.
Relation between Joule-Thomson coefficient and other thermodynamic parameters.
Maxwell relations.
Numericals based on Carnot Cycle & Entropy.

(B).	**Adsorption**

Introduction
Classification of Adsorption
Chemical Adsorption.
Physical Adsorption.
Difference between Chemical and Physical Adsorption.
Adsorption Isotherms:

Freundlich adoption isotherm.
Langmuir adsorption isotherm.
Mechanism of adsorption.
Applications of adsorption.

Unit 3 : (A). Alkenes, Alkynes and cycloalkanes

Alkenes and Alkynes

General Methods of Preparations of Alkenes: Dehydrohalogenation; Dehydration of alcohols; Dehalogenation ; Witting Reaction ; Addition Reaction ; Kolbe's Hydrocarbon Synthesis.

Chemical Reactions of Alkenes: Addition of Water ; Oxymercuration-Demercuration (With Mechanism) ; Addition of HX (Markonikov's Rule & Anti – Markonikov's Rule with Mechanism and suitable examples) ; Hydroboration Oxidation (With Mechanism) ; Ozonolysis.

General Methods of Preparations of Alkynes: Preparative methods of Acetylene; Dehydrohalogenation of dihaloalkanes (1,1 and 1,2 elimination) ; From haloforms ; From dehalogenation of vicinal tetrahaloalkanes ; Kolbe's electrolytic reaction ; Preparations of higher alkynes to lower alkynes.

Chemical Reactions of Alkynes: With $NaNH_2$; With Metals such as: Cu, Ag and Au ; With Grignard's reagent.

Cyclo alkanes

Bayer's Strain Theory
Conformation of Cyclohexane with energy diagram, Axial & Equatorial positions
Conformations of monosubstituted cyclohexenes

(B). Stereochemistry of Organic Compounds

Types of Isomerism (Only brief introduction): Structural isomerism OR Constitutional isomerism ; Stereoisomerism

Stereoisomerism: Optical Activity ; Optical Isomerism ; Chirality ; Enantiomers ; Diastereomers ; Mesomers ; Racemic Mixture and its Resolution

Configuration and projection formulae: Wedge–Dash formula **;** Fischer Projection ; Interconversion of Wedge–Dash formula to Fischer formula; Interconversion of Fischer formula to Wedge–Dash formula ; Sawhorse projection formula ; Newman projection formula.

Relative and absolute configuration: D – L Configuration **;** R – S Configuration

Geometrical Isomerism (Notation using CIP Rules)

Unit 4 Synthetic Dyes

Classification of Dyes:

Anionic and Cationic dyes
Vat dyes
Mordent dyes
Reactive and Dispersed dyes

Synthesis of some important Dyes

Alizarin
Malachite green
Indigo
Congo red
Eosin

Reference Books

1. Lee, J.D.; Concise Inorganic Chemistry, Volume 1, Wiley India. [Page no. 194-236; 857-901]
2. Malik, Tuli, Madan; Selected topics of Inorganic Chemistry, S. Chand Publication. [Page no. 452-520; 521-672]
3. G.S. Sodhi; Principles of Inorganic Chemistry, Viva Publication [Page no. 1375-391; 631-675]
4. Overton, T.L.; Rourke, J.P.; Weller; Inorganic chemistry,6th edition, Oxford publication,
5. [Page no. 550-577; 625-651].
6. Morrison, R. N.; Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education) 7th edition: (Pg. No. 169-225; 291-473)
7. Finar, I. L. Organic Chemistry (Volume 1, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education). 6th edition (Pg. No. 93-144)
8. Mehta Bhupinder ; Mehta Manju ; Organic Chemistry , PHL Learning Private Limited ; 2nd edition (Pg No. 63-106; 199-252; 273-293)
9. Kalsi P S ; Oza R S ; Organic Reactions : Stereochemistry and Mechanism , New Age International Publication; 5th edition (Pg No. 100-191)
10. Arun Bahl, B S Bahl and G D Tuli; Essentials of Physical Chemistry; S Chand Publication, Pg.: 236-265, 303-335.
11. B.R. Puri, L.R. Sharma, Madan S. Pathania, Principles of physical chemistry, Vishal publishing-Jalandhar, 44th Edition, Pg.: 525-551, 571-608.
12. Atkins, P.W.; Paula, J.de. (2014), Atkin's Physical Chemistry Ed., 10th Edition, Oxford University Press, Pg.: 362-393.
13. Ira N. Levine, Physical Chemistry, 6th Edition, Mc Graw Hill Higher Education, Pg.: 1-104.

110390202 Major-2 Chemistry Practical-2
Credit: 4

Course Outcomes:

CO1: Conduct organic qualitative analysis, identifying functional groups and elemental composition.

CO2: Perform quantitative estimations of water hardness, Ni, and chloride.

CO3: Analyze soil samples for organic matter, moisture, pH, EC, sodium, potassium, and phosphorus.

CO4: Execute physico-chemical experiments, including hydrolysis kinetics and adsorption studies.

PART – 1 (Organic Qualitative Analysis)

Concept of types of organic compound, lassaigne's elements, Organic functional groups, water soluble/insoluble compounds, Aromatic character, MP/ BP and their measurement, Chemical properties of different organic compounds.

Organic spotting

Acids: Benzoic acid (S), Salicylic acid (S), Succinic acid (S), Oxalic acid (S)
Phenol: α-naphthol & β-naphthol
Base: P-nitroaniline (S)
Neutral: Urea (S), Thiourea (S), Naphthalene (S)

PART – 2 (Soil Analysis and Physico-Chemicals Experiments)

(A). Estimations

1. Hardness of Water sample, Ca & Mg (Total Hardness) by EDTA.
2. Estimation of Ni by using EDTA, $MgCl_2$ and Eriochrome Black-T (Back Titration).
3. To determine the amount of Chloride from water sample (Argentometric titration).

(B). Soil Analysis

1. To determine organic Matter and Moisture content of given soil sample.
2. To determine pH and Electrical Conductivity (EC) of given soil sample.
3. To determine Sodium and Potassium of given soil sample.
4. To determine Phosphorus of given soil sample.

(C). Physico-Chemicals

3. To determine the relative strength between HCl and H2SO4 by studying hydrolysis of methyl acetate.
4. To study the adsorption of an organic acid by Animal Charcoal. (Acetic acid /Oxalic acid).
5. To determine the temperature coefficient and energy of activation of hydrolysis of methyl acetate catalysed by acid.

Reference Books

1. 'Vogel's Textbook of Quantitative Chemical analysis' Revised by G. H. Jeffery, J. Bassett, J. Mendham & R. C. Denney, ELBS (English Language Book Society) Longman. 5th Ed., New York
2. Comprehensive Practical Organic Chemistry: Qualitative Analysis by V. K. Ahluwalia, Sunita Dhingra, Universities press (India) Private Ltd, Hyderabad.
3. 'Analytical Chemistry' by Dhruba Charan Dash, 2011, 2nd Ed., PHI Learning Private Ltd, New Delhi.
4. Handbook of Methods in Environmental Studies, Vol. 2 (Air, Noise, Soil and Overburden Analysis) by S.K. Maiti, Published by Oxford Book Co., 2020.

110391203 Minor-1 Physics-2
Credit: 2

Objectives

- In present paper, the aim is to include as much of basic physics as possible, while make the student familiar to the applied aspects of physics. We also need to keep in view the role of physics as a training process for the brain. Not all students who study Physics will go on to become professional physicists. Nevertheless, the study of physics is likely to make them good at logical thinking, quantitative argumentation, etc.
- we also need to remember that this is an era of interdisciplinary studies. The physics student will benefit by the study of fields that overlap with other domains of knowledge. The syllabus presented here represents an attempt to balance all these requirements.

Course Outcomes:

CO1:. Understand the principles of atomic spectroscopy, including electron configurations, angular momentum coupling, and the effects of magnetic and electric fields on spectral lines.

CO2:. Explain the structural and magnetic properties of solids through basic crystallography, X-ray diffraction methods, and concepts like superconductivity and magnetism.

Unit: 1. Atomic Spectroscopy

Hydrogen atom spectrum, Orbital magnetic moment of hydrogen, Larmor precession, Stern-Gerlach experiment, Electron spin, The vector atom model, Spin-orbit interaction and fine structure, Pauli's exclusion principle and electronic configuration, Total angular momentum in many electron atoms, L-S coupling, j-j coupling, Hund rules, Energy levels and transitions of Helium, Alkali spectra, Shielding of core electrons, Spectral terms of equivalent electrons, Normal Zeeman effect, experimental arrangement and theory, Anomalous Zeeman effect, Paschen-Bach effect, Stark effect, Characteristics X-ray spectrum, Moseley's law, Width of spectral lines.

Unit: 2. Solid State Physics

Nature of the solid state, law of constancy of interfacial angles, law of rational indices, Miller indices, elementary ideas of symmetry, symmetry elements and symmetry operations, qualitative idea of point and space groups, seven crystal systems and fourteen Bravais lattices; X-ray diffraction, Bragg's law, a simple account of rotating crystal method and powder pattern method. Analysis of powder diffraction patterns of NaCl, CsCl and KCl. Superconductivity, Diamagnetism, Para magnetism, Ferromagnetism, Anti-ferromagnetism.

Reference Books

1. *Modern Physics* by G. Aruldhas & P. Rajagopal. PHI Learning Pvt. Ltd., 2005.
2. *Introduction to Solid State Physics* by C. Kittel. Wiley India, 2005 (8th ed.).
3. *Principles of Modern Physics* by A. K. Saxena. Narosa Publishing House, 2005.
4. *Modern Physics* (2nd Edition) by Kenneth S. Krane. John Wiley & Sons, 1996.
5. *Atomic and Molecular Spectra* by Rajkumar. Kedarnath Ramnath Prakashan, Meerut, 2003.
6. *Elements of Solid State Physics* (2nd Edition) by J. P. Srivastava. PHI Learning Pvt. Ltd., 2006.
7. *Solid State Physics* (6th Edition) by S. O. Pillai. New Age International Publishers, 2005.
8. *Solid State Physics* (4th Edition) by S. L. Kakani & C. Hemrajani. Sultan Chand & Sons, 2004.

110391204 Minor-2 Physics Practical-2
Credit: 2

Course Outcomes:

CO1:. Perform and understand experiments related to optics, magnetism, mechanics, and modern physics using instruments such as diffraction gratings, telescopes, and magnetometers.

CO2:. Interpret experimental data through logical analysis, verification of electronic principles, and accurate measurements of physical constants and properties.

List of Practicals:

1. To determine Resolving power of grating.
2. To determine Resolving power of telescope.
3. Diffraction by single slit.
4. To study Logic Gates (AND, OR, NOT, NAND, NOR)
   Verification of truth tables and giving understanding of voltage level for '0'and'1'level.
5. Study of magnetic field of bar magnet with compass
   - of a bar magnet
   - of likes poles facing each other
   - of unlike poles facing each other
6. Flywheel - To determine the moment of inertia.
7. Deflection Magnetometer - To determine the magnetic moment (M) of given bar magnate using deflection magnetometer in Gauss A and B position.
8. Newton's Ring - To find the wavelength of light of given monochromatic source.
9. To study double refraction in calcite prism.
10. To measure a threshold current of a LASER diode at room temperature.

Reference Books

1. B.Sc. Practical Physics by C. L. Arora. S. Chand & Company Ltd., 2012.
2. Practical Physics (18th Edition) by S. L. Gupta & V. Kumar. Pragati Prakashan, 2011.
3. Advanced Practical Physics for Students (9th Edition) by B. L. Worsnop & H. T. Flint. Methuen & Co. Ltd., 1962.
4. Practical Physics (4th Edition) by G. L. Squires. Cambridge University Press, 2001.

110392205 MDC-1 Mathematics-2
Credit: 2

Objectives:

- The main objective is to learn basics of differential equations and understand its practical applications in different branches of science.

Course Outcomes:

CO1: Understand vector operations, dot product, cross product, and scalar triple product.

CO2: Apply concepts of vector differentiation, gradient, divergence, and curl.

Unit: 1. Differential equation of first order and first degree

Ordinary differential equation, order & degree of differential equation, general solution, particular solution, formation of differential equation. Integrating factor.

Methods of solving differential equation of first order & first degree: Variable separable, Homogenous differential equation, Linear differential equation, Bernoulli's differential equation, Exact differential equation and equations reducible to them.

Unit: 2. Differential equation of higher order and first degree

Differential operators, linear differential equation of higher order and first degree with constant coefficients. Complementary & Particular Integrals (solutions).

Inverse operator, operational methods for its solutions. Euler form of Homogenous linear differential equation with variable coefficients.

Reference Books

1. Integral Calculus, Shanti Narayan, S. Chand and Co. Publication
2. Calculus, James Stewart, sixth edition.
3. Differential Equations and their applications, Prentice Hall of India- Zafar Ahsan
4. Ordinary and Partial differential equations theory and applications by Nita H. Shah, PHI.

110392206 MDC-2 Industrial Chemistry
Credit: 2

Objective

- In this study, students will explore various aspects of chemistry, including water chemistry, detergent use, and synthetic fibres.
- They will learn about the chemical composition of water, water treatment processes, and the impact of detergent use on the environment.
- The study also covers the synthesis and properties of synthetic fibres. Students will gain practical skills in water quality testing, detergent analysis, and explore the applications of synthetic fibres in different industries.
- The course concludes with an examination of environmental chemistry, addressing chemical processes and pollution effects.
- Overall, Students will develop a well-rounded understanding of chemistry, preparing them for advanced studies and practical applications in the field.

Course Outcomes:

CO1: Learn water quality characteristics, sterilization methods, and water softening processes.

CO2: Understand the types of detergents and eco-friendly alternatives.

Unit: 1 (A) Water Chemistry

Main quality characteristics of water : Alkalinity ; Hardness ; Total solids ; Oxidation ; Transparency ; Silica content.

Chemical methods of sterilisation of water : Precipitation method ; Aeration ; Ozonisation ; Bleaching powder method ; Chloramine method ; Chlorine dioxide.

Softening of water : Clark's process ; Modified lime soda process ; Zeolite process ; Ion exchange process.

(B). Detergents

Classification of detergents : Anionic detergents ; Cationic detergents ; Non – ionic detergents ; Amphoteric detergents.

Soaps.

Alkyl Sulphate ; Alkyl Sulphonates ; Alkyl Aryl Sulphonates ; Amide Sulphonates.

Ecofriendly Detergents

Unit: 2 (A) Synthetic Fibers

Classification of Fibers.

Difference between Natural Fibre & Synthetic Fibre.

Properties of Synthetic Fibres.

Common Preparation of Synthetic Fibres.

Synthesis of selected Synthetic Fibres :

Nylon – 6 (Kapron) PHBV

Nylon – 66	Dynel
Dacron	Orlon
Teflon	Saran
Vinyon	Melamine
Bakelite	Buna – N
Buna – S	Neoprene
Nylon – 2 – Nylon – 6	PAN

(B). Environmental Chemistry

Acid Rain.
Smog and its different types.
Depletion of Ozone layer and its effects.
Green House effect and Global warming.
Sources and types of water pollution.
Biochemical Oxygen Demand (BOD) and Dissolved Oxygen Demand (COD)

Reference Books

1. Industrial Chemistry by B K Sharma , Goel Publishing House.
2. Mehta Bhupinder ; Mehta Manju ; Organic Chemistry , PHL Learning Private Limited ; 2nd edition.
3. Shreve's Chemical Process Industry by George Austin , 5th Edition , Tata McGraw Hill Higher Education.

110393207 SEC

Basic Principles of Good Laboratory Operations Credits: 2

Objectives

- In this study, students will enhance precision in experimental data and calculations by mastering the use of significant figures. They will analyse molecular formulas to determine the percentage of elements in organic compounds.
- Additionally, a solid understanding of concentration measures, such as normality, molarity, molality, formality, mole fraction, and various percentage concentrations, will be gained for accurate solution quantification. The comprehension of parts per million (ppm) in extremely dilute solutions will ensure nuanced understanding of concentration levels.
- Moreover, students will achieve proficiency in the Standard Operating Procedures (SOP) for instruments, ensuring correct and efficient usage, maintenance, and adherence to established protocols, thereby enhancing precision and reliability in experimental and analytical processes.

Course Outcomes:

CO1: Master SI units, derived units, conversions, and significant figures for experimental data.

CO2: Calculate percentage of elements from molecular formulas and determine molecular formulas from percentages.

Unit : 1 Fundamentals Principles

- **SI Units**
  - Definitions of the Seven Base Units
  - Derived units
  - Conversion between units
  - Significant figures
- **Percentage of elements from Molecular Formula.**
- **Identification of Molecular formula of Organic Compounds from Percentage of elements.**
- **Concentration of Solutions**
  - Normality
  - Molarity
  - Molality
  - Formality
  - Mole fraction
  - % w / w ; % w / w ; % v / v
  - ppm

Unit : 2 Standard Operating Procedures (SOP) for Instruments

- pH meter
- Conductometer
- Gerber Tube
- Desiccator

- Potentiometer
- Colourimeter
- UV-Vis Spectrophotometer
- Muffle Furnace
- Hot Air Oven
- Incubator
- BOD- Incubator
- COD-Incubator
- Ice Maker
- Kjeldahl Apparatus
- Flame Photometer
- Centrifuge
- Cooling Centrifuge
- Water bath
- UV-Chamber
- M.P. Apparatus
- Turbidimeter
- HVAS (High Volume air sampler)
- Magnetic Stirrer
- Weighing Balance

Reference Books

1. Evert, R. F., Eichhorn, S. E., Perry, J.B. (2012). Laboratory Topics in Botany. W.H. Freeman and Company.
2. Mesh, M.S., Kebede-Westhead, E. (2012). Essential Laboratory Skills for Biosciences. John Wiley & Sons, Ltd.
3. Mu, P., Plummer, D. T. (2001). Introduction to practical biochemistry. Tata McGraw Hill Education.
4. Mann, S. P. (2016). Introductory Statistics, 9th edition. Hoboken, NJ, John Wiley and Sons Inc.
5. Danniel, W.W. (1987). Biostatistics. New York, NY: John Wiley Sons.
6. Jones, A.M., Reed, R., Weyers, J. (2016). Practical Skills in Biology, 6th Edition, Pearson
7. Bisen, P.S. (2014). Laboratory Protocols in Applied Life Sciences, 1st edition. CRC Press

110394208 AEC Practical English
Credits: 2

Objectives

- The course aims at enhancing the knowledge of efficient communication in English among students of B.Sc.
- The objective is to introduce students to various elements of communication both theoretically and through various integrated tasks.
- The goal is to improve their reading, writing, listening, and speaking skills in formal as well as informal everyday interactions.
- The main objective is to shape their verbal and non-verbal behaviour as well written communication, especially in workplace.

Course Outcomes:

CO1: Demonstrate proficiency in various forms of communication—including face-to-face, interpersonal, and intra-personal—while adhering to appropriate cellphone and social media etiquette in professional contexts.

CO2: Apply critical listening, reading, writing, and speaking skills to convey ideas clearly and accurately, including the ability to summarize, paraphrase, translate, and interpret content to avoid miscommunication and plagiarism.

Unit 1 Effective Business Communication

1. Elements of Communication:
   a. Face to Face Communication
   b. Inter-personal Communication
   c. Intra-personal Communication
   d. Perspectives in Communication
2. Cell phone etiquette
   a. Learning how to handle different types of calls.
   b. Social Networking Etiquette: Working with social media sites
3. Summarization and Paraphrasing: The ability to avoid plagiarism while using reference material

Unit 2 Developing Communication Skills

1. Listening Skills
   a. A Better Listener: Deep listening, Full listening, Critical listening, Therapeutic listening
2. Reading Skills:
   a. Analytical Reading: Learning close reading, skimming, scanning, extensive reading
   b. Narration and Description: Learning the difference between narrating a story / event and describing and explaining a process / method / mechanism
3. Writing Skills:
   a. Translation and interpretation from Gujarati to English: Translating paragraphs from Gujarati to English

4. Speaking Skills
   a. Effective Communication: Essential tips to avoid miscommunication and other barriers
   b. Vocabulary: Words often misspelt, confusing words, common errors, better way of saying common words and sentence

Activities:

1. Card Pieces
2. Listen and Draw
3. Guess who am I?
4. Secret Message

Reference Books

1. Middle School English Grammar and Composition by Wren & Martin
2. Business Communication by Meenakshi Raman, Prakash Singh
3. Business English by Pearson Publications
4. English at Workplace by Macmillan Publications
5. Basic communication skills for Technology, Andreja. J. Ruther Ford, 2nd Edition, Pearson Education, 2011
6. The Ace of Soft Skills: Attitude, Communication and Etiquette for success, GopalaSwamy Ramesh, 5th Edition, Pearson, 2013
7. Developing your influencing skills, Deborah Dalley, Lois Burton, Margaret, Greenhall, 1st Edition Universe of Learning LTD, 2010

110395209 VAC Indic Knowledge System-1 Credits: 2

Objective Of the Course

This course is designed to understand and enhance the holistic understanding of Indian Knowledge System. This course provides the basic understanding of the rich Indian knowledge system and its traditions. The course will introduce to the various ancient Indian Schools and its relevance in contemporary period with the great achievements of IKS to the world. It helps in understanding and analysing the Ancient Indian knowledge system.

Course Outcomes:

CO1: Explain the foundational concepts, literature, and educational systems of Indian Knowledge Systems (IKS), including the significance of Shastras and the evolution of Bharatiya education from ancient to modern times

CO2: Analyze and illustrate the contributions of IKS in diverse domains such as mathematics, life sciences, metallurgy, architecture, Ayurveda, and traditional arts, highlighting their scientific principles and global relevance.

Unit 1: Introduction to IKS

1. Introduction to IKS & Its importance
   - Introduction & importance of IKS
   - Various IKS Systems
2. Shashtra – Foundational Literature of Bharatvarsha
   - What is Shashtra?
   - Importance of Shashtra
   - Classification of Shashtra – Vaidic & Avaidic (with examples of imp. Literature)
3. Base of IKS proliferation
   - Bhartiya Education System and its philosophy
   - History of BES from Ancient to Modern
   - Domains of Education: Gurukul, Pathshala, Vidyalay, Vishvavidyalay

Unit 2: Contribution of IKS to the World

1. Mathematics & Astronomy
   - Number System
   - Algebra & Arithmetic
   - Geometry
   - Trigonometry
   - Planetary System
   - Speed of Light
   - Eclipse
2. Life sciences
   - Physics
   - Chemistry
   - Botany
3. Metal Technology

- Mining Techniques
- Types of Metals
- Tools & Techniques for Metal Smelting with examples

4. Town planning & Temple Architecture
   - Indigenous tools & technologies for town planning & Temple Architecture
   - Science of Architecture
   - Lothal, Mohan Jo Daro, Dholavira
   - Angkorvat, Lepakshi Temple, Jagannath Puri Temple, Thanjavur Temple, Modhera and Konark Sun Temple, Hampi Temple Etc.
5. Ayurveda
   - Introduction of Ayurveda- Definition, Branches of Ayurveda, Books and Pioneers
   - Concept of Tri Dosh and importance of its Balance in the body
   - Indic Medical Science Achievement: Tools & Technology
6. Art & Traditions
   - History and Origin
   - Skill Enhancement with 64 Kala
   - Science behind our traditions and rituals

Reference Books

1. Introduction to Indian Knowledge System- Concept and Application by B. Mahadevan, Vinayak Rajat Bhat, Nagendra Pavan R.N.
2. 'Pride of India: A Glimpse into India's Scientific Heritage' by R.M. Pujari, Pradeep Kolhe, N. R. Kumar, Samskrita Bharati Publication.
3. 'Indian Contribution to science', compiled by Vijnana Bharati.
4. 'Knowledge traditions and practices of India', Kapil Kapoor, Michel Danino, CBSE, India.

B.Sc. Chemistry Semester 3

110390301 Major-1 Organic Chemistry-1
Credits: 4

Course Objectives:

- Understand the concept of aromaticity, resonance structures, Huckel's rule, and the preparation of benzene.
- Study the mechanisms of electrophilic substitution reactions in aromatic compounds and their orientation and reactivity.
- Learn the preparation, nucleophilic substitution, and elimination reactions of haloalkanes and haloarenes.
- Explore the synthesis, properties, and reactions of alcohols, phenols, ethers, epoxides, and polynuclear hydrocarbons.

Course Outcomes:

CO1: Understand the concepts of aromaticity, resonance, Huckel's rule, and the preparation of benzene.

CO2: Learn the mechanisms and reactivity of electrophilic substitution reactions in benzene and the effect of substituents on reactivity and orientation.

CO3: Study the preparation, nucleophilic substitution, and elimination reactions of haloalkanes and haloarenes.

CO4: Explore the properties, synthesis, and reactions of alcohols, phenols, ethers, epoxides, and polynuclear hydrocarbons.

Unit: 1 (A) Aromaticity (05 Marks)

- Concepts of Aromaticity
  - Structure of Benzene: Hybridization and Shape
  - Kekule Structure
  - Resonance Structure
  - Orbital Picture of Benzene
- Resonance energy: stability of benzene
- Huckel's rule and aromaticity
- Preparation of Benzene

Unit: 1 (B) Electrophilic Substitution Reactions (10 Marks)

Aromatic Electrophilic Substitution Reactions—Mechanism, Orientation and Reactivity

- Introduction
- Mechanism of Electrophilic Substitution Reactions of Benzene
  - Halogenation
  - Nitration
  - Friedel–Crafts Alkylation
  - Friedel–Crafts Acylation
  - Sulfonation
- Orientation and reactivity in monosubstituted
- Benzene: effect of substituents on electrophilic substitution reactions
  - Nature of Groups
  - Effect of Group on the Reactivity
  - Effect of Groups on Orientation
- Orientation in disubstituted benzene

Unit: 2 (A) Halogenated hydrocarbons: Haloalkanes (08 Marks)

- Preparation of haloalkanes
  - By halogenation of alkanes
  - By addition of hydrogen halides to alkenes
  - From alcohols
  - From silver salts of carboxylic acids (Hunsdiecker reaction)
  - From other haloalkanes
- Nucleophilic substitution reactions
- S_N1, S_N2, S_Ni reaction mechanism with stereochemical aspect
- Reactions of haloalkanes
  - Reaction with oxygen nucleophiles
  - Reaction with nitrogen nucleophiles
  - Reaction with carbon nucleophiles
  - Reaction with sulphur nucleophiles
  - Reaction with ambident nucleophiles

- Elimination reactions
  - E1, E2, E1cB reaction mechanism
- Substitution versus elimination

Unit: 2 (B) Halogenated hydrocarbons: Haloarenes (07 Marks)

- Preparation of haloarenes
  - Halogenation of benzene
  - From arene diazonium salts
  - From silver salt of carboxylic acid
- Nucleophilic substitution reactions
  - S_NAr and Benzyne reaction mechanism

Unit: 3 (A) Alcohols and Phenols (8 Marks)

- Monohydric alcohols (alkanols)
- Introduction
  - Physical properties
- Preparation of monohydric alcohols
- Chemical properties of monohydric alcohols
  - Alcohols as an acid as well as base: a general discussion
  - Reactions involving the acidic characteristics of alcohols
  - Reactions involving the basic characteristics of alcohols
  - Reactions involving the entire alcohol molecule
- Polyhydric alcohols (diols and triols)
- Introduction
- Physical properties
- Ethylene glycol [ethane-1,2-diol]
  - Preparations
  - Chemical properties
  - Uses of ethylene glycol
- PINACOLS
  - Preparation of 2,3-dimethylbutane-2,3-diol
  - Pinacol–Pinacolone Rearrangement

- Physical Properties
- Preparations
- Chemical Properties

Unit: 3 (B) Ether and Epoxides (7 Marks)

Ethers

- Introduction
- Physical Properties
- Preparation of ethers
- From Alcohols
- From Halo Compounds
- Alkoxymercuration–demercuration of Alkenes
- Chemical properties of Ethers
- Reactions due to Etheral Oxygen
- Reactions Involving Ether Linkage [Cleavage of Carbon Oxygen Bond]
- Other Reactions
- Common Uses of Ethers
- Crown ethers

Epoxides

- Introduction
- Preparation of epoxides
- Chemical properties of epoxides
- General Mechanism for Ring Opening in Epoxides
- Ring Opening in Unsymmetrical Epoxides

Unit: 4 Polynuclear hydrocarbon (10 Marks)

- Nomenclature
- Structure and synthesis of Naphthalene and its derivatives (Haworth method, Friedel Craft acylation, Diels Alder reaction, Elbs reaction and Pschorr Synthesis)
- Properties: Physical properties, discussion on the following reaction (with mechanism) for Naphthalene, Anthracene and Phenanthrene:

- Oxidation, Electrophilic substitution- Friedel Craft reaction, Chloromethylation,
- Halogenation, Formylation, Nitration and Sulphonation.
- Reduction reaction and Diels Alder reaction.

Reference Books

1. Morrison, R. N.; Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education)
2. Finar, I. L. Organic Chemistry (Volume 1& 2), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Mehta Bhupinder ; Mehta Manju ; Organic Chemistry , PHL Learning Private Limited ; Second
4. Kalsi P S ; Oza R S ; Organic Reactions : Stereochemistry and Mechanism , New Age International Publication

110390302 Major-2 Physical Chemistry-1
Credits: 4

Course Objectives:

- Study the structure, properties of liquids, and ionic equilibria, including ionization and buffer solutions.
- Understand colligative properties, Raoult's law, osmotic pressure, and their applications.
- Learn electrochemical cells, electrode potential, Nernst equation, and emf applications.
- Explore polymerization methods, polymer types, and properties of colloidal systems.

Course Outcomes:

CO1: Understand the liquid state, its properties, and various ionic equilibria concepts.

CO2: Apply colligative properties to determine molecular weights and understand activity/activity coefficients.

CO3: Explore electrochemistry, electrochemical cells, electrode potentials, and applications of EMF measurements.

CO4: Understand polymer classification, polymerization types, and properties of colloidal systems.

Unit: 1 (A) Liquid State (05 Marks)

- Qualitative treatment of the structure of the liquid state
- Physical properties of liquids ; vapour pressure, surface tension and coefficient of viscosity, and their determination.
- Effect of addition of various solutes on surface tension and viscosity.
- Explanation of cleansing action of detergents.
- Temperature variation of viscosity of liquids and comparison with that of gases.

Unit: 1 (B) Ionic Equilibria (10 Marks)

- Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water.
- Ionization of weak acids and bases, pH scale, common ion effect.
- Dissociation constants of mono and diprotic acids

- Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts.
- Buffer solutions; derivation of Henderson equation and its applications.
- Solubility and solubility product of sparingly soluble salts – applications of solubility product principle.
- Qualitative treatment of acid – base titration curves (Calculation of pH at various stages).
- Theory of acid–base indicators; selection of indicators and their limitations.
- Numericals based on different terms involved in it.

Unit: 2 Solutions and Colligative Properties (10 Marks)

- Colligative Properties: Dilute solutions
- Lowering of vapour pressure: Raoult's law (Ideal and Non-Ideal Solution)
- Henry's law (Pressure and Solubility Relation)
- Thermodynamic basis of the colligative properties
  - Lowering of vapour pressure
  - Elevation of Boiling Point
  - Depression of Freezing point
  - Osmotic pressure and derivation of expressions for these using chemical potential
- Application of colligative properties
  - Calculating molar masses of normal and abnormal molecular mass
  - Dissociated and associated solutes in solutions (vant's Hoff Factor "i")
- Concept of activity and activity coefficients
- Numerical based on Lowering vapour pressure, Elevation in boiling point, Depression in freezing point, Osmotic pressure, and Vant's Hoff factor.

Unit: 3 Electrochemistry (12 Marks)

- Introduction to Electrochemistry
- Types of Electrochemical Cells
  - Galvanic or Denial Cell (Construction, Working, Cell reaction/representation)
  - Electrolytic Cell (Construction, Working, Cell reaction/representation)

- Reversible and Irreversible Cell (with Proper examples)
- Reversible and Irreversible Electrodes
  - Metal-Metal-ion electrode: (w.r.t. Cations)
  - Amalgam Electrode
  - Redox electrode
  - Metal-Insoluble-salt electrode: (w.r.t. Anions)
  - Gas Electrodes
  - Standard WESTON cell (Cadmium cell)
- Poggendorff's Compensation method (for determining emf of the cell)
- Reference Electrode (Construction, Working, Cell reaction/representation, Electrode potential equation)
  - Standard Hydrogen Electrode (SHE)
  - Calomel Electrode
  - Quinhydrone Electrode
- Derive Nernst's Single Electrode Potential Equation
- Applications of emf measurement to calculate:
  - ΔG, ΔS and ΔH
  - Equilibrium constant K or Keq
  - Solubility and Solubility product of sparingly soluble salt
  - hydrolysis constant of salt
  - Ionic product of water
- Numerical Based on Applications of emf measurement methods.

Unit: 4 (A) Polymer Chemistry (07 Marks)

- Definition: Monomer, Polymer, Polymerization
- Classification of Polymers based on:
  - Source
  - structure
  - mode of polymerisation
  - molecular forces

- Chain polymerization
- Free radical (benzoyl peroxide or acetyl peroxide)
- Ionic polymerization [cationic-Lewis acids or protonic acids and anionic by ammonia]
- Coordination polymerization
- Step polymerization
  - Polycondensation
  - Polyaddition
  - Ring Opening Polymerization-epoxide and caprolactam

Unit: 4 (B) Colloids (06 Marks)

- Colloidal Systems
  - Dispersed phase
  - Dispersed medium
  - Type of system
- Preparation of Colloidal Solutions
  - Physical methods (peptization)
  - Chemical methods
- General Properties of Colloidal Systems
  - Heterogeneous nature
  - Brownian movement
  - Tyndall effect
  - Electrical properties
- Classification of Colloids
  - Based on interaction between phases (lyophobic and lyophilic colloids)
  - Based on molecular forces (macromolecular, multi molecular and associated colloids)
- Purification of Colloidal solution
  - Dialysis
  - Electrodialysis
- Applications of colloidal solutions

Reference Books

1. Peter, A.; Paula, J. de. (2011), Physical Chemistry, 9th Edition, Oxford University Press.
2. Kapoor, K.L. (2015), A Textbook of Physical Chemistry, Vol 2, 6th Edition, McGraw Hill.
3. Puri, Sharma and Pathania, Principles of Physical Chemistry, 42nd Edition, Vishal Publishing Company.
4. 7. Arun Bahl, B S Bahl and G D Tuli, Essentials of Physical Chemistry; S CHAND Publication.
5. Atkins, P.W.; Paula, J.de. (2014), Atkin's Physical Chemistry Ed., 10th Edition, Oxford University Press.

110390303 Major-3 Chemistry Practical-3
Credits: 4

Course Objectives:

- Determine the boiling points of liquid compounds using distillation and capillary methods.
- Purify organic compounds by crystallization using water, alcohol, and alcohol-water mixtures.
- Identify unknown organic substances (solid/liquid) through qualitative analysis, including functional group and elemental identification.
- Estimate the molecular weight of monobasic, dibasic, and tribasic organic acids.
- Estimate the amount of aniline and glucose in given solutions.

Course Outcomes:

CO1: Perform organic qualitative analysis, including boiling/melting point determination and purification by crystallization.

CO2: Quantitatively estimate organic compounds like organic acids, aniline, and glucose.

CO3: Conduct physico-chemical analysis experiments, including enthalpy of neutralization and elevation of boiling point.

CO4: Utilize instruments like pH meter and potentiometer for titrations and property measurements.

Part-1: Organic Qualitative Analysis

Exp : 1 Determination of boiling point of liquid compounds.

Boiling point lower than and more than 100°C by distillation and capillary method.

Exp : 2 Purification of organic compounds by crystallization using the following solvents:

a. Water

b. Alcohol

c. Alcohol-Water

Exp : 3 Qualitative Analysis of Organic substance:

To identify the given unknown organic substance **(Solid/Liquid)** by qualitative analysis comprising nature identification, elemental analysis, functional groups identification and melting point/boiling point. (Minimum six samples will be given)

Part-2: Organic Estimation

Exp : 1 To determine the Molecular Weight of a given monobasic organic acid.

Exp : 2 To determine the Molecular Weight of a given dibasic organic acid.

Exp : 3 To determine the Molecular Weight of a given tribasic organic acid.

Exp : 4 To determine the amount of aniline in the given solution.

Exp : 5 To determine the amount of glucose in the given solution.

Part-3: Physico-Chemical Analysis

Exp : 1 Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide.

Exp : 2 To study the effect of concentration of solute on elevation of boiling point of water.

Exp : 3 To study the elevation in boiling point on adding same concentrations of electrolyte and nonelectrolyte to a specific volume of water.

Exp : 4 To determine the partition co-efficient of benzoic acid between benzene and water.

Exp : 5 Study the variation of surface tension with different concentration of detergent solutions by (i) drop number (ii) drop weight method using Viscometer.

Exp : 6 Study the variation of surface tension with different concentration of detergent solutions by Stalagmometer.

Part-4: Instruments

pH meter

Exp : 1 Preparation of buffer solutions of different pH values and comparison of pH value with Standard Buffer solution.

- Sodium acetate-acetic acid
- Ammonium chloride-ammonium hydroxide

Exp : 2 Find out pH value of Fruit juice, Soap Solution and Shampoo.

Exp : 3 pH metric titration of strong acid with strong base.

Potentiometer

Exp : 4 Perform the potentiometric titration: Strong acid vs. strong base or weak acid vs. strong base.

Exp : 5 Perform the potentiometric titration: Potassium dichromate vs. Mohr's salt.

Reference Books

1. Khosla, B.D.; Garg, V.C.; Gulati, A. (2015), Senior Practical Physical Chemistry, R. Chand & Co, New Delhi.

2. Garland, C. W.; Nibler, J. W.; Shoemaker, D. P. (2003), Experiments in Physical Chemistry, 8th Edition, McGraw-Hill, New York

3. Kapoor, K.L. (2019), A Textbook of Physical Chemistry, Vol.7, 1st Edition, McGraw Hill Education.

4. J. B. Yadav, “Advanced Practical Physical Chemistry”: Krishna Prakashan, Meerut, 29th Edition, 2010.

5. P. H. Parsania, “Experiments in Physical Chemistry”: Neminath Printers Rajkot 1st Edition 2004.

6. Mann, F. G.; Saunders, B. C. (2009), Practical Organic Chemistry, Pearson Education.

7. Ahluwalia, V.K.; Dhingra, S. (2004),Comprehensive Practical Organic Chemistry: Qualitative Analysis, University Press.

8. Leonard, J.; Lygo, B.; Procter, G. Advanced Practical Organic Chemistry, CRC Press.

9. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R.(2012),Vogel's Textbook of Practical Organic Chemistry, Pearson.

110392304 MDC-1
Astrophysics and Nuclear Physics Credits: 2

Course Objectives

To enable learners to understand basic tools of observational techniques in Astrophysics study various types of nuclear detectors

Course Outcomes:

CO1:. Understand the basic concepts of observational astronomy, including types of telescopes, stellar magnitudes, distances, and motions of stars.

CO2:. Explain the working principles of nuclear detectors and particle accelerators, and their applications in studying subatomic particles and nuclear interactions.

UNIT – I: ASTROPHYSICS

Astronomical Instruments

Light and properties, The Earth's atmosphere and the electromagnetic radiation, Optical telescopes, Radio telescopes, The Hubble space telescope, Astronomical spectrographs, Photographic photometry

Magnitudes, Motions and Distances of Star

Stellar magnitude sequence, Absolute magnitude and distance modulus, The bolometric magnitude, Different magnitude standards: The UBV system and six colour photometry, Radiometric magnitudes, The colour index of a star, Luminosities of stars, Stellar parallax (Trigonometric) and the units of stellar distances, Stellar positions: The stellar coordinates, Stellar motions

UNIT – II: NUCLEAR PHYSICS

Physical Tools

Introduction, Interaction between particles & Matter, brief survey, Detectors for Nuclear particles (i) Proportional counter (ii) The Geiger counter (iii) Scintillation counter (iv) Solid state or semi-conductor detectors (v) Cloud & Bubble chambers (vi) Spark chamber

Particle Accelerators

Need for an accelerator of charged particles, (i) Van de Graff Generator (ii) The cyclotron (iii) Synchrotron (iv) The Betatron, Beta ray spectrometer

Reference Books

1. An Introduction to Astrophysics (2nd Edition, Articles 1.1 to 1.7; 3.1 to 3.10) by Baidyanath Basu, Tanuka Chattopadhyay & Sudhindra Nath Biswas. PHI Learning Pvt. Ltd., 2010.
2. Astrophysics for Physicists by Arnab Rai Choudhuri. Cambridge University Press, 2010.
3. Nuclear Physics: An Introduction (Articles 1.1.1 to 1.1.5) by S. B. Patel. New Age International (P) Ltd., 1991.
4. Nuclear Physics by D. C. Tayal. Himalaya Publishing House, 2003.

110392305 MDC-2 Statistics
Credits: 2

Learning Objectives:

In this paper, our objective is to develop a positive attitude toward statistics and to understand its practical applications in life. One will be able to analyse the given data and then further doing the interpretation of the data and draw conclusions from the analyses.

Course Outcomes:

CO1: Understand basic concepts of statistics, data organization, and graphical representation.

CO2: Calculate measures of central tendency and dispersion for data analysis.

Unit 1: Basic Statistics

- Measures of Central tendency: Arithmetic mean, median, mode, geometric mean, harmonic mean.
- Partition values: Quartiles, Deciles and percentiles.
- Measures of Dispersion: Range, mean deviation, quartile deviation, standard deviation and variance.
- Moments, Skewness and kurtosis.

Unit 2: Correlation, Regression and Curve fitting

- Correlation: definition, types of Correlation, Karl Pearson coefficient of Correlation, rank Correlation.
- Regression: definition, Lines of Regression, Regression coefficients and its properties.
- Curve fitting: Curve fitting of a straight-line, second-degree polynomial.

Reference Books:

1. S.C. Gupta and V.K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand and sons Publication.
2. D. C. Montgomery and G. C. Runger, Applied Statistics and Probability for Engineers, Wile

3. J. L. Devore, Probability and Statistics for Engineering and the Sciences, Cengage Learning.
4. S. Ross, A First Course in Probability, 6th Ed., Pearson Education India
5. Kapur J.N. and Saxena H.C., Mathematical Statistics, S. Chand & Company Ltd.
6. Kachot K.R., Numerical & Statistical methods, Mahajan Publishing House.

110393306 SEC Basics of Nanotechnology Credits: 2

Course Objectives:

- Understand the fundamental concepts and principles of nanoscience and nanotechnology.
- Gain knowledge about the historical development and current trends in the field.
- Learn about different types of nanomaterials, including nanoparticles, nanowires, nanotubes, and thin films.
- Study the methods of synthesis and fabrication of nanomaterials.

Course Outcomes:

CO1: Understand the foundational principles of nanotechnology, including atomic-scale structure, quantum mechanical concepts, and crystal geometry relevant to nanoscale materials.

CO2: Explain the origin, classification, and physical significance of various nanomaterials, quantum structures, and confinement effects, with applications in modern nanoscience.

Unit 1:

Background to Nanotechnology: Scientific revolution, molecular and atomic size, emergence of Nanotechnology, Challenges in Nanotechnology, Carbon age :(new forms of carbon graphene sheet to CNT)

Introduction to Quantum Mechanics & Crystal structure De-Broglie hypothesis, Uncertainty Principle, Schrödinger Equation, Operator, Particle in a 1D box, Particle in a 3D box (qualitative), Crystal structure, Crystal orientation, Crystal planes, Bravais lattice, Miller Indices, Atomic Packing Density, crystal symmetry, ZnS, Diamond and NaCl crystal structure, Melting point, Coordination number, Atomic Bonding.

Unit 2:

Introduction to Nanoscience Emergence of Nanoscience with special reference to Feynman and Drexler, Role of particle size, Spatial and temporal scale, Exciton, Concept of confinement, strong and weak confinement with suitable examples, Development of quantum structures, Basic concept of quantum well, quantum wire and quantum dot. Density of states of 1D, 2D & 3D structure, surface effect.

Types of Nanomaterials Nanoclusters, Solid solutions, Thin film, Nanocomposites (Metal Oxide and Polymer based), Core Shell Nanostructure, Buckyballs, Carbon nano tubes and, Zeolites minerals, Dendrimers, Micelles, Liposomes, Block Copolymers, Porous Materials, Metal Nanocrystals, Semiconductor nanomaterials.

Reference Books

1. **Material Science & Engineering – An Introduction** (9th Edition, 2014) by William D. Callister Jr. Wiley.
2. **Nanoscale Materials** (1st Edition, 2003) by Luis M. Liz-Marzán & Prashant V. Kamat. Springer.
3. **Introduction to Nanotechnology** (1st Edition, 2003) by Charles P. Poole Jr. & Frank J. Owens. Wiley-Interscience.
4. **Nanotechnology: Basic Science and Emerging Technologies** (1st Indian Edition, 2008) by M. Wilson, K. Kannangara, G. Smith, M. Simmons & B. Raguse. Overseas Press India Pvt. Ltd., New Delhi.
5. **The Chemistry of Nanomaterials: Synthesis, Properties & Applications** (1st Edition, 2004) by C. N. R. Rao & A. Müller. Wiley-VCH.
6. **Nanostructures and Nanomaterials: Synthesis, Properties and Applications** (2nd Edition, 2011) by Guozhong Cao. Imperial College Press.
7. **Handbook of Nanostructured Materials & Nanotechnology: Optical Properties** (Vol. 4, 1st Edition, 2000) by Hari Singh Nalwa. Academic Press.
8. **Nano Fabrication Towards Biomedical Applications** (1st Edition, 2005) by C. S. S. R. Kumar, Wonbong Choi & Jo-won Lee. Wiley-VCH Verlag GmbH & Co., Weinheim.

110394307 AEC Effective Communication Skill
Credits: 2

Course Outcomes:

CO1: Demonstrate effective written communication by composing analytical paragraphs, professional emails, and academic texts with appropriate structure, clarity, and citation practices.

CO2: Apply verbal and non-verbal communication strategies to deliver structured oral presentations and speeches, incorporating audience analysis and appropriate use of audio-visual aids

Unit 1 Corporate Communication

1. **Communication Style Matrix**
   a. Direct Communication Style
   b. Spirited Communication Style
   c. Systematic Communication Style
   d. Considerate Communication Style
2. **E-mail etiquette**
   a. Learning to make attachments in mail and downloading and uploading files
   b. Dos and Don'ts of Personal and Professional mail
3. **Analytical Paragraph**
   a. The ability to describe, analyze, compare and evaluate given data

Unit 2 Dynamics of Communication Sills

1. **Listening Skills**
   a. Barriers of effective listening:

Cultural barrier, Psychological barrier, Linguistic barrier, Physical barrier, Organizational barrier

2. **Reading Skills:**
   a. Understanding the content of a Book:

First page details, Publication details, Copyright information, Index, References and Bibliography

3. **Writing Skills:**
   a. Academic writing: The ability to write a research-based article
   b. Creating Bibliography: The ability to do in-text citation as well as creating a citation list
4. **Speaking Skills**
   a. Preparing a speech: Self-introduction, Logical coherence, Topic and Audience

b. Oral Presentation: Audio - Visual aids, preparing materials, language, stage movement, hand movement, eye contact, overall personality, handling the audience

Activities:

1. Owner and Auction

2. Best Advertisement competition
3. Match the sound
4. Elocution competition

Reference Books

1. Soft skills and professional communication, Francis Peters SJ, 1stEdition, McGraw Hill Education, 2011
2. Developing your influencing skills, Deborah Dalley, Lois Burton, Margaret, Greenhall, 1st Edition Universe of Learning LTD, 2010
3. Middle School English Grammar and Composition by Wren & Martin
4. Business Communication by Meenakshi Raman, Prakash Singh
5. English at Workplace by Macmillan Publications
6. Basic communication skills for Technology, Andreja. J. Ruther Ford, 2nd Edition, Pearson Education, 2011
7. The Ace of Soft Skills: Attitude, Communication and Etiquette for success, GopalaSwamy Ramesh, 5th Edition, Pearson, 2013
8. Developing your influencing skills, Deborah Dalley, Lois Burton, Margaret, Greenhall, 1st Edition Universe of Learning LTD, 2010

110395308 VAC Climate Change
Credits: 2

Course Objectives:

- Understand the concepts of global warming, climate change, and the evolution of Earth's atmosphere.
- Study the impacts of climate change on weather patterns, agriculture, biodiversity, and human health.
- Learn about ozone layer depletion, its causes, effects, and mitigation measures.
- Explore environmental policies, international agreements like the Montreal and Kyoto protocols, and climate change mitigation strategies.

Course Outcomes:

CO1: Understand the basics of climate and weather systems, including Earth's energy balance.

CO2: Identify causes of climate change, both natural and anthropogenic, and their impacts.

Unit: 1. Introduction to Climate Change and its Impacts

- Global warming and climate change Evolution and development of Earth's atmosphere; atmospheric structure and composition.
- Significance of atmosphere in making the Earth, the only biosphere.
- Trends of global warming and climate change; drivers of global warming and Global Warming Potential (GWP) & climate change.
- Impact of climate change on atmosphere, weather patterns, sea level rise, agricultural productivity and biological responses - range shift of species, **CO2:** fertilization and agriculture.
- Impact on economy and spread of human diseases.

Unit: 2. Policies and Mitigation

- Ozone layer depletion, environmental policy & agreements Ozone layer or ozone shield.
- Importance of ozone layer; ozone layer depletion and causes; Chapman cycle.
- Process of spring time ozone depletion over Antarctica.
- Ozone depleting substances (ODS); effects of ozone depletion.
- Mitigation measures and international protocols. Environmental policy debate.
- International agreements; Montreal protocol 1987; Kyoto protocol 1997.
- Convention on Climate Change; carbon credit and carbon trading; clean development mechanism.

Reference Books

1. Barry, R. G. 2003. Atmosphere, Weather and Climate. Routledge Press, UK.

2. Gillespie, A. 2006. Climate Change, Ozone Depletion and Air Pollution: Legal Commentaries with Policy and Science Considerations. Martinus Nijhoff Publishers.
3. Manahan, S.E. 2010. Environmental Chemistry. CRC Press, Taylor and Francis Group.
4. Maslin, M. 2014. Climate Change: A Very Short Introduction. Oxford Publications.
5. Mathez, E.A. 2009. Climate Change: The Science of Global Warming and our Energy Future. Columbia University Press.
6. Mitra, A.P., Sharma, S., Bhattacharya, S., Garg, A., Devotta, S. &Sen, K. 2004. Climate Change and India. Universities Press, India.
7. Philander, S.G. 2012. Encyclopedia of Global Warming and Climate Change (2nd edition). Sage Publications.

B.Sc. Chemistry Semester 4

110390401 Major-1 Inorganic Chemistry-1
Credits: 4

Course Objectives:

- Study properties of s- and p-block elements.
- Explore transition elements and their complexes.
- Understand quantum mechanics in chemistry.
- Learn metallurgical principles and techniques.
- Apply theoretical concepts to practical uses.

Course Outcomes:

CO1: Understand properties and reactivity of s- and p-block elements.

CO2: Explore characteristic properties and complexes of d-block transition elements.

CO3: Comprehend the chemistry of f-block elements, including lanthanides and actinides.

CO4: Understand basic quantum mechanics principles as applied to atomic and molecular systems.

Unit: 1 Chemistry of s and p block elements

- Inert pair effect
- Relative stability of various oxidation states
- Diagonal relationship and anomalous behaviour of first member of each group
- Allotropy and catenation
- Complex formation tendency of s and p block elements
- Hydrides and their classification
- Basic beryllium acetate and nitrate
- Study of the following compounds (structure, bonding, preparation, properties and
- applications:

- Boric acid and borates, diborane, boron nitride
- Carboranes and graphitic compounds
- Silanes, oxides and oxoacids of nitrogen, phosphorus and chlorine
- Peroxo acids of sulphur, interhalogen compounds, polyhalide ions, pseudohalogens and basic properties of halogens

Unit: 2 Chemistry of Transition Elements

- Characteristic properties of d-block elements.
- General characteristics of Elements of first, second and third Transition Series:
  - Electronic Configuration and Variable Oxidation States.
  - Complex Formation Tendency
  - Magnetic Behaviour, Formation of Coloured Ions/Compounds and Catalytic Activity
  - Periodic Properties and Their Variation along the Series
- Binary compounds (hydrides, carbides and oxides) of the elements of the first transition series and complexes with respect to relative stability of their oxidation states, Coordination number and geometry.
- Comparative treatment of Zr/Hf, Nb/Ta, Mo/W in respect of ionic radii, oxidation states, magnetic behaviour, spectral properties.

Unit: 3 Wave-Mechanics

- Basic postulates of quantum mechanics.
- Eigen values and Eigen functions
- Characteristics of the wave functions
- Type of operators: their addition, subtraction and multiplication
- Hamiltonian Operator for H, He, Li, Be, B atoms, H_2 molecule and H_2^+ ion
- Concept of Commutators.
- Particle in a one dimensional box
- Concept of zero point energy
- Electron in a ring

Unit: 4 General Principles of Metallurgy

- Chief modes of occurrence of metals based on standard electrode potentials.
- Ellingham diagrams for reduction of metal oxides using carbon and carbon monoxide as reducing agent.
- Electrolytic Reduction, Hydrometallurgy with reference to cyanide process for silver and gold.
- Methods of purification of metals: Electrolytic process, Van Arkel-De Boer process, Zone refining.

Reference Books

1. J. D. Lee,"Concise Inorganic Chemistry" 5th Ed (1996) Blackwell Science
2. R.D. Madan, "Modern Inorganic Chemistry', S. Chand & Co. Ltd., New Delhi, 2nd Edition
3. Puri, Sharma, Kalia, "Principles of Inorganic Chemistry", Milestone Publishers & Distributors, New Delhi, 3rd Edition.
4. Gurdeep Raj, "Advanced Inorganic Chemistry", Goel Publishing House, Meerut, Volume –I
5. Cotton, F.A., Wilkinson, G., & Gaus, P.L. "Basic Inorganic Chemistry" 3rdEd.; Wiley India.
6. Douglas, B.E. and McDaniel, D.H. Concepts & Models of Inorganic Chemistry, Oxford, 1970
7. Huheey, J. E.; Keiter, E.A. & Keiter, R.L. "Inorganic Chemistry, Principles of Structure and Reactivity" 4th Ed.,
8. Harper Collins 1993, Pearson,2006.
9. Atkins, P.W.; Overton, T.L.; Rourke, J.P.; Weller, M.T.; Armstrong, F.A. (2010), Shriver and Atkins "Inorganic Chemistry", 5th Edition, Oxford University Press.
10. Miessler, G. L. & Donald, A. Tarr. Inorganic Chemistry 4th Ed., Pearson, 2010
11. Sharpe, A.G., Inorganic Chemistry, 4th Indian Reprint (Pearson Education) 2005.

110390402 Major-2 Analytical Chemistry-1 Credits: 4

Course objectives:

The objective of this course is to make students aware about the importance and the concepts of qualitative and quantitative analysis, to learn about Accuracy, precision of Analytical data, Acid-Base and redox titration, and pH/Conductometry.

Course Outcomes:

CO1: Understand basic principles of qualitative and quantitative analysis, including titration.

CO2: Analyze and minimize errors, and apply statistical tests for accuracy and precision.

CO3: Perform acid-base and redox titrations, determining endpoints through different methods.

CO4: Conduct pHmetry and conductometry experiments using various electrodes and conductance

Unit: I [A] Basic concepts of Qualitative and Quantitative Analysis

- Introduction
- Solubility product principle
- Common ion effect
- Separation of cations of each groups
- Test and separation of acid radicals anions
- Introduction of volumetric titration:
    i. End point, Equivalent point and Indicator
    ii. Use of primary and secondary standard and apparatus
    iii. Calculation based on Normality and Molarity of the solution
- Conditions for volumetric analysis and types of titrimetric analysis
- specific gravity of solutions

UNIT: 2 Errors and treatment of Analytical data

- Significant figures
- Accuracy and precision
- Types of errors and minimization of errors

- Ways of expressing accuracy and precision:
    i. Methods to Indicate Accuracy
    ii. Method to Indicate Precision
- Rejection of a result
- Significant Test:
    i. Q-Test
    ii. Student t-Test
    iii. F-Test
- correlation coefficient
- Numericals

UNIT: 3 [A] Acid Base Titration

- Theory of acid-base titration
- Types of Titrations
- Ways of locating the end point of an acid-base titration
- Classification Acid-Base Titration:
    i. Titration of strong acid with strong base
    ii. Titration of weak acid with strong base
    iii. Titration of weak base with strong acid
    iv. Titration of weak base with weak acid
- Factors determining the exact form of a pH curve

[B] Redox titration:

- Theory of redox titration,
- Study of redox titration by electrochemical potential method:
    i. British Method
    ii. American Method
- Ways of locating the end point for redox titration:
    i. Visual Method (By using Indicator)
    ii. Electropotential Method (Experimental method)
- Numericals based on Redox Titration

UNIT-4: [A] pHmetry

- Introduction
- Types of indicator electrodes
  - Glass Membrane IE
  - Crystal Membrane IE
  - Polymer Membrane IE
- Reference electrodes
  - Standard Hydrogen Electrode
  - Saturated Calomel Electrode
  - Silver /Silver Chloride Electrode
- Types of titrations

(i) Strong acid against Strong base

(ii) Weak acid against Strong base

(iii) Mixture of acids against Strong base

[B] Conductometry

- Introduction
- Types of conductance
  - Specific Conductance
  - Equivalent Conductance
  - Molar Conductance
- Effect of dilution
- Conductivity cells
- Types of titrations

(i) Strong acid against Strong base

(ii) Weak acid against Strong base

(iii) Mixture of acids against Strong base

Reference Books

1. Dhruba Charan Dash, “Analytical Chemistry”, PHI Learning Pvt. Ltd., New Delhi, 2011.
2. R.A.Day, A.L.Underwood, “Quantitative Analysis”, Prentice-Hall of India Pvt.Ltd., New Delhi, 2004. (Sixth edition)

3. Gary D. Christian, “Analytical Chemistry”, John Wiely & Sons, INC, New York, 1994. (Fifth edition)
4. Fundamentals of Analytical Chemistry: D. A. Skoog, D. M. West and F. J. Holler, 9th Edition, Cengage Learning.
5. Y.Anjaneyulu, K.Chandrasekhar, Valli Manickam, “A Textbook of Analytical Chemistry”, Pharma Book Syndicate, Hyderabad, India, 2006.
6. Instrumental Methods of analysis: (CBS) H.H . Willard, L.L. Mirrit, J.A. Dean

110390403 Major-3 Chemistry Practical-4
Credits: 4

Course Objectives:

- Identify constituents of inorganic salts using semi-micro methods, including group analysis and confirmatory tests.
- Perform inorganic estimations such as the determination of oxalic acid, sodium oxalate, Fe(II), chlorine in bleaching powder, and sodium thiosulphate strength.
- Study the water-soluble and insoluble inorganic salts containing a variety of cations and anions.
- Develop skills in performing titrations and using standardized solutions for inorganic analysis.

Course Outcomes:

CO1: Perform qualitative analysis of inorganic salts, identifying cations and anions using semi-micro methods, group analysis, and confirmatory tests.

CO2: Estimate inorganic compounds such as oxalic acid, Fe(II), chlorine in bleaching powder, and sodium thiosulphate strength through titrations.

CO3: Conduct gravimetric analysis to determine the presence of Fe, Ba, and Al in samples.

CO4: Perform volumetric analysis for determining nitrite, calcium, acetic acid, and aspirin content in samples and assess errors in quantitative analysis.

Inorganic chemistry Practicals

Inorganic Qualitative Analysis

Detection and identification of constituents of given inorganic salt by using semi-micro methods. Inorganic salts composed of two positive and two negative ions to be identified by specific method comprising dry/wet test, original solution preparation, group analysis and confirmative tests. [Minimum 10 samples]

Water Soluble and Insoluble Inorganic salts of following cations and anions:

Cations: K^+, NH_4^+, Mg^{2+}, Ba^{2+}, Ca^{2+}, Sr^{2+}, Fe^{2+}, Fe^{3+}, Al^{3+}, Cr^{3+}, Zn^{2+}, Mn^{2+}, **CO3:**$^+$, Pb^{2+}, Cu^{2+}.

Anions: S^{2-}, SO_4^{2-}, **CO3:**$^{2-}$, PO_4^{3-}, CrO_4^{2-}, Cl^-, Br^-, I^-, NO_3^-, O^{2-}

Inorganic Estimation

Exp : 1 Estimation of oxalic acid and sodium oxalate in a given mixture.

Exp : 2 Estimation of Fe (II) using standardized $KMnO_4$ solution.

Exp : 3 Estimation of chlorine in a sample of bleaching powder Iodometrically.

Exp : 4 To determine the strength of sodium thiosulphate solution by standard copper sulphate solution.

Analytical chemistry Practicals
Gravimetric Analysis

1. Fe as Fe_2O_3
2. Ba as $BaSO_4$
3. Al as Al_2O_3

Volumetric Analysis:

1. Determination of Nitrite by back titration.
2. To determine the amount of calcium in toothpaste.
3. Determination of acetic acid in commercial vinegar by titrating with standard NaOH. Express your results as average ± standard deviation. (Standardization of base must be performed with standard KHP).
4. Estimation of Aspirin from a given tablet and find errors in quantitative analysis. (Standardization of acid must be performed with standard Na_2**CO3:** solution, prepared from dried anhydrous AR grade Na_2**CO3:**)

Reference Books

1. Vogel's "Textbook of Quantitative Chemical Analysis": Pearson Education Ltd. 6th Edition, 2008.
2. Vogel's "Qualitative Inorganic Analysis": Pearson Education Ltd. 7th Edition, 2009.

3. Principles of Instrumental Analysis by DA Skoog, 3rd Edition.
4. Instrumental methods of chemical analysis by GW Ewing.
5. 'Vogel's Textbook of Quantitative Chemical analysis' Revised by G. H. Jeffery, J. Bassett, J. Mendham & R. C. Denney, ELBS (English Language Book Society) Longman. 5th Ed., New York
6. Vogel's Text book of Macro and Semi micro Qualitative Inorganic Analysis, 5/E, Orient Longman Ltd.
7. 'Advanced Practical Inorganic Chemistry' by Gurdeep Raj, 9th Ed., Goel Publishing House, Meerut.

110391404 Minor-1 Physics-3
Credits: 2

Course Objectives:

- understand architectural acoustics
- acquire detailed knowledge on the polarization phenomenon of wave optics
- understand the basic concepts of special theory of relativity

Course Outcomes:

CO1:. Understand the principles of architectural acoustics and the behavior of polarized light, including double refraction and the use of optical devices for polarization analysis.

CO2:. Explain the foundational concepts of special relativity and apply them to phenomena such as time dilation, length contraction, mass-energy equivalence, and relativistic transformations.

Unit 1: Sound and Optics

Sound

Architectural Acoustics, Sabine's formula, Reverberation time-theoretical treatment, Reverberation time of a live room, Reverberation time of a dead room, optimum reverberation time.

Polarization of light & double refraction

Plane polarized light, pictorial representation of light vibrations, method to produce plane polarized light (only names), double refraction or birefringence, geometry of calcite crystal, Optical axis principal section & principal plane, Nicol prism, Parallel & Crossed Nicol prism, Huygen's theory of double refraction in uniaxial crystals, refractive indices for o-rays & e-rays, Polaroids.

Production & Analysis of Polarized light

Introduction, superposition of two plane polarized waves having perpendicular vibrations, The elliptically & circularly polarized light, quarter wave plate, half wave plate, production of plane elliptically & circularly polarized light, detection of plane elliptically & circularly polarized light, systematic analysis of polarized light

Unit 2: Special Theory of Relativity

Postulates of Special Relativity, Time Dilation, Doppler Effect, Length Contraction, Twin Paradox, Electricity and Magnetism, Relativity of mass, Mass and Energy, Massless Particles, Lorentz Transformation, Velocity addition, Michelson-Morley Experiment.

Reference Books

1. A Textbook on Oscillations, Waves & Acoustics (Articles 24.1 to 24.5) by M. Ghosh & D. Bhattacharya. S. Chand Publishers.
2. Optics & Atomic Physics (Articles 10.2 to 10.4, 10.9 to 10.12, 10.14 to 10.16, 10.18, 10.21, 11.1 to 11.17) by Singh & Agrawal. Pragati Prakashan, Meerut.
3. Optics by Ajoy Ghatak. Tata McGraw Hill Publishing Co. Ltd.
4. A Textbook of Optics by N. Subrahmanyam & Brij Lal. S. Chand & Company Ltd.
5. Concepts of Modern Physics (4th Edition, Articles 1.1 to 1.11, Appendix I) by Arthur Beiser. McGraw Hill Publishing Co.
6. Modern Physics by R. Murugeshan & K. Sivaprasath. S. Chand & Company Ltd.

110391405 Minor-2 Physics Practical-3
Credits: 2

Course objectives

To enable the learners to

- understand the physical phenomena and fundamentals of general Physics
- perform experiments in the field of general Physics

Course Outcomes:

CO1:. Perform experiments related to electronics, oscillatory motion, optics, and electrical circuits using appropriate instruments and measurement techniques.

CO2:. Analyze experimental results involving code conversions, semiconductors, and optical properties to understand underlying physical principles and develop problem-solving skills.

List of Practical:

1. IV characteristics of PN junction diode.
2. Resonance pendulum
3. Gray to binary and binary to Gray code conversion
4. Optical lever
5. L by Maxwell's bridge
6. To find band gap of semiconductor material
7. Decimal to BCD conversion and BCD to seven segment decoder
8. C1/C2 by De-Sauty's method
9. To study double refraction in calcite prism.
10. Numerical Study of Oscillatory Motion. (Calculator/computer preferable using Excel)

Reference Books

1. Advanced Practical Physics for Students (9th Edition) by B. L. Worsnop & H. T. Flint. Methuen & Co. Ltd., 1962.
2. B.Sc. Practical Physics (5th Edition) by C. L. Arora. S. Chand & Company Ltd., 2012.
3. Practical Physics (4th Edition) by G. L. Squires. Cambridge University Press, 2001.

110393406 SEC Biostatistics
Credits: 2

Course Outcomes:

CO1: Explain the fundamental concepts, scope, types of data, sampling methods, and tools used in biostatistics, and effectively represent data using textual, tabular, and graphical formats.

CO2: Compute and interpret measures of central tendency (mean, median, and mode) and measures of dispersion (range, variance, standard deviation) for grouped and ungrouped data, and evaluate their merits and limitations in biological data analysis.

Unit 1: Analysis of Biochemical data

- Introduction and scope in biostatistics
- Kinds of data and variables based on nature (numerical discrete continuous, categorical ordinal and nominal)
- Based on source primary and secondary data
- Sampling Methods: Random and Non-Random Methods
- Representation of data: Textual, Tabular, and Graphical Methods
- Tools and software used in Biostatistics.
- Applications of Biostatistics

Unit 2: Central Tendency and Dispersion

- Measurement of central tendency: Mean, Mode, Median, grouped data, ungrouped data; merits and demerits.
- Measures of dispersion: Range, Variance and Standard Deviation of grouped and ungrouped data; merits and demerits

Reference Books

1. Fundamentals of Biostatistics, 2006 – Bernard A Rosner
2. Fundamentals of Biostatistics,5th edition, Khan and Khanum
3. Methods in Biostatistics, 2010, B.K. Mahajan
4. Fundamentals of Biostatistics, 2009 , V.B. Rastogi

5. Research Methodology: Methods and Techniques, 2004, C. R. Kothari

6. Bioinformatics databases, tools and algorithms, O. Bosu & S. K. Thukral

7. Bioinformatics: Sequence and Genome Analysis by Mount D., Cold Spring Harbor Laboratory Press, New York. 2004

8. Introduction to bioinformatics by Teresa K. Attwood, David J. Parry-Smith. Pearson Education. 1999 Old editions

110394407 AEC
Life Skills and Personality Development Credits: 2

Course Outcomes:

CO1: Demonstrate professional grooming, dressing etiquette, and effective interpersonal skills tailored to diverse formal and corporate settings.

CO2: Develop and present well-structured written documents including reports, resumes, and formal letters using appropriate tone, format, and language conventions.

Unit 1 Corporate Communication

1. **Dressing and Grooming Skills**:
   a. To become aware of diverse style of dressing and handling your personality at different occasions
2. **Report Writing:**
   a. The ability to document and explain data obtained through graphs and charts

Unit 2 Dynamics of Communication Skills

1. **Listening Skills**
   a. Feedback: Providing feedback and Appropriate responding
2. **Reading Skills**
   a. Pronunciation: Phonetics- study of speech sound, and learning silence letters
3. **Writing Skills**
   a. CV/ Resume writing: The ability to write an application for a job with a covering letter
   b. Formal Letters: The ability to write a letter of request, complaint, apology, order, etc.
4. **Speaking Skills**
   a. Interview skills: Body language, dressing sense, polite responses, asking the right question in right way, preparation strategy, understanding the organization

Activities:

1. Mock Product designing and selling
2. Act it out
3. Writing Real Letters
4. Mock Interview

Reference Books

1. Letters for All Occasion by A S Myers
2. Spoken English by V. Shasikumar and P V Dhanija
3. Soft skills and professional communication, Francis Peters SJ, 1stEdition, McGraw Hill Education, 2011
4. Developing your influencing skills, Deborah Dalley, Lois Burton, Margaret, Greenhall, 1st Edition Universe of Learning LTD, 2010
5. Middle School English Grammar and Composition by Wren & Martin
6. Business Communication by Meenakshi Raman, Prakash Singh
7. English at Workplace by Macmillan Publications
8. Basic communication skills for Technology, Andreja. J. Ruther Ford, 2nd Edition, Pearson Education, 2011
9. The Ace of Soft Skills: Attitude, Communication and Etiquette for success, GopalaSwamy Ramesh, 5th Edition, Pearson, 2013
10. Developing your influencing skills, Deborah Dalley, Lois Burton, Margaret, Greenhall, 1st Edition Universe of Learning LTD, 2010

110395408 VAC Indic Knowledge System-2 Credits: 2

Objective Of the Course

This course is designed to understand and enhance the holistic understanding of Indian Knowledge System. This course provides the basic understanding of the rich Indian knowledge system and its traditions. The course will introduce to the various ancient Indian Schools and its relevance in contemporary period with the great achievements of IKS to the world. It helps in understanding and analyzing the Ancient Indian knowledge system.

Course Outcomes:

CO1: Describe and interpret the foundational vocabulary, philosophical principles, and textual traditions of Indian Knowledge Systems (IKS), including the methods of studying Shastras and techniques of manuscript preservation.

CO2: Analyze and evaluate the historical contributions of IKS in science & technology, trade, administration, and arts, with experiential understanding through practices such as yoga, mantra chanting, and indigenous technologies.

Unit-1 Understanding of IKS

o Unique aspects of IKS: Idea Vs Ideology, IKS in present perspective

o Vocabulary related to IKS – Dharma, Sanatan, Moksha, Karma etc.

o Science of Sastra

Shruti & Smriti Parampara

Methods to Study Shashtra

Overview of Shastrartha Parampara

o Manuscriptology: Art of preserving Knowledge

Script & Language, Sanskrit Language and it's importance

Manuscripts: It's History, types and Its

preservation Techniques

Famous Manuscript repositories

Unit-2 Contribution of IKS in

o Science & Technology

Astronomy

Encryption Method used in ancient India

Introduction to Yantra Shashtra – Vaimanik

Shashtra

Textile Technologies

Agriculture Technologies

Forest Management and Water management techniques

o Trade & Commerce

Concept of Indic Economy (ArthVyavastha)

Trade and Commerce

o Administration & Governance

Concept Introduction: Indic Administration

Administrative Structure in Ancient India

Niti Sashtra (Law & Orders)

o Fine Art & Performing Art

Performing Art: Bhav, Ras, Types, Process, Famous Literature, Famous Art & Artists

Fine Art: Types, Process, Famous Literature,

Famous Art and Artists

Case Studies Local Art & Tradition

o Experiential sessions

Introduction to Ashtang Yog and practice of Yogasan & Pranayam

Methods of Chanting the Mantra and Chanting Practice

Reference Books

1. Introduction to Indian Knowledge System- Concept and Application by B. Mahadevan, Vinayak Rajat Bhat, Nagendra Pavan R.N.
2. R.M. Pujari, Pradeep Kolhe, N. R. Kumar, 'Pride of India: A Glimpse into India's Scientific Heritage', Samskrita Bharati Publication.
3. 'Indian Contribution to science', compiled by Vijnana Bharati.
4. 'Knowledge traditions and practices of India', Kapil Kapoor, Michel Danino, CBSE, India.

B.Sc. in Microbiology Programme Outcomes (PO)

PO1. Acquire a thorough understanding of fundamental concepts in microbiology, including microbial physiology, genetics, immunology, and pathogenicity.

PO2. Develop practical skills in microbiological techniques, including culturing, staining, microscopy, and biochemical testing.

PO3. Enhance the ability to analyze and interpret scientific data, particularly in the context of microbial research.

PO4. Gain experience in designing and conducting independent research projects, including hypothesis formulation, experimentation, and data analysis.

PO5. Apply critical thinking and problem-solving skills to address complex biological questions and issues related to microbiology.

PO6. Effectively communicate scientific information through written reports, research papers, and oral presentations.

PO7. Work effectively as part of a team in laboratory and research settings, demonstrating leadership, cooperation, and communication skills.

PO8. Understand and adhere to ethical standards in scientific research and professional practice, including issues related to bioethics and biosafety.

PO9. Integrate knowledge from related disciplines such as biochemistry, molecular biology, and environmental science to enhance understanding of microbial processes.

PO10. Foster a commitment to continuous education and professional development to stay abreast of advancements in the field of microbiology.

PSO 1: Demonstrate proficiency in microbiological techniques and laboratory skills, including cultivation, identification, and control of microorganisms, ensuring adherence to safety and ethical standards.

PSO 2: Apply core concepts of microbial physiology, biochemistry, molecular biology, and genetics to analyze microbial processes, perform diagnostic assays, and interpret experimental data relevant to clinical, industrial, and environmental microbiology.

B.Sc. Microbiology Semester-1

110420101 Major-1
Introduction to Microbiology and Microbial Diversity Credits: 4

Objectives

The main aim of studying Introduction to Microbiology and Microbial Diversity is for students to:

- To learn how Van Leeuwenhoek, Spallanzani, Pasteur, Cohn, and Koch contributed to the field of microbiology.
- To impart knowledge of the basic principles of bacteriology, virology, mycology,
- To know about the roles of microorganisms in ecosystems.
- To know about the diverse groups of bacteria and their nomenclature
- Understanding Microscopy will also provide opportunities for a student to develop diagnostic skills in microbiology, including the practical application.

Course Outcomes:

CO1: To enrich students' knowledge and train them in the pure microbial sciences
CO2: To introduce the concepts of application and research in Microbiology o inculcate sense of scientific responsibilities and social and environment awareness
CO3: To help students build-up a progressive and successful career
CO4: To inculcate sense of scientific responsibilities and social and environment Awareness

Unit: 1 (A) History of Development of Microbiology- I

- Development of microbiology as a discipline, Spontaneous generation vs. biogenesis. Contributions of Anton von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming

(B) History of Development of Microbiology- II

- Role of microorganisms in fermentation, Germ theory of disease, Development of various microbiological techniques and the golden era of microbiology, Development of the field of soil microbiology: Contributions of Martinus W. Beijerinck, Sergei N. Winogradsky, Selman A.Waksman Establishment of areas of medical microbiology and immunology through the work of Paul Ehrlich, Elie Metchnikoff, Edward Jenner

Unit: 2 (A) Diversity of Microbial World I- Systems of classification

- Binomial Nomenclature, Whittaker's five kingdom and Carl Woese's three kingdom classification systems, and the inutility. Difference between prokaryotic and eukaryotic microorganisms. Aim and principles of classification, systematic and

taxonomy, concept of species, taxa, strain; conventional, molecular, and recent approaches to polyphasic bacterial taxonomy, evolutionary chronometers,

(B). General characteristics of different groups

- Acellular microorganisms (Viruses, Viroid's, Prions) and Cellular microorganisms (Bacteria, Algae, Fungi, and Protozoa) with emphasis on distribution and occurrence, morphology, mode of reproduction, and economic importance.
- Protozoa: General characteristics with particular reference to Amoeba, Paramecium, Plasmodium, Leishmania and Giardia

Unit 3 : (A). Diversity of Microbial World II- Algae

- History of phycology with emphasis on contributions of Indian scientists; General characteristics of algae including occurrence, thallus organization, algae cell ultrastructure, pigments, flagella, eyespot food reserves, vegetative, asexual, and sexual reproduction.
- Applications of algae in agriculture, Industry, environment, and food.

(B). Fungi

- Historical developments in the field of Mycology include significant contributions of eminent mycologists. General characteristics of fungi include habitat, distribution, nutritional requirements, fungal cell ultra-structure, thallus organization and aggregation, fungal wall structure and synthesis, asexual reproduction, sexual reproduction, and heterokaryosis.
- Economic importance of fungi with examples in agriculture, environment, Industry, medicine, food, biodeterioration, and mycotoxins.

Unit 4 Techniques use to study microorganisms

A) Microscopy
   I) Principles of Microscopy, magnification and resolving power
   II) Light microscopy: Simple and compound microscope, bright field and dark field microscopy
   III) Principles and applications of phase contrast, fluorescent and Electron microscopy
B) Staining
   I) Dyes and stains: Definition, acidic, basic dyes and leuco-compounds
   II) Smear: Fixation, use of mordents, intensifiers and decolourizers
   III) Mechanism of staining, Types of staining: Simple and differential staining

Reference Books

1. Tortora GJ, Funke BR and Case CL. (2008). Microbiology: An Introduction. 9th edition. Pearson Education
2. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms. 14th edition. Pearson International Edition
3. Cappucino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited
4. Wiley J M, Sherwood LM, and Woolverton CJ. (2013) Prescott's Microbiology. 9th Edition. McGraw Hill International.
5. Atlas RM. (1997). Principles of Microbiology. 2nd edition. WM. T. Brown Publishers.
6. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company.
7. Stanier RY, Ingraham J L, Wheelis M L, and Painter P R. (2005). General Microbiology. 5th edition. McMillan.
8. General Microbiology, 5th edition, McMillan.

110420102 Major-2 Microbiology Practical Credits: 4

Course Outcomes:

CO1: Acquire technical skills laboratory equipment, tools, and materials.

CO2: Demonstrate an understanding of laboratory procedures including safety and scientific methods.

CO3: Acquire the complementary skills of collaborative learning and teamwork in laboratory settings.

CO4: Application of knowledge of microscope

List of Practical

1. Microbiology Good Laboratory Practices and Bio Safety.
2. To study the principles and applications of essential instruments (biological safety cabinets, autoclave, incubator, BOD incubator, hot air oven, light microscope, pH meter) used in the microbiology laboratory.
3. Preparation of culture media for bacterial cultivation.
4. Sterilization of medium using Autoclave and assessment for sterility
5. Sterilization of glassware using Hot Air Oven and review for sterility
6. Sterilization of heat-sensitive material by membrane filtration and inspection for sterility
7. Demonstration of the presence of microflora in the environment by exposing nutrient agar plates to air.
8. Study of Rhizopus, Penicillium, and Aspergillus using Permanent slides
9. Study of Spirogyra and Chlamydomonas, Volvox using permanent slides
10. Analysis of the following protozoans using permanent mounts/photographs: Amoeba, Entamoeba, Paramecium, and Plasmodium
11. Preparation of different media: synthetic media BG-11, Complex media-nutrient agar, McConkey agar, EMB agar.
12. Simple staining: Monochrome staining and Negative staining
13. Gram's staining
14. Motility by hanging drop method.

Reference Books

1. Basic Practical Microbiology: A manual
2. Experimental Microbiology Volume 1 by Rakesh J Patel.
3. Basic Practicals of Microbiology Volume 1 By Ankita Patadia and Ami Varia

110421103 Minor-1 Cell Biology
Credits: 2

Course Introduction

- Cell Biology is an essential discipline within the field of biology that explores the structure, function, and behavior of cells, the fundamental units of life. This course provides a comprehensive introduction to the fascinating world of cells, delving into their molecular makeup, intricate processes, and critical roles in living organisms.

Course Objectives:

1. **Understanding Cell Structure:** Explore the diverse cellular structures, organelles, and their functions, from the cell membrane to the nucleus and everything in between.
2. **Cellular Diversity:** Explore the wide variety of cell types found in different organisms and tissues, highlighting their unique adaptations and specialized functions.
   Cellular Processes: Examine the fundamental processes that govern cell life, including cell cycle, cancer, and aging.

Course Outcomes:

CO1: Understanding Cell Structure: Explore the diverse cellular structures, organelles, and their functions, from the cell membrane to the nucleus and everything in between.

CO2: Cellular Diversity: Explore the wide variety of cell types found in different organisms and tissues, highlighting their unique adaptations and specialized functions.

Cellular Processes: Examine the fundamental processes that govern cell life, including cell cycle, cancer, and aging.

Unit: 1. Basic Cell Structure and Functions

- The Cell Theory; Basic structure of cells; Types of cells; Prokaryotic, Eukaryotic, Archaea Differences between prokaryotes and eukaryotes; Differences between plants and animal cells; The organization of cells into tissues; Different types of tissues.

Unit: 2. Structural Components of Cell

- Membrane structure: Singer – Nicholson's Fluid Mosaic Model, Structure and functions of membrane lipids and glycolipids
- Membrane proteins: Carrier protein and Channel proteins
- Nature of Cytosol, Cytoskeleton structures and functions – Microtubules, Microfilaments, Intermediate filaments

Reference Books

1. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley & Sons. Inc.

2. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
3. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). The World of the Cell. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.
4. Lodish H, Berk A, Zipursky SL et al. (2000) Molecular Cell Biology, 4th edition. New York: WH Freeman.
5. Cooper, G. M., & Ganem, D. (1997). The cell: a molecular approach. Nature Medicine.

110421104 Minor-2 Cell Biology Practical
Credits: 2

Course Outcomes:

CO1: Demonstrate proficiency in basic laboratory techniques used in cell biology and bimolecular studies.

CO2: Analyze and interpret experimental data related to the identification and quantification of biomolecules.

List of Practical

1. Study of Various Laboratory Instruments.
2. Preparation of buffers and standard solutions.
3. Thin sectioning and staining of plant tissue.
4. Microscopic study of tissues and organs through sectioning, staining, and examining those sections under a microscope

Reference Books

1. Oser: Hawk's Physiological Chemistry (14th ed)
2. Plummer: An introduction to practical Biochemistry
3. Sheela Sharma: Experiments and Techniques, 2007.
4. Thomas and Schalkhammer: Analytical Biochemistry, 2002
5. Varlery H: Practical Clinical Biochemistry
6. Whatton and McCarty: Experimental methods in Biochemistry
7. Willard and Merrit: Instrumental methods of analysis.

110422105 MDC-1
Fundamentals of Biochemistry Credits: 2

Objective:

- Understand their classification and determine chemical structures.
- Explore enzyme structure, function, and metabolic roles.
- Recognize DNA and RNA as essential biomolecules.
- Study structure, classification, and reactions of Amino acids.
- Essential roles and classification of oils and fats.
- Explore methods for analysing oils, fats, and waxes.
- Understand basic concepts of vitamins and chemical structures of retinol and pyridoxine.

Course Outcomes:

CO1: Studying Fundamentals of Chemistry provides a strong foundation by covering a wide range of skills, from grasping atomic structure principles to applying analytical techniques.

CO2: These skills form the basis for further studies and applications in the field of chemistry.

Unit: 1 (A). Carbohydrates

- Classification of Carbohydrates: Monosaccharides, Disachharides and Polysachharides.
- Detailed Chemical Structure determination of
  - Glucose
  - Fructose
  - Sucrose
  - Maltose
  - Lactose
- Step-up and step-down rection (Killani Fischer synthesis and Ruff's Degradation).
- Enzymes.
- Nucleic Acid.
- Importance of Carbohydrates.

(B). Amino Acids

- Introduction
- Classification of Amino acids.
- Types of Amino acids.
- **Physical Properties of Amino acids**
  - Zwitter ion
  - Isoelectronic point
- **Synthesis of Amino acids**
  - Strecker's Synthesis

- Gabriel phthalimide synthesis
- Phthalimido malonic ester synthesis

- Chemical Reactions of Amino acids.
- Peptide and Polypeptide bond.

Unit: 2 (A). Oil , Fats and Waxes

- **Fats and Oils**
- Introduction
- Distinction between Oils and Fats.
- Properties.
- Classification
- **Waxes**
  - Introduction
  - Classification of waxes.
  - Properties.
  - Some common waxes
- **Analysis of Oils, Fats and Waxes**
  - Saponification value
  - Acid value
  - Iodine value
  - Reichert – Meissl value

(B). Vitamins

- Introduction.
- Classification and Nomenclature of Vitamins.
- Vitamin Activities.
- **Structure and Biochemistry of:**
  - Vitamin – A1 (Retinol)
  - Vitamin – B6 – (Pyridoxine)

Reference Books

1. Fundamental of Biochemistry by Dr. A C Deb , 4th Edition , New Central Book Agency .
2. Biochemistry by U. Satyanarayan and U. Chakrapani , 6th Edition , Elsevier Health Sciences.
3. Mehta Bhupinder ; Mehta Manju ; Organic Chemistry , PHL Learning Private Limited ; 2nd edition

110422106 MDC-2
Fundamentals of Biochemistry Practical Credits: 2

Course Outcomes:

CO1: Perform and interpret qualitative tests to identify different types of carbohydrates.

CO2: Analyze proteins and amino acids through specific colorimetric tests.

List of Practical:

1. Qualitative analysis of monosachharide by benedicts and barfoed test
2. Qualitative analysis of disachharides by Molisch and saliwanoff test
3. Qualitative analysis of pentose sugar by Bial's test.
4. Qualitative analysis of starch by Iodine test
5. Qualitative analysis of protein by Biuret test
6. Qualitative analysis of protein by xanthoproteic test.
7. Qualitative analysis of aromatic amino acid by glyoxylic and Ehrlich's test

Reference Books

1. A Level Biology Revision, https://alevelbiology.co.uk
2. https://ncert.nic.in
3. Experimental volume 1 and 2 by Rakesh Patel

110393107 SEC Environmental Audit
Credits: 2

Objective:

The key objective of an environmental audit is to:

- Determine the performance of the existing environmental management system in place and its instrumentality.
- To identify which environmental management practices are working effectively.
- Verify compliance with the relevant laws and regulations.

Course Outcomes:

CO1: Understand the overview, objectives, and importance of environmental auditing.
CO2: Identify different types of environmental audits and their advantages.

Unit: 1. Environmental Audit Scheme

Introduction to Environmental Audit
Overview of environmental auditing
Importance of an environmental auditor
The objective of environmental auditing
Objectives
Performance analysis of available environmental management systems
Compliance measures
Types of Environmental Audits
Types of pollution applicable for environmental auditing
Environmental compliance audits
Environmental management audits
Functional environmental audits
Advantages of Environmental Auditing
Benefits of an environmental audit
Limitations of an environmental audit

Unit: 2. Auditors and their roles and responsibilities

Environmental Auditor Do
Responsible for examining and reviewing the company's environmental policies.
Plan audit methodology and procedures
Requirements to become an Environmental Auditor
Environmental Professional – Compliance Environmental Auditor (EPCEA)
Environmental Professional – Environmental Management Systems Auditor (EPEMSA)
Certified Environmental Auditor (CEA)
Duties of Environmental Auditors
Regular auditing of all environmental policies and procedures
How environmental compliance is being handled.
Steps to carry out Environment Audit

Pre–Audit Phase
Audit Phase
Post Audit Phase

References

1. Guidelines of GPCB
2. Guidelines of CPCB
3. Details Regarding Environment Audit
   https://gpcb.gujarat.gov.in/webcontroller/viewpage/details-regarding-environment-audit
4. Environment Audit Scheme
   https://www.scribd.com/document/332051048/Environment-Audit-Scheme
5. Guide on Environmental Audit:
   http://kb.icai.org/pdfs/PDFFile5b28e322df0fd2.63902464.pdf

110394108 AEC
English and Communication Skills Credits: 2

Objectives

- The course aims at inculcating a proficient level of language competency in English among students of B.Sc.
- The objective is to introduce students to Communication as a subject and its foundational theoretical concepts.
- This knowledge will help them handle various day to day situations, both in personal as well as professional world, proficiently.
- The goal is to introduce them to the basics of reading, writing, listening, and speaking communication skills.
- The main objective is to sensitize them to the nuances of basic English communication and its application for various business communication.

Course Outcomes:

CO1: Demonstrate an understanding of communication processes and apply effective communication and business etiquette in workplace and meeting scenarios.

CO2: Develop core communication skills — listening, reading, writing, and speaking — to effectively interpret, analyze, and convey information in professional and social contexts.

Unit 1 Effective Business Communication

1. Communication Skills
   a. Introduction to communication and its importance
   b. Process of Communication
2. Business Etiquette
   a. Importance of business communication and etiquettes
   b. Learning the critical aspects pertaining to workplace etiquette
3. Note-making:
   a. The ability to comprehend the gist, make drafts and concise content

Unit 2 Developing Communication Skills

1. Listening Skills
   a. Ideal process of listening and types of Listening
   b. Effective or Active Listening and techniques to become an active listener
2. Reading Skills
   a. Introduction to reading skills: Introduction and types of reading skills
   b. Comprehension Passage: Reading purposefully and understanding what is read, drawing conclusions, findings and analysis
3. Writing Skills:
   a. Translation and interpretation from Gujarati to English: Basic grammar including parts of speech and sentence structure

4. Speaking Skills
    a. Social communication: Making a request, seeking permission or information, placing and receiving an order, accepting an invitation, giving direction, lecture discussion

Activities:

1. Bring Stories to life
2. Reading photographs
3. I Spy with Words
4. Role Play

Reference Books

1. Middle School English Grammar and Composition by Wren & Martin
2. Business Communication by Meenakshi Raman, Prakash Singh
3. Business English by Pearson Publications
4. English at Workplace by Macmillan Publications
5. Basic communication skills for Technology, Andreja. J. Ruther Ford, 2nd Edition, ++Pearson Education, 2011
6. The Ace of Soft Skills: Attitude, Communication and Etiquette for success, GopalaSwamy Ramesh, 5th Edition, Pearson, 2013
7. Developing your influencing skills, Deborah Dalley, Lois Burton, Margaret, Greenhall, 1st Edition Universe of Learning LTD, 2010

110395109 VAC National Service Scheme (NSS) Credits: 2

Objectives:

The key objectives of studying NSS is to:

- Sensitize the members of National Service Society (NSS) to advocate the motto of NSS "service before self"
- Encourage the members of NSS to undertake any activity or engage in activities reflecting the motto and spirit of NSS.
- Train members of NSS the importance of offering social service to those in need especially during pandemic crisis
- Generate ideas or ways to offer social services or assistance to those in need.

Course Outcomes:

CO1: Understand the history, objectives, and organizational structure of NSS.

CO2: Sensitize to the NSS motto "service before self" and encourage social service activities.

Unit: 1. Introduction of National Service Scheme

History and its Objectives.

Organizational structure of N.S.S. at National, State, University and College Levels.

Advisory committee and their functions with special reference to college principal, Programme officer, N.S.S. group leader and N.S.S. volunteers in the implementation.

Unit: 2. National Integration & Special Programme

Need of National integration.

Various obstacles in the way of National Integration; such as caste, religion, language and provisional problems etc.

- Legal awareness
- Health awareness
- First-aid
- Career guidance
- Leadership training - cum - Cultural Programme
- Globalization and its Economic Social Political and Cultural impacts.

References

1. National Service Scheme Manual, Government of India
2. Training Programme on National Programme scheme, TISS.
3. Orientation Courses for N.S.S. Programme officers, TISS.
4. Case material as Training Aid for field workers, Gurmeet Hans. 5. Social service opportunities in Hospitals, Kapil K. Krishan, TISS. 6. Social Problems in India, Ram Ahuja.

B.Sc. Microbiology Semester-2

110420201 Major-1 Bacteriology
Credits: 4

Objectives

- The main aim of studying Bacteriology is for students to:1. To requisite knowledge about the structural characteristics of bacteria.
- Students will understand the structures and purposes of basic components of prokaryotic cells, especially macromolecules, membranes, and organelles, Students will also understand how these cellular components are used to generate and utilize energy in cells.
- To provide the students with a basic fundamental knowledge of how microorganisms grow and react with specific types of growth media and their biochemical reactions with media used in identification.

Course Outcomes:

CO1: Describe the structure and function of various bacterial cell components including surface appendages, surface layers, cytoplasmic organelles, and bacterial endospores.

CO2: Explain the nutritional requirements of bacteria and demonstrate the preparation and use of different types of culture media for the cultivation and growth of bacteria.

CO3: Illustrate the principles of microbial control and evaluate the effectiveness of physical and chemical agents in controlling microbial growth.

CO4: Compare the characteristics, ecological roles, and economic significance of important groups of Archaebacteria and Eubacteria.

Unit: 1 (A) Structure of typical bacterial cell

- Surface appendages:
  1. flagella
  2. pili and fimbriae
  3. Prosthecae and stalks
- Surface layers:
  1. Capsule and slime layer
  2. Cell wall
  3. Cytoplasmic membrane and mesosomes

(B) Cytoplasm and cell organelles:

- Cytoplasm

- Ribosome
- Nuclear material and Plasmid
- Cellular reserve food material
- Bacterial endospore: Spore structure, Sporulation and Spore germination

Unit: 2 (A) Introduction to Bacterial nutrition

- Nutritional diversities in bacteria
- Nutritional requirements of bacteria

(B) Culture media

- Principles of media formulation
- Media ingredients
- Types of media
- Cultivation methods of bacteria, Growth characteristics in broth and solid media

Unit 3 (A) Principles of Microbial control

- General principles: Control by killing, inhibition and removal.
- Physical agents of microbial control:
- Heat
- Radiation
- Osmotic pressure
- Filtration

(B) Chemical agents of microbial control

- Ideal antimicrobial agent, Major groups of antimicrobial agents:
- Phenols
- Halogens
- Surfactants
- Alcohols
- Heavy metals
- Gaseous agents

Unit 4 Important archaeal and eubacterial groups

- Archaebacteria: General characteristics, phylogenetic overview, genera belonging to Nanoarchaeota (Nanoarchaeum), Crenarchaeota (Sulfolobus, Thermoproteus) and Euryarchaeota [Methanogens (Methanobacterium, Methanocaldococcus), thermophiles(Thermococcus, Pyrococcus,Thermoplasma), and Halophiles (Halobacterium, Halococcus)].
- Eubacteria: Morphology, metabolism, ecological significance and economic importance of Gram positive and gram-negative bacteria.

Reference Books

1. Tortora GJ, Funke BR and Case CL. (2008). Microbiology: An Introduction. 9th edition. Pearson Education
2. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms. 14th edition. Pearson International Edition

3. Cappucino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited
4. Wiley J M, Sherwood LM, and Woolverton CJ. (2013) Prescott's Microbiology. 9th Edition. McGraw Hill International.
5. Atlas RM. (1997). Principles of Microbiology. 2nd edition. WM. T. Brown Publishers.
6. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company.
7. Stanier RY, Ingraham J L, Wheelis M L, and Painter P R. (2005). General Microbiology. 5th edition. McMillan.
8. GeneralMicrobiology.5th edition. McMillan.

110420202 Major-2 Bacteriology Practical
Credits: 4

Course Outcomes:

CO1: Demonstrate the preparation and use of various synthetic, complex, and specialized media for the cultivation of aerobic and anaerobic bacteria.

CO2: Perform and interpret different cultivation techniques for bacterial growth, including streak plate, spread plate, and pour plate methods, and estimate bacterial population by CFU count.

CO3: Apply various staining techniques for the identification of bacterial cell structures such as endospores, capsules, granules, and acid-fast characteristics.

CO4: Evaluate the effect of different physical factors such as pH, temperature, and osmotic pressure on bacterial growth and practice appropriate methods for microbial culture preservation.

1. Preparation of different media: Synthetic Media, Complex media (Nutrient Agar, McConkey agar).
2. Cultivation methods for bacteria
   - Broth culture
   - Agar slope/slant culture
   - Agar plate method
   - Streak plate method
   - Pour plate method
   - Spread plate method
3. Cultivation of anaerobic bacteria by use of
   - Robertson's cooked meat media
   - Thioglycolate broth
   - Anaerobic jar (Demonstration)
4. Preservation of microbial cultures
   - Periodic sub culturing and storage at refrigeration temperature
   - Preservation in soil (fungi/Azotobacter)
5. Study of pigmented bacteria

- Staphylococcus aureus
- Staphylococcus epidermidis
- Micrococcus luteus
- Serratia marscecens
- Pseudomonas aeruginosa

6. Study of bacterial structure by structural staining
   - Endospore by Dorner's method
   - Cell wall by Dyer's method
   - Capsule by Hiss's method
   - Granule by Albert's method
7. Use of special staining technique to study bacteria
   - Spirochaetes by Fontana's method
8. Study of the effect of various physical agents on the growth of bacteria
   - Effect of pH
   - Effect of temperature
   - Effect of osmotic pressure (NaCl and Sucrose)
9. Acid-fast staining (permanent slide only).
10. Estimation of CFU count by spread plate method/pour plate method.

Reference Books

1. Basic Practical Microbiology: A manual
2. Experimental Microbiology Volume 1 by Rakesh J Patel.
3. Basic Practicals of Microbiology Volume 1 By Ankita Patadia and Ami Varia

110421203 Minor-1 Cell Culture techniques Credits: 2

Course Introduction

Cell culture serves as an incredibly adaptable tool for exploring fundamental scientific and translational research inquiries. Employing cell lines in scientific investigations confers a distinctive advantage due to their uniformity, resulting in heightened data reproducibility. Within this paper, we delve into the fundamentals of establishing a cell culture laboratory for different types of cells and provide essential safety protocols for both lab personnel and the cultivated cells. Additionally, we address the issue of potential microbiological contaminants, detailing methods for prevention and early detection.

Course Objectives:

1. To explain the concept of culturing different microbes.
2. To learn concept of growing plant cells in vitro
3. To apply the concept of growing animal cells in vitro

To explain the concept of cultivating virus and its interactions with different hosts.

Course Outcomes:

CO1: To explain the concept of culturing different microbes., To learn concept of growing plant cells in vitro

CO2: To apply the concept of growing animal cells in vitro. To explain the concept of cultivating virus and its interactions with different hosts.

Unit: 1. General Microbial techniques

- Isolation
- Mixed culture
- Pure culture
- Colony characters
- Anaerobic cultivation
- Principles of staining

Unit: 2. Cultivation of Viruses

- General characteristics
- Nomenclature
- Classification
- Replication
- Cultivation
- Lytic and Lysogeny
- Enumeration
- Applications

Reference Books

1. Wiley J M, Sherwood LM, and Woolverton CJ. (2013) Prescott's Microbiology. 9th Edition. McGraw Hill International.
2. Atlas RM. (1997). Principles of Microbiology. 2nd edition. WM. T. Brown Publishers.
3. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company.
4. Stanier RY, Ingraham J L, Wheelis M L, and Painter P R. (2005). General Microbiology. 5th edition. McMillan.

110421204 Minor-2
Cell Culture techniques Practical Credits: 2

Course Outcomes:

CO1: Perform the isolation of microorganisms from various sources such as human skin, water samples, polluted sites, and sewage, using appropriate microbiological techniques and aseptic procedures.

CO2: Identify and characterize microorganisms, including Gram-negative bacteria and bacteriophages, using staining, cultural, and biochemical methods, and interpret the results accurately.

List of Practical

1. Isolation of microorganisms from human skin.
2. Isolation of microorganisms from water samples.
3. Isolation of microorganisms from polluted Isolation of microorganisms from polluted sites.
4. Identification of Gram-negative bacteria using biochemical kit.
5. Isolation of bacteriophage from sewage samples.

Reference Books

1. Freshney, R.I. (1993) Culture of Animal Cells, A Manual of Basic Technique, 3rd ed., New York: Wiley-Liss.
2. Spector, D., Goldman, R.R., and Leinwand, L.A., eds. (1998) Cells: a Laboratory Manual. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.
3. Drexler, H.G. et al., eds. (1997) DSMZ Catalogue of Human and Animal Cell Lines. 6th ed.
4. Tortora, G. J., Funke, B. R., and Case C. L. (2006). Microbiology, An Introduction, 9 th edition, Pearson/Benjamin Cummings Publishing Co. Inc

110422205 MDC-1 Advanced Biochemistry Credits: 2

Objectives

- Understand their classification and determine chemical structures.
- Explore enzyme structure, function, and metabolic roles.
- Recognize DNA and RNA as essential biomolecules.
- Study structure, classification, and reactions of Amino acids.
- Essential roles and classification of oils and fats.
- Explore methods for analysing oils, fats, and waxes.
- Understand basic concepts of vitamins and chemical structures of retinol and pyridoxine.

Course Outcomes:

CO1: At the end of the course, students will be able to …. Explain thermodynamic systems, properties, Zeroth law of thermodynamics, temperature scales and energy interactions.

CO2: Determine heat, work, internal energy, enthalpy for flow &non-flow process using First and Second Law of Thermodynamics, as well as biomedical importance of carbohydrate and proteins.

Unit: 1 (A) Bioenergetics

- First and second laws of Thermodynamics.
- Definitions of Gibb's Free Energy, Enthalpy, and Entropy and mathematical relationship among them, Standard free energy change and equilibrium constant Coupled reactions and additive nature of standard free energy change,
- Energy rich compounds: Phosphoenolpyruvate, 1,3- Bisphosphoglycerate, Thioesters, ATP.

(B) Carbohydrates

- Sugar derivatives, glucosamine, galactosamine, muramic acid, N- acetyl neuraminic acid,
- Disaccharides; concept of reducing and non-reducing sugars, occurrence and Haworth projections of maltose, lactose, and sucrose,
- Polysaccharides, storage polysaccharides, starch and glycogen. Structural Polysaccharides, cellulose, peptidoglycan and chitin.

Unit: 2 (A) Proteins

Structure and functions of naturally occurring glutathione and insulin and synthetic aspartame, Secondary structure of proteins: Peptide unit and its salient features. The alpha

helix, the beta pleated sheet and their occurrence in proteins, Tertiary and Quaternary structures of proteins. Forces holding the polypeptide together. Human haemoglobin structure.

(B) Enzymes

- Structure of enzyme: Apoenzyme and cofactors, prosthetic group-TPP, coenzyme
- NAD, metal cofactors, Classification of enzymes, Mechanism of action of enzymes: active site, transition state complex and activation energy. Lock and key hypothesis and Induced Fit hypothesis.

Reference Books

1. Fundamental of Biochemistry by Dr. A C Deb , 4th Edition , New Central Book Agency .
2. Biochemistry by U. Satyanarayan and U. Chakrapani , 6th Edition , Elsevier Health Sciences.
3. Mehta Bhupinder ; Mehta Manju ; Organic Chemistry , PHL Learning Private Limited ; 2nd edition
4. Campbell, MK (2012) Biochemistry, 7th ed., Published by Cengage Learning.
5. Campbell, PN and Smith AD (2011) Biochemistry Illustrated, 4th ed., Published by Churchill Livingstone.
6. Tymoczko JL, Berg JM and Stryer L (2012) Biochemistry: A short course, 2nd ed., W.H.Freeman.
7. Berg JM, Tymoczko JL and Stryer L (2011) Biochemistry, W.H.Freeman and Company.
8. Nelson DL and Cox MM (2008) Lehninger Principles of Biochemistry, 5th Edition., W.H. Freeman and Company.
9. Willey MJ, Sherwood, LM & Woolverton C J (2013) Prescott, Harley and Klein's Microbiology by. 9th Ed., McGrawHill.
10. VoetD. and Voet J.G (2004) Biochemistry 3rd edition, John Wiley and Sons.

110422206 MDC-2
Advanced Biochemistry Practical Credits: 2

Course Outcomes:

CO1: Explain the fundamental biochemical concepts including the properties of water, pH, buffers, standard free energy changes, and enzyme kinetics, and perform related numerical calculations and laboratory experiments.

CO2: Demonstrate practical skills in handling laboratory instruments such as micropipettes, perform qualitative analysis of biomolecules, study protein structures using models, and analyze enzyme kinetics parameters like Vmax, Km, and Kcat.

List of Practical

1. Properties of water, Concept of pH and buffers, preparation of buffers and Numerical problems to explain the concepts.
2. Handling of micropipettes and checking their accuracy.
3. Standard Free Energy Change of coupled reactions.
4. Qualitative tests for carbohydrates, reducing sugars, non-reducing sugars.
5. Qualitative tests for lipids and proteins.
6. Study of protein secondary and tertiary structures with the help of models.
7. Study of enzyme kinetics – calculation of Vmax, Km, Kcat values.

Reference Books

1. A Level Biology Revision, https://alevelbiology.co.uk
2. https://ncert.nic.in
3. Experimental volume 1 and 2 by Rakesh Patel

110393207 SEC

Basic Principles of Good Laboratory Operations Credits: 2

Objective

- In this study, students will enhance precision in experimental data and calculations by mastering the use of significant figures. They will analyse molecular formulas to determine the percentage of elements in organic compounds.
- Additionally, a solid understanding of concentration measures, such as normality, molarity, molality, formality, mole fraction, and various percentage concentrations, will be gained for accurate solution quantification. The comprehension of parts per million (ppm) in extremely dilute solutions will ensure nuanced understanding of concentration levels.
- Moreover, students will achieve proficiency in the Standard Operating Procedures (SOP) for instruments, ensuring correct and efficient usage, maintenance, and adherence to established protocols, thereby enhancing precision and reliability in experimental and analytical processes.

Course Outcomes:

CO1: Master SI units, derived units, conversions, and significant figures for experimental data.

CO2: Calculate percentage of elements from molecular formulas and determine molecular formulas from percentages.

Unit : 1 Fundamentals Principles

- **SI Units**
  - Definitions of the Seven Base Units
  - Derived units
  - Conversion between units
  - Significant figures
- **Percentage of elements from Molecular Formula.**
- **Identification of Molecular formula of Organic Compounds from Percentage of elements.**
- **Concentration of Solutions**
  - Normality
  - Molarity
  - Molality
  - Formality
  - Mole fraction
  - % w / w ; % w / w ; % v / v
  - ppm

Unit : 2 Standard Operating Procedures (SOP) for Instruments

- pH meter
- Conductometer
- Gerber Tube
- Desiccator

- Potentiometer
- Colourimeter
- UV-Vis Spectrophotometer
- Muffle Furnace
- Hot Air Oven
- Incubator
- BOD- Incubator
- COD-Incubator
- Ice Maker
- Kjeldahl Apparatus
- Flame Photometer
- Centrifuge
- Cooling Centrifuge
- Water bath
- UV-Chamber
- M.P. Apparatus
- Turbidimeter
- HVAS (High Volume air sampler)
- Magnetic Stirrer
- Weighing Balance

Reference Books

1. Evert, R. F., Eichhorn, S. E., Perry, J.B. (2012). Laboratory Topics in Botany. W.H. Freeman and Company.
2. Mesh, M.S., Kebede-Westhead, E. (2012). Essential Laboratory Skills for Biosciences. John Wiley & Sons, Ltd.
3. Mu, P., Plummer, D. T. (2001). Introduction to practical biochemistry. Tata McGraw Hill Education.
4. Mann, S. P. (2016). Introductory Statistics, 9th edition. Hoboken, NJ, John Wiley and Sons Inc.
5. Danniel, W.W. (1987). Biostatistics. New York, NY: John Wiley Sons.
6. Jones, A.M., Reed, R., Weyers, J. (2016). Practical Skills in Biology, 6th Edition, Pearson
7. Bisen, P.S. (2014). Laboratory Protocols in Applied Life Sciences, 1st edition. CRC Press

110394208 AEC Practical English
Credits: 2

Objectives

- The course aims at enhancing the knowledge of efficient communication in English among students of B.Sc.
- The objective is to introduce students to various elements of communication both theoretically and through various integrated tasks.
- The goal is to improve their reading, writing, listening, and speaking skills in formal as well as informal everyday interactions.
- The main objective is to shape their verbal and non-verbal behaviour as well written communication, especially in workplace.

Course Outcomes:

CO1: Demonstrate proficiency in various forms of communication—including face-to-face, interpersonal, and intra-personal—while adhering to appropriate cellphone and social media etiquette in professional contexts.

CO2: Apply critical listening, reading, writing, and speaking skills to convey ideas clearly and accurately, including the ability to summarize, paraphrase, translate, and interpret content to avoid miscommunication and plagiarism.

Unit 1 Effective Business Communication

1. Elements of Communication:
   a. Face to Face Communication
   b. Inter-personal Communication
   c. Intra-personal Communication
   d. Perspectives in Communication
2. Cell phone etiquette
   a. Learning how to handle different types of calls.
   b. Social Networking Etiquette: Working with social media sites
3. Summarization and Paraphrasing: The ability to avoid plagiarism while using reference material

Unit 2 Developing Communication Skills

1. Listening Skills
   a. A Better Listener: Deep listening, Full listening, Critical listening, Therapeutic listening
2. Reading Skills:
   a. Analytical Reading: Learning close reading, skimming, scanning, extensive reading
   b. Narration and Description: Learning the difference between narrating a story / event and describing and explaining a process / method / mechanism

3. Writing Skills:
   a. Translation and interpretation from Gujarati to English: Translating paragraphs from Gujarati to English
4. Speaking Skills
   a. Effective Communication: Essential tips to avoid miscommunication and other barriers
   b. Vocabulary: Words often misspelt, confusing words, common errors, better way of saying common words and sentence

Activities:

1. Card Pieces
2. Listen and Draw
3. Guess who am I?
4. Secret Message

Reference Books

1. Middle School English Grammar and Composition by Wren & Martin
2. Business Communication by Meenakshi Raman, Prakash Singh
3. Business English by Pearson Publications
4. English at Workplace by Macmillan Publications
5. Basic communication skills for Technology, Andreja. J. Ruther Ford, 2nd Edition, Pearson Education, 2011
6. The Ace of Soft Skills: Attitude, Communication and Etiquette for success, GopalaSwamy Ramesh, 5th Edition, Pearson, 2013
7. Developing your influencing skills, Deborah Dalley, Lois Burton, Margaret, Greenhall, 1st Edition Universe of Learning LTD, 2010

110395209 VAC Indic Knowledge System-1 Credits: 2

Objective Of the Course

This course is designed to understand and enhance the holistic understanding of Indian Knowledge System. This course provides the basic understanding of the rich Indian knowledge system and its traditions. The course will introduce to the various ancient Indian Schools and its relevance in contemporary period with the great achievements of IKS to the world. It helps in understanding and analysing the Ancient Indian knowledge system.

Course Outcomes:

CO1: Explain the foundational concepts, literature, and educational systems of Indian Knowledge Systems (IKS), including the significance of Shastras and the evolution of Bharatiya education from ancient to modern times

CO2: Analyze and illustrate the contributions of IKS in diverse domains such as mathematics, life sciences, metallurgy, architecture, Ayurveda, and traditional arts, highlighting their scientific principles and global relevance.

Unit 1: Introduction to IKS

1. Introduction to IKS & Its importance
   - Introduction & importance of IKS
   - Various IKS Systems
2. Shashtra – Foundational Literature of Bharatvarsha
   - What is Shashtra?
   - Importance of Shashtra
   - Classification of Shashtra – Vaidic & Avaidic (with examples of imp. Literature)
3. Base of IKS proliferation
   - Bhartiya Education System and its philosophy
   - History of BES from Ancient to Modern
   - Domains of Education: Gurukul, Pathshala, Vidyalay, Vishvavidyalay

Unit 2: Contribution of IKS to the World

1. Mathematics & Astronomy
   - Number System
   - Algebra & Arithmetic
   - Geometry
   - Trigonometry
   - Planetary System
   - Speed of Light
   - Eclipse
2. Life sciences
   - Physics
   - Chemistry
   - Botany
3. Metal Technology

- Mining Techniques
- Types of Metals
- Tools & Techniques for Metal Smelting with examples

4. Town planning & Temple Architecture
   - Indigenous tools & technologies for town planning & Temple Architecture
   - Science of Architecture
   - Lothal, Mohan Jo Daro, Dholavira
   - Angkorvat, Lepakshi Temple, Jagannath Puri Temple, Thanjavur Temple, Modhera and Konark Sun Temple, Hampi Temple Etc.
5. Ayurveda
   - Introduction of Ayurveda- Definition, Branches of Ayurveda, Books and Pioneers
   - Concept of Tri Dosh and importance of its Balance in the body
   - Indic Medical Science Achievement: Tools & Technology
6. Art & Traditions
   - History and Origin
   - Skill Enhancement with 64 Kala
   - Science behind our traditions and rituals

Reference Books

1. Introduction to Indian Knowledge System- Concept and Application by B. Mahadevan, Vinayak Rajat Bhat, Nagendra Pavan R.N.
2. 'Pride of India: A Glimpse into India's Scientific Heritage' by R.M. Pujari, Pradeep Kolhe, N. R. Kumar, Samskrita Bharati Publication.
3. 'Indian Contribution to science', compiled by Vijnana Bharati.
4. 'Knowledge traditions and practices of India', Kapil Kapoor, Michel Danino, CBSE, India.

B.Sc. Microbiology Semester 3

110420301 Major-1 Microbial Physiology
Credits: 4

Course Outcomes:

CO1: Principles of taxonomy and classification of major groups of Microorganisms can be studied in one of the papers.

CO2: Able to describe and comprehend the fundamental concepts of microbial physiology and metabolism

CO3: To inculcate basic concept of bacterial metabolism

CO4: To define certain physiological terms such as metabolism, catabolism and Anabolism

Unit:1 Microbial Nutrition and Growth **Teaching hrs: 15**

[A] Modes of Nutrient uptake and Transport**:**

Entry of nutrients in cell, Passive and facilitated diffusion, Primary and secondary active transport, concept of uniport, symport and antiport, Group translocation

[B] Culture media: Components of Media,

Chemically Defined Media, Complex media, Selective, Differential, Indicator, Enriched and Enrichment media, Transport media

[C] Bacterial Growth

I. Reproduction of bacterial cells: Binary Fission, cell Elongation, DNA Replication, Septum Formation.

II. Normal Growth Curve of Bacteria (phases of growth), Calculation of Generation time and Growth Rate

[D] Measurement of Microbial growth, Cell mass and Cell numbers

[E] Batch culture, Continuous culture, Synchronous Growth, Diauxic Growth Curve

Unit: 2 Effect of Environment on Microbial Growth and Cell Communications
Teaching hrs: 15

[A] Microbial growth in response to environment –

I. Temperature (Psychrophiles, Mesophiles, Thermophiles, Thermodurics, Psychrotrophs),

II. pH (Neutrophiles, Acidophiles, Alkaliphiles),

III. Oxygen (Aerobic, Anaerobic, Microaerophilic, Facultative anaerobe),

IV. Salt/Sugar/Solute and Water activity (Halophiles, Xerophiles, Osmophilic),

V. Hydrostatic Pressure: Barophiles.

[B] Biofilms, Cell-Cell communication, Inter domain Communication

Unit: 3 Aerobic and Anaerobic Respiration
Teaching hrs: 15

[A] Substrate level Phosphorylation

[B] Oxidative phosphorylation

[C] Nitrate reduction

[D] Denitrification, .reverse electron transport.

Unit: 4. Chemotherapeutic agents
Teaching hrs: 15

[A] Principles of chemotherapy

[B] Chemical structure and mode of action of antibiotics

I. Inhibition of cell wall synthesis (Penicillin G)

II. Inhibition of membrane functions (Polymyxin b)

III. Inhibition of DNA synthesis (Ciprofloxacin)

IV. Inhibition of RNA synthesis (Rifamycin B)

V. Inhibition of protein synthesis and Enzymes (Streptomycin and Sulfonamides)

Reference Books

1. Microbiology, Pelczar JR., Chan ECS, Krieg NR, 5th Edition (1993), McGraw-Hill Book Company, NY.

2. Principles of Microbiology, R. M. Atlas, 2nd Edition (Indian Edition) (2015) McGraw Hill Education (India) Private Limited, New Delhi, India.

3. Microbiology, Prescott, Joanne Willey, Kathleen Sandman and Dorothy Wood, 5th Edition (1993), McGraw-Hill Book Company, NY.

URLs/Weblinks for E-content

1. Binary fission in bacteria https://youtu.be/XlCA-cdvSvU?si=cMyUvzwaZocXDNl9
2. Bacterial Growth curve https://youtu.be/JpnH_6kqvdw?si=D26WwgdinyE_xwg5
3. Measurement of Growth https://youtu.be/2fbwCsCxmt4?si=tCUwQRc0QBJNltP6
4. Types of culture media https://youtu.be/mE9PRcBJWdo?si=-F0J0GkWw2qQ-eCJ
5. Effect of temperature on bacterial growth https://youtu.be/cmHZWaxndsU?si=JdG_qtrUmRqDwckK
6. Factors affecting microbial growth https://youtu.be/N1DaPuO5gRY?si=Izgf9oOK4LZ93vH1
7. Biofilm https://youtu.be/2AQ6iLmo0h0?si=iVt6HhTLyCoIoJ6I
8. Chemical methods of microbial control https://youtu.be/mu6JFX3WkmA?si=TXRFiLl78Jpcgwed
9. Inhibition of cell wall synthesis https://youtu.be/eoHWobPU6C4?si=rUMfOq9r8HUOXOro
10. Inhibition of cell membrane synthesis https://youtu.be/3otG8ic14kk?si=ErPZQGzoqv08gnhL
11. Inhibion of DNA synthesis https://youtu.be/IENaBxJBW78?si=OPqy6zt9xlC8JPu9
12. Inhibition of RNA synthesis https://youtu.be/1i5h1OCA6i4?si=-uiIDUDPK9hXF6Ge
13. Inhibition of protein synthesis https://youtu.be/FfSqugAKF7I?si=dFBSM7SaPJTehjmN

110420302 Major-2 Molecular Biology
Credits: 4

Course Outcomes:

CO1: Explain the structure, organization, and properties of genetic material including the historical development of DNA structure, different forms of DNA and RNA, DNA topology, and the molecular organization of genetic material in prokaryotes, eukaryotes, and viruses.

CO2: Describe the molecular mechanisms and enzymes involved in DNA replication in prokaryotic and eukaryotic systems, including replication models, DNA repair mechanisms, and regulation of genome integrity.

CO3: Illustrate the processes of transcription and translation in prokaryotes and eukaryotes, detailing the roles of RNA polymerases, transcription factors, the genetic code, translational machinery, and inhibitors of protein synthesis.

CO4: Analyze mechanisms regulating gene expression in prokaryotic and eukaryotic cells, using classical examples like the lac and trp operons, yeast mating type switching, and epigenetic modifications such as DNA methylation and histone acetylation.

Unit 1 Structures of DNA and RNA / Genetic Material

DNA Structure: Miescher to Watson and Crick- historic perspective, DNA structure, Salient features of double helix, Types of DNA, Types of genetic material, denaturation and renaturation, cot curves. DNA topology: linking number, topoisomerases; Organization of DNA Prokaryotes, Viruses, Eukaryotes.RNA Structure,

Unit 2 Replication of DNA (Prokaryotes and Eukaryotes)

Bidirectional and unidirectional replication, semi- conservative, semi- discontinuous replication. Mechanism of DNA replication: Enzymes and proteins involved in DNA replication –DNA polymerases, DNA ligase, primase, telomerase – for replication of linear ends. Various models of DNA replication including rolling circle, D- loop (mitochondrial), Θ (theta) mode of replication and other accessory protein, Mismatch and excision repair.

Unit 3 Transcription in Prokaryotes and Eukaryotes

Central Dogma

Transcription: Definition, difference from replication, promoter - concept and strength of promoter RNA Polymerase and the transcription unit. Transcription in Eukaryotes: RNA polymerases, general Transcription factors.

Unit 4

a) Translation (Prokaryotes and Eukaryotes)

Translational machinery, Charging of tRNA, aminoacyl tRNA synthetases, Mechanisms of initiation, elongation and termination of polypeptides in both prokaryotes and eukaryotes, Fidelity of translation, Inhibitors of protein synthesis in prokaryotes and eukaryote.

b) Regulation of gene Expression in Prokaryotes and Eukaryotes

Principles of transcriptional regulation, regulation at initiation with examples from lac and trp

operons, Sporulation in Bacillus, Yeast mating type switching, Changes in Chromatin

Structure - DNA methylation and Histone Acetylation mechanisms.

Reference Books

1. Watson JD, Baker TA, Bell SP, Gann A, Levine M and Losick R (2008) Molecular Biology of the Gene, 6th edition, Cold Spring Harbour Lab. Press, Pearson

Publication.

2. Becker WM, Kleinsmith LJ, Hardin J and Bertoni GP (2009) The World of the Cell, 7th edition, Pearson Benjamin Cummings Publishing, San Francisco.

3. De Robertis EDP and De Robertis EMF (2006) Cell and Molecular Biology, 8th edition. Lippincott Williams and Wilkins, Philadelphia.

4. Karp G (2010) Cell and Molecular Biology: Concepts and Experiments, 6th edition, John Wiley & Sons. Inc.

5. Sambrook J and Russell DW. (2001). Molecular Cloning: A Laboratory Manual. 4 th Edition, Cold Spring Harbour Laboratory press.

6. Krebs J, Goldstein E, Kilpatrick S (2013). Lewin's Essential Genes, 3rd Ed., Jones and Bartlett Learning.

7. Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley – India

110420303 Major-3 Microbiology Practical Credits: 4

Course Outcomes:

CO1: Explain the principles and applications of various culture media and cultivation techniques for the growth and identification of microorganisms.

CO2: Perform qualitative analyses of biomolecules and interpret the results based on colorimetric and solubility-based biochemical reactions.

CO3: Evaluate the effect of antimicrobial agents and environmental factors on bacterial growth using standardized microbiological methods.

CO4: Isolate, quantify, and analyse nucleic acids, and interpret molecular biology concepts through practical demonstrations and data analysis.

List of Practical

1. Study of different types of media

A. Selective media: Rose Bengal agar medium

B. Differential medium: MacConkey's agar medium, EMB agar medium, Triple sugar iron agar medium

C. Enrichment media: Selenite broth

D. Enriched media: Blood agar medium

E. Natural media: Soil extract agar medium,

2. Qualitative analysis of biomolecules

A. Carbohydrates: Iodine test, Molisch's test, Benedict's test, Barfoed's test, Bial's test and Seliwanoff's test

B. Protein: Biuret test, Ehrlich's test, Glyoxilic acid test and Xanthoproteic test

C. Qualitative analysis of lipids –Sudan IV Dye test, Solubility test, Saponification test, Potassium permanganate test for unsaturated fatty acids

3. Study of effect of antimicrobial compounds on growth of bacteria

A. Study of effect of heavy metal on growth of bacteria

B. Study of effect of chemicals (5% phenol, 1% crystal violet and 0.001% $HgCl_2$) on growth of bacteria (Agar cup method)

C. Study of effect of antibiotics on growth of bacteria using paper disc method

D. Study of effect of antibiotic on growth of bacteria using agar ditch method

4. Study of normal growth curve of *E. coli* (Demonstration only)

5. Study of effects of environmental factors on growth on microorganism (Tube method)

A. Study of effect of Temperature on growth of *E. coli*

B. Study of effect of pH on growth of *E. coli*

C. Study of effect of NaCl concentration on growth of *E. coli*

6. Study of biochemical reactions

A. Based on utilization of carbon source

I. Fermentation of sugars:

(a) Broth media: Glucose, Xylose, Mannitol

(b) Agar media: TSI agar slant

II. Detection of glucose break-down products: Methyl red test and Voges Proskauer's test

III. Citrate utilization test

IV. Starch utilization test

B. Based on utilization of nitrogen source

I. Indole production test

II. H2S production test

III. Urea utilization test

IV. Gelatine Hydrolysis test

V. Deamination test

VI. Ammonia production test

VII. Nitrate reduction test

C. Based on enzymes: Dehydrogenase test, Catalase test and Oxidase test

7. Study of different types of DNA and RNA using micrographs and model/schematic representations.
8. Study of semi-conservative replication of DNA through micrographs / Schematic representations.
9. Isolation of genomic DNA from E. coli.
10. Estimation of salmon sperm / calf thymus DNA using colorimeter (diphenylamine reagent) and UV spectrophotometer (A260 measurement).
11. Estimation of RNA using colorimeter (orcinol reagent) and UV spectrophotometer (A260 measurement).

Reference Books

1. A Level Biology Revision, https://alevelbiology.co.uk
2. https://ncert.nic.in
3. Experimental volume 1 and 2 by Rakesh Patel
4. Basic Practical Microbiology: A manual
5. Experimental Microbiology Volume 1 by Rakesh J Patel.
6. Basic Practicals of Microbiology Volume 1 By Ankita Patadia and Ami Varia

110422304 MDC-1 Analysis of Water
Credits: 2

Course Outcomes:

CO1: Explain the concepts of water purity, sources and categories of water contamination, and various water sampling and purification methods.

CO2: Perform qualitative and quantitative analyses of water samples to determine physicochemical parameters including hardness, acidity, alkalinity, total dissolved solids, pH, conductance, and carbonate content using standardized laboratory techniques.

WATER MICROBIOLOGY

Unit 1	**Analysis of water-I** • Introduction • Concept of pure water • Water Contamination • Sources of water contamination • Category of water contaminants • Water sampling methods • Water purification method ▪ Boiling ▪ Filtration ▪ Distillation ▪ Chlorination ▪ Reverse osmosis
Unit 2	**Analysis of water-II** • Determination of total, permanent and temporary hardness of water sample (EDTA method) • Determination of Acidity of water sample. • Determination of Alkalinity of water sample. • Determination of total dissolved solids of water sample. • Determination of carbonates and bicarbonates of water sample. • Determination of pH of water sample. • Determination of conductance of water sample.

Reference Books

1. Gauging the Ganga: Guidelines for sampling and monitoring water quality, 2017 by Chandra Bhushan and D D Basu, Centre for Science and Environment, New Delhi.

2. Standard methods for the examination of water and wastewater, American public health association.

110422305 MDC-2 Analysis of Air
Credits: 2

Course Outcomes:

CO1: Describe the nature of bioaerosols, types of airborne microorganisms, their impact on human health, environment, and their significance in food, pharmaceutical industries, and clinical settings.

CO2: Perform air sampling, isolation, and identification of airborne microorganisms using appropriate bioaerosol samplers, culture media, and microbial analysis techniques including CFU calculation.

AIR MICROBIOLOGY

Unit 1	**Aeromicrobiology** • Bio aerosols, • Airborne microorganisms (bacteria, Viruses, fungi) and their impact on human health and environment, • Significance in food and pharma industries and operation theatres, allergens.
Unit 2	**Air sample collection and analysis** • Bio aerosol sampling • air samplers, methods of analysis • CFU • Culture media for bacteria and fungi, Identification characteristics.

Reference Books

1. Da Silva N, Taniwaki MH, Junqueira VC, Silveira N, Nascimento MS, Gomes RAR (2012) Microbiological Examination Methods of Food and Water-A Laboratory Manual, CRC Press
2. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA.

110393306 SEC Basics of Nanotechnology Credits: 2

Course Objectives:

- Understand the fundamental concepts and principles of nanoscience and nanotechnology.
- Gain knowledge about the historical development and current trends in the field.
- Learn about different types of nanomaterials, including nanoparticles, nanowires, nanotubes, and thin films.
- Study the methods of synthesis and fabrication of nanomaterials.

Course Outcomes:

CO1: Understand the foundational principles of nanotechnology, including atomic-scale structure, quantum mechanical concepts, and crystal geometry relevant to nanoscale materials.

CO2: Explain the origin, classification, and physical significance of various nanomaterials, quantum structures, and confinement effects, with applications in modern nanoscience.

Unit 1:

Background to Nanotechnology: Scientific revolution, molecular and atomic size, emergence of Nanotechnology, Challenges in Nanotechnology, Carbon age :(new forms of carbon graphene sheet to CNT)

Introduction to Quantum Mechanics & Crystal structure De-Broglie hypothesis, Uncertainty Principle, Schrödinger Equation, Operator, Particle in a 1D box, Particle in a 3D box (qualitative), Crystal structure, Crystal orientation, Crystal planes, Bravais lattice, Miller Indices, Atomic Packing Density, crystal symmetry, ZnS, Diamond and NaCl crystal structure, Melting point, Coordination number, Atomic Bonding.

Unit 2:

Introduction to Nanoscience Emergence of Nanoscience with special reference to Feynman and Drexler, Role of particle size, Spatial and temporal scale, Exciton, Concept of confinement, strong and weak confinement with suitable examples, Development of quantum structures, Basic concept of quantum well, quantum wire and quantum dot. Density of states of 1D, 2D & 3D structure, surface effect.

Types of Nanomaterials Nanoclusters, Solid solutions, Thin film, Nanocomposites (Metal Oxide and Polymer based), Core Shell Nanostructure, Buckyballs, Carbon nano tubes and, Zeolites minerals, Dendrimers, Micelles, Liposomes, Block Copolymers, Porous Materials, Metal Nanocrystals, Semiconductor nanomaterials.

Reference Books

1. **Material Science & Engineering – An Introduction** (9th Edition, 2014) by William D. Callister Jr. Wiley.
2. **Nanoscale Materials** (1st Edition, 2003) by Luis M. Liz-Marzán & Prashant V. Kamat. Springer.
3. **Introduction to Nanotechnology** (1st Edition, 2003) by Charles P. Poole Jr. & Frank J. Owens. Wiley-Interscience.
4. **Nanotechnology: Basic Science and Emerging Technologies** (1st Indian Edition, 2008) by M. Wilson, K. Kannangara, G. Smith, M. Simmons & B. Raguse. Overseas Press India Pvt. Ltd., New Delhi.
5. **The Chemistry of Nanomaterials: Synthesis, Properties & Applications** (1st Edition, 2004) by C. N. R. Rao & A. Müller. Wiley-VCH.
6. **Nanostructures and Nanomaterials: Synthesis, Properties and Applications** (2nd Edition, 2011) by Guozhong Cao. Imperial College Press.
7. **Handbook of Nanostructured Materials & Nanotechnology: Optical Properties** (Vol. 4, 1st Edition, 2000) by Hari Singh Nalwa. Academic Press.
8. **Nano Fabrication Towards Biomedical Applications** (1st Edition, 2005) by C. S. S. R. Kumar, Wonbong Choi & Jo-won Lee. Wiley-VCH Verlag GmbH & Co., Weinheim.

110394307 AEC Effective Communication Skill
Credits: 2

Course Outcomes:

CO1: Demonstrate effective written communication by composing analytical paragraphs, professional emails, and academic texts with appropriate structure, clarity, and citation practices.

CO2: Apply verbal and non-verbal communication strategies to deliver structured oral presentations and speeches, incorporating audience analysis and appropriate use of audio-visual aids

Unit 1 Corporate Communication

1. Communication Style Matrix

a. Direct Communication Style
b. Spirited Communication Style
c. Systematic Communication Style
d. Considerate Communication Style

2. E-mail etiquette

a. Learning to make attachments in mail and downloading and uploading files
b. Dos and Don'ts of Personal and Professional mail

3. Analytical Paragraph

a. The ability to describe, analyze, compare and evaluate given data

Unit 2 Dynamics of Communication Sills

1. Listening Skills

a. Barriers of effective listening: Cultural barrier, Psychological barrier, Linguistic barrier, Physical barrier, Organizational barrier

2. Reading Skills:

a. Understanding the content of a Book:
First page details, Publication details, Copyright information, Index, References and Bibliography

3. Writing Skills:

a. Academic writing: The ability to write a research-based article
b. Creating Bibliography: The ability to do in-text citation as well as creating a citation list

4. Speaking Skills

a. Preparing a speech: Self-introduction, Logical coherence, Topic and Audience
b. Oral Presentation: Audio - Visual aids, preparing materials, language, stage movement, hand movement, eye contact, overall personality, handling the audience

Activities:

1. Owner and Auction

2. Best Advertisement competition
3. Match the sound
4. Elocution competition

Reference Books

1. Soft skills and professional communication, Francis Peters SJ, 1stEdition, McGraw Hill Education, 2011
2. Developing your influencing skills, Deborah Dalley, Lois Burton, Margaret, Greenhall, 1st Edition Universe of Learning LTD, 2010
3. Middle School English Grammar and Composition by Wren & Martin
4. Business Communication by Meenakshi Raman, Prakash Singh
5. English at Workplace by Macmillan Publications
6. Basic communication skills for Technology, Andreja. J. Ruther Ford, 2nd Edition, Pearson Education, 2011
7. The Ace of Soft Skills: Attitude, Communication and Etiquette for success, GopalaSwamy Ramesh, 5th Edition, Pearson, 2013
8. Developing your influencing skills, Deborah Dalley, Lois Burton, Margaret, Greenhall, 1st Edition Universe of Learning LTD, 2010

110395308 VAC Climate Change
Credits: 2

Course Objectives:

- Understand the concepts of global warming, climate change, and the evolution of Earth's atmosphere.
- Study the impacts of climate change on weather patterns, agriculture, biodiversity, and human health.
- Learn about ozone layer depletion, its causes, effects, and mitigation measures.
- Explore environmental policies, international agreements like the Montreal and Kyoto protocols, and climate change mitigation strategies.

Course Outcomes:

CO1: Understand the basics of climate and weather systems, including Earth's energy balance.

CO2: Identify causes of climate change, both natural and anthropogenic, and their impacts.

Unit: 1. Introduction to Climate Change and its Impacts

- Global warming and climate change Evolution and development of Earth's atmosphere; atmospheric structure and composition.
- Significance of atmosphere in making the Earth, the only biosphere.
- Trends of global warming and climate change; drivers of global warming and Global Warming Potential (GWP) & climate change.
- Impact of climate change on atmosphere, weather patterns, sea level rise, agricultural productivity and biological responses - range shift of species, **CO2:** fertilization and agriculture.
- Impact on economy and spread of human diseases.

Unit: 2. Policies and Mitigation

- Ozone layer depletion, environmental policy & agreements Ozone layer or ozone shield.
- Importance of ozone layer; ozone layer depletion and causes; Chapman cycle.
- Process of spring time ozone depletion over Antarctica.
- Ozone depleting substances (ODS); effects of ozone depletion.
- Mitigation measures and international protocols. Environmental policy debate.

- International agreements; Montreal protocol 1987; Kyoto protocol 1997.
- Convention on Climate Change; carbon credit and carbon trading; clean development mechanism.

Reference Books

1. Barry, R. G. 2003. Atmosphere, Weather and Climate. Routledge Press, UK.
2. Gillespie, A. 2006. Climate Change, Ozone Depletion and Air Pollution: Legal Commentaries with Policy and Science Considerations. Martinus Nijhoff Publishers.
3. Manahan, S.E. 2010. Environmental Chemistry. CRC Press, Taylor and Francis Group.
4. Maslin, M. 2014. Climate Change: A Very Short Introduction. Oxford Publications.
5. Mathez, E.A. 2009. Climate Change: The Science of Global Warming and our Energy Future. Columbia University Press.
6. Mitra, A.P., Sharma, S., Bhattacharya, S., Garg, A., Devotta, S. &Sen, K. 2004. Climate Change and India. Universities Press, India.
7. Philander, S.G. 2012. Encyclopedia of Global Warming and Climate Change (2nd edition). Sage Publications.

B.Sc. Microbiology Semester 4

110420401 Major-1

Environmental Microbiology Credits: 4

Course Outcomes:

CO1: Information for microbial interactions in environment

CO2: Information regarding various biogeochemical cycles and their effect in environment

CO3: Information regarding Waste management, disposal, and treatment in environment.

CO4: Perform bacteriological examination of drinking water using standard microbiological techniques, differentiate fecal and non-fecal coliforms, identify nuisance organisms, understand water purification methods, and explain the microbial causes of waterborne diseases.

Unit 1 Microbial Interactions No. of Hours: 15

Microbe interactions: Mutualism, synergism, commensalism, competition, amensalism, parasitism, predation.

Microbe-Plant interaction: Symbiotic and non-symbiotic interactions.

Microbe-animal interaction: termite gut microflora, nematophagus fungi and symbiotic luminescent bacteria.

Objective: Information regarding various biogeochemical cycles and their effect in environment

Unit 2 Biogeochemical Cycling No. of Hours: 15

Carbon cycle: Microbial degradation of cellulose, hemicelluloses, lignin and chitin.

Nitrogen cycle: Nitrogen fixation, ammonification, nitrification, denitrification and nitrate reduction. Phosphorus cycle: Phosphate immobilization and solubilisation.

Sulphur cycle: Microbes involved in sulphur cycle. Other elemental cycles: Iron and manganese.

Objective: Information regarding Waste management, disposal, and treatment in environment.

Unit 3 Waste Management No. of Hours: 15

Solid Waste management: Sources and types of solid waste, Methods of solid waste disposal (composting and sanitary landfill).

Liquid waste management: Composition and strength of sewage (BOD and COD), Primary, secondary (oxidation ponds, trickling filter, activated sludge process and septic tank) and tertiary sewage treatment.

UNIT 4 Microbiology of Drinking Water No. of Hours: 15

[A] Microbial indicators of fecal pollution of drinking water

1. Coliforms as indicator

2. Differentiation of fecal and non-fecal coliforms by Elevated temperature test

3. Differentiation of ***E. coli*** and ***E. aerogenes*** by IMViC test

[B] Nuisance organisms in drinking water:

1. Fecal streptococci, Slime forming bacteria, Iron bacteria, Sulphur bacteria, Algae and Viruses

[C] Bacteriological examination of drinking water 1. Sampling 2. Standard plate count of water sample 3. Detection of coliforms in water sample: (i) Presumptive, Confirmed and Completed test (ii) Membrane filtration technique (iii) Defined substrate test (iv) Presence - Absence test

[D] Purification of drinking water: Sedimentation, Filtration and Disinfection [E] Sanitary survey of water producing system

[F] Water borne diseases: Introduction to Typhoid, Cholera, Hepatitis (A), Polio, Amoebiasis, Giardiasis

Reference Books

1. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA.
2. Madigan MT, Martinko JM and Parker J. (2014). Brock Biology of Microorganisms. 14th edition. Pearson/ Benjamin Cummings.
3. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition, Academic Press.
4. Okafor, N (2011). Environmental Microbiology of Aquatic & Waste systems. 1st edition, Springer, New York.
5. Singh A, Kuhad, RC & Ward OP (2009). Advances in Applied Bioremediation. Volume 17, Springer-Verlag, Berlin Hedeilberg.

6. Barton LL & Northup DE (2011). Microbial Ecology. 1st edition, Wiley Blackwell, USA.

7. Campbell RE. (1983). Microbial Ecology. Blackwell Scientific Publication, Oxford, England.

8. Coyne MS. (2001). Soil Microbiology: An Exploratory Approach. Delmar Thomson Learning.

9. Lynch JM & Hobbie JE. (1988). Microorganisms in Action: Concepts & Application in Microbial Ecology. Blackwell Scientific Publication, U.K.

10. Martin A. (1977). An Introduction to Soil Microbiology. 2nd edition. John Wiley & Sons Inc. New York & London.

11.. Stolp H. (1988). Microbial Ecology: Organisms Habitats Activities. Cambridge University Press, Cambridge, England.

12. Subba Rao NS. (1999). Soil Microbiology. 4th edition. Oxford & IBH Publishing Co. New Delhi.

13. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.

110420402 Major-2
Food and Dairy Microbiology Credits: 4

Course Outcomes:

CO1: Information regarding substrate for microorganisms in food and its role in spoilage.

CO2: Information regarding involvement of microorganisms in different types of food related infections.

CO3: Information for better preservation of food against microbial activity.

CO4: Information regarding microorganism's involvement in fermented foods.

Unit 1 Foods as a substrate for microorganisms No. of Hours: 15

Intrinsic and extrinsic factors that affect growth and survival of microbes in foods, natural flora and source of contamination of foods in general.

Unit 2 Microbial spoilage of various food No. of Hours: 15

Principles, Spoilage of vegetables, fruits, meat, eggs, milk and butter, bread, canned foods.

Unit 3 Principles and methods of food preservation No. of Hours: 15

Principles, physical methods of food preservation: temperature (low, high, canning, drying), irradiation, hydrostatic pressure, high voltage pulse, microwave processing and aseptic packaging, chemical methods of food preservation: salt, sugar, organic acids, SO_2, nitrite and nitrates, ethylene oxide, antibiotics and bacteriocins.

Unit 4 Fermented foods No. of Hours: 15

Dairy starter cultures, fermented dairy products: yogurt, acidophilus milk, kumiss, kefir, dahi and cheese, other fermented foods: dosa, sauerkraut, soy sauce and tampeh, Probiotics: Health benefits, types of microorganisms used, probiotic foods available in market.

Reference Books

1. Adams MR and Moss MO. (1995). Food Microbiology. 4th edition, New AgeInternational (P) Limited Publishers, New Delhi, India.
2. Banwart JM. (1987). Basic Food Microbiology. 1st edition. CBS Publishers andDistributors, Delhi, India.
3. Davidson PM and Brannen AL. (1993). Antimicrobials in Foods. Marcel Dekker,New York.
4. Dillion VM and Board RG. (1996). Natural Antimicrobial Systems and FoodPreservation. CAB International, Wallingford, Oxon.
5. Frazier WC and Westhoff DC. (1992). Food Microbiology. 3rd edition. TataMcGraw-Hill Publishing Company Ltd, New Delhi, India.
6. Gould GW. (1995). New Methods of Food Preservation. Blackie Academic andProfessional, London.
7. Jay JM, Loessner MJ and Golden DA. (2005). Modern Food Microbiology. 7thedition, CBS Publishers and Distributors, Delhi, India.
8. Lund BM, Baird Parker AC, and Gould GW. (2000). The Microbiological Safetyand Quality of Foods. Vol. 1-2, ASPEN Publication, Gaithersberg, MD.
9. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9thedition. Pearson Education.

110420403 Major-3 Microbiology Practical
Credits: 4

Course Outcomes:

CO1: Demonstrate the ability to isolate, cultivate, and characterize diverse microorganisms including nitrogen-fixing bacteria, actinomycetes, yeasts, molds, and gram-positive bacteria from various natural sources.

CO2: Apply appropriate microbiological techniques such as standard plate count, MPN, MBRT, RRT, and fecal coliform testing for the quantitative and qualitative analysis of microbial load in soil, water, food, and milk samples.

CO3: Identify and differentiate specific groups of microorganisms through microscopic examination, staining methods, and the study of permanent slides, including acid-fast bacteria, Clostridium spp., Fusarium spp., Amoeba, and Spirulina.

CO4: Develop practical skills in setting up specialized culture techniques and demonstration models such as Winogradsky's column to study microbial diversity and ecological interactions in natural environments.

List of Practical

1. Isolation and cultivation of symbiotic nitrogen fixing bacteria from root nodules
2. Isolation and cultivation of non-symbiotic nitrogen fixing bacteria from soil
3. Isolation and cultivation of actinomycetes from soil
4. Isolation and cultivation of yeast from curd or grape
5. Isolation and cultivation of molds (*Mucor, Rhizophus, Aspergillus, Penicillium*) from soil
6. Standard plate count of soil, water, food and milk samples
7. Detection of fecal pollution of water by performing presumptive, confirmed and completed test
8. Determination of MPN of coliforms from water sample
9. Determination of microbial load by use of MBRT of raw, boiled and pasteurized milk
10. Determination of microbial load by use of RRT of milk sample
11. Detection of Acid-fast bacteria in milk
12. Study of permanent slides: Acid fast bacteria, *Clostridium spp., Fusarium spp, Amoeba, Spirulina*

13. Study of microbial diversity in soil by using Winogradsky's column (Demonstration only)
14. Isolation, cultivation and identification of gram-positive bacteria- *Bacillus Megaterium, Bacillus subtilis, Bacillus cereus* and *Staphylococcus aureus*

Reference Books

1. Basic Practical Microbiology: A manual
2. Experimental Microbiology Volume 1 by Rakesh J Patel.
3. Basic Practicals of Microbiology Volume 1 By Ankita Patadia and Ami Varia

110421404 Minor-1 Bioprocess Technology Credits: 2

Course Outcomes:

CO1: To provide an overview of bioprocess technology: The paper can aim to introduce the principles of bioprocess technology, including the basic concepts, process design, and optimization.

CO2: To describe the different types of operations bioprocess: The paper can aim to explain the different types of bioprocesses, type reactors, scale up process and downstream processing.

Unit 1: Bioreactors

● Introduction to fermentation, Principle of Microbial growth and Culture systems (Batch, continuous and fed batch culture)

● Bioreactor design: Parts & Functions

● Bioreactor: Material, Containments

● Types of Bioreactors: Stirred Tank Reactor, Air-lift, Hollow fiber, Membrane reactors.

● Introduction to Scale up process, Upstream and Downstream

Unit 2: Operation of Bioreactor

● Sterilization (Sterilization of media, Use of high-pressure steam: principle, batch and continuous sterilization process)

● Inoculation and Sampling

● Aeration

● Control Systems (pH, Temperature, Dissolved Oxygen, Foam Control, Gas control)

● Cleaning

Reference Books

1. Principles of Fermentation Technology, Stanbury P F, Whitaker A and Hall SJ, (1995), 2nd edition, Pergamon Press, London, UK

2. Industrial Microbiology: An Introduction, Waites, M J and Morgan N L, (2002), Blackwell Science

3. Biotechnology: A Textbook of Industrial Microbiology, Crueger W and Crueger A, (2000), 2 nd edition, Panima Publishing Corporation, New Delhi, India

4. Fermentation Microbiology and Biotechnology, El-Mansi E M T, Bryce CFA, Dahhou B, Sanchez S, Demain AL, Allman AR (eds), (2011), 3 rd edition, CRC Press; Taylor and Francis Group, Boca Raton

5. Industrial Microbiology, Casida LE, Jr. (1968), Wiley Eastern Ltd, New Delhi, India

110421405 Minor-2
Bioprocess Technology Practical Credits: 2

Course Outcomes:

CO1: Determine the effect of various aeration parameters on Oxygen Transfer Rate (OTR) through sulphite oxidation under static, shaking, and sparging conditions, and interpret their influence on bioprocess efficiency.

CO2: Perform extraction, purification, and quantitative estimation of industrially important microbial metabolites such as citric acid from Aspergillus niger culture and alcohol concentration from fermentation samples, applying appropriate biochemical and analytical techniques.

List of Practical

1. Determine the effect of aeration parameters on Oxygen Transfer Rate (OTR) by Sulphite oxidation.
    1.1. Static condition
    1.2. Shaking condition
    1.3. Sparging condition
2. Extraction and purification of citric acid from the culture medium of Aspergillus niger.
3. Estimation of alcohol concentration in the given sample.

Reference Books

1. Basic Practical Microbiology: A manual
2. Experimental Microbiology Volume 1 by Rakesh J Patel.
3. Basic Practicals of Microbiology Volume 1 By Ankita Patadia and Ami Varia

110393406 SEC Biostatistics
Credits: 2

Course Outcomes:

CO1: Explain the fundamental concepts, scope, types of data, sampling methods, and tools used in biostatistics, and effectively represent data using textual, tabular, and graphical formats.

CO2: Compute and interpret measures of central tendency (mean, median, and mode) and measures of dispersion (range, variance, standard deviation) for grouped and ungrouped data, and evaluate their merits and limitations in biological data analysis.

Unit 1: Analysis of Biochemical data

- Introduction and scope in biostatistics
- Kinds of data and variables based on nature (numerical discrete continuous, categorical ordinal and nominal)
- Based on source primary and secondary data
- Sampling Methods: Random and Non-Random Methods
- Representation of data: Textual, Tabular, and Graphical Methods
- Tools and software used in Biostatistics.
- Applications of Biostatistics

Unit 2: Central Tendency and Dispersion

- Measurement of central tendency: Mean, Mode, Median, grouped data, ungrouped data; merits and demerits.
- Measures of dispersion: Range, Variance and Standard Deviation of grouped and ungrouped data; merits and demerits

Reference Books

1. Fundamentals of Biostatistics, 2006 – Bernard A Rosner
2. Fundamentals of Biostatistics,5th edition, Khan and Khanum
3. Methods in Biostatistics, 2010, B.K. Mahajan
4. Fundamentals of Biostatistics, 2009 , V.B. Rastogi

5. Research Methodology: Methods and Techniques, 2004, C. R. Kothari

6. Bioinformatics databases, tools and algorithms, O. Bosu & S. K. Thukral

7. Bioinformatics: Sequence and Genome Analysis by Mount D., Cold Spring Harbor Laboratory Press, New York. 2004

8. Introduction to bioinformatics by Teresa K. Attwood, David J. Parry-Smith. Pearson Education. 1999 Old editions

110394407 AEC
Life Skills and Personality Development Credits: 2

Course Outcomes:

CO1: Demonstrate professional grooming, dressing etiquette, and effective interpersonal skills tailored to diverse formal and corporate settings.

CO2: Develop and present well-structured written documents including reports, resumes, and formal letters using appropriate tone, format, and language conventions.

Unit 1 Corporate Communication

1. **Dressing and Grooming Skills**:
   a. To become aware of diverse style of dressing and handling your personality at different occasions
2. **Report Writing:**
   a. The ability to document and explain data obtained through graphs and charts

Unit 2 Dynamics of Communication Skills

1. **Listening Skills**
   b. Feedback: Providing feedback and Appropriate responding
2. **Reading Skills**
   b. Pronunciation: Phonetics- study of speech sound, and learning silence letters
3. **Writing Skills**
   a. CV/ Resume writing: The ability to write an application for a job with a covering letter
   b. Formal Letters: The ability to write a letter of request, complaint, apology, order, etc.
4. **Speaking Skills**
   b. Interview skills: Body language, dressing sense, polite responses, asking the right question in right way, preparation strategy, understanding the organization

Activities:

1. Mock Product designing and selling
2. Act it out
3. Writing Real Letters
4. Mock Interview

Reference Books

1. Letters for All Occasion by A S Myers
2. Spoken English by V. Shasikumar and P V Dhanija
3. Soft skills and professional communication, Francis Peters SJ, 1stEdition, McGraw Hill Education, 2011
4. Developing your influencing skills, Deborah Dalley, Lois Burton, Margaret, Greenhall, 1st Edition Universe of Learning LTD, 2010
5. Middle School English Grammar and Composition by Wren & Martin
6. Business Communication by Meenakshi Raman, Prakash Singh
7. English at Workplace by Macmillan Publications
8. Basic communication skills for Technology, Andreja. J. Ruther Ford, 2nd Edition, Pearson Education, 2011
9. The Ace of Soft Skills: Attitude, Communication and Etiquette for success, GopalaSwamy Ramesh, 5th Edition, Pearson, 2013
10. Developing your influencing skills, Deborah Dalley, Lois Burton, Margaret, Greenhall, 1st Edition Universe of Learning LTD, 2010

110395408 VAC Indic Knowledge System-2 Credits: 2

Objective Of the Course

This course is designed to understand and enhance the holistic understanding of Indian Knowledge System. This course provides the basic understanding of the rich Indian knowledge system and its traditions. The course will introduce to the various ancient Indian Schools and its relevance in contemporary period with the great achievements of IKS to the world. It helps in understanding and analyzing the Ancient Indian knowledge system.

Course Outcomes:

CO1: Describe and interpret the foundational vocabulary, philosophical principles, and textual traditions of Indian Knowledge Systems (IKS), including the methods of studying Shastras and techniques of manuscript preservation.

CO2: Analyze and evaluate the historical contributions of IKS in science & technology, trade, administration, and arts, with experiential understanding through practices such as yoga, mantra chanting, and indigenous technologies.

Unit-1 Understanding of IKS

o Unique aspects of IKS: Idea Vs Ideology, IKS in present perspective

o Vocabulary related to IKS – Dharma, Sanatan, Moksha, Karma etc.

o Science of Sastra

Shruti & Smriti Parampara

Methods to Study Shashtra

Overview of Shastrartha Parampara

o Manuscriptology: Art of preserving Knowledge

Script & Language, Sanskrit Language and it's importance

Manuscripts: It's History, types and Its

preservation Techniques

Famous Manuscript repositories

Unit-2 Contribution of IKS in

o Science & Technology

Astronomy

Encryption Method used in ancient India

Introduction to Yantra Shashtra – Vaimanik Shashtra

Textile Technologies

Agriculture Technologies

Forest Management and Water management techniques

o Trade & Commerce

Concept of Indic Economy (ArthVyavastha)

Trade and Commerce

o Administration & Governance

Concept Introduction: Indic Administration

Administrative Structure in Ancient India

Niti Sashtra (Law & Orders)

o Fine Art & Performing Art

Performing Art: Bhav, Ras, Types, Process, Famous Literature, Famous Art & Artists

Fine Art: Types, Process, Famous Literature, Famous Art and Artists

Case Studies Local Art & Tradition

o Experiential sessions

Introduction to Ashtang Yog and practice of Yogasan & Pranayam

Methods of Chanting the Mantra and Chanting Practice

Reference Books

1. Introduction to Indian Knowledge System- Concept and Application by B. Mahadevan, Vinayak Rajat Bhat, Nagendra Pavan R.N.
2. R.M. Pujari, Pradeep Kolhe, N. R. Kumar, 'Pride of India: A Glimpse into India's Scientific Heritage', Samskrita Bharati Publication.
3. 'Indian Contribution to science', compiled by Vijnana Bharati.
4. 'Knowledge traditions and practices of India',Kapil Kapoor, Michel Danino, CBSE, India.

B.Sc. in Biotechnology Programme Outcomes (PO)

PO1. Students will comprehend the fundamental concepts of biotechnology, including interdisciplinary knowledge in cell biology, genetics, biochemistry, microbiology, and molecular biology.

PO2. Students will apply advanced biotechnological concepts to solve problems across various fields, such as genomics, proteomics, stem cell biology, DNA technology, and biochemistry.

PO3. By using both traditional and modern ICT-based teaching methods, students' subject knowledge will be enriched.

PO4. Students will acquire interdisciplinary skills related to biotechnology, including understanding cell biology, genetics, and molecular biology.

PO5. Students will be equipped with knowledge of advanced modern techniques and will develop an appreciation for nature care.

PO6. As biotechnology is an interdisciplinary field, students will gain technological know-how by connecting different disciplines.

PO7. Students will acquire knowledge applicable to biotechnology industries and research settings.

PO8. Students will learn about stereochemistry and how different molecules and bio-molecules are represented using various methods.

PO9. Students will understand fluid mechanics, geometrical optics, and surface tension through experimental, computational, and theoretical methods.

PO10. Students will appreciate the importance of parasites in human health and understand the classification and construction of various animal systems.

PSO1. Apply biotechnological tools and interdisciplinary knowledge to conduct experiments, analyze results, and solve real-world biological problems in academic, industrial, and clinical research settings.

PSO2. Demonstrate proficiency in communicating scientific information effectively through academic writing, oral presentations, and data interpretation in both research and industrial environments.

B.Sc. Biotechnology Semester 1

110430101 Major-1 Cell Biology
Credits: 4

Course Introduction

- Cell Biology is an essential discipline within the field of biology that explores the structure, function, and behavior of cells, the fundamental units of life. This course provides a comprehensive introduction to the fascinating world of cells, delving into their molecular makeup, intricate processes, and critical roles in living organisms.

Course Objectives:

1. **Understanding Cell Structure:** Explore the diverse cellular structures, organelles, and their functions, from the cell membrane to the nucleus and everything in between.
2. **Cellular Diversity:** Explore the wide variety of cell types found in different organisms and tissues, highlighting their unique adaptations and specialized functions.
3. **Cellular Processes:** Examine the fundamental processes that govern cell life, including cell cycle, cancer, and aging.

Course Outcomes:

CO1: Understanding Cell Structure: Explore the diverse cellular structures, organelles, and their functions, from the cell membrane to the nucleus and everything in between.

CO2: Cellular Diversity: Explore the wide variety of cell types found in different organisms and tissues, highlighting their unique adaptations and specialized functions.

CO3: Structural and Chemical Organization of Cells: Understand the relationship of the structure and chemistry of the cell and its subcellular components.

CO4: Cellular Processes: Examine the fundamental processes that govern cell life, including cell cycle, cancer, and aging. Understand the molecular basis of various biochemical reactions.

UNIT I: Basic Cell Structure and Functions

- The Cell Theory
- Basic structure of cells; Types of cells; Prokaryotic, Eukaryotic, Archaea
- Differences between prokaryotes and eukaryotes
- Differences between plants and animal cells
- The organization of cells into tissues
- Different types of tissues.

UNIT II: Structural Components of Cell

- Membrane structure: Singer – Nicholson's Fluid Mosaic Model, Structure and functions of membrane lipids and glycolipids
- Membrane proteins: Carrier protein and Channel proteins

- Nature of Cytosol, Cytoskeleton structures and functions – Microtubules, Microfilaments, Intermediate filaments.

UNIT III: Cell Organelles

- Introduction to various cell organelles
- Structure and functions of Nucleus
- Structure and functions of Mitochondria
- Structure and functions of Chloroplasts
- Structure and functions of Endoplasmic reticulum
- Structure and functions of Rough and smooth endoplasmic reticulum
- Structure and functions of Ribosomes
- Structure and functions of Golgi bodies
- Structure and functions of Lysosome
- Structure and functions of Vacuole
- Structure and functions of Peroxisome.

UNIT IV: Cell Cycle and Regulation

- Introduction to Cell Cycle
- Phases of cell cycle (Interphase and M phase)
- Cell cycle regulation
- Check points (G1, G2 and M)
- Role of cyclins and CDKs, p53 and Rb proteins.
- Cancer and Aging.

Reference Books

1. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. (6th ed). John Wiley & Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. (8th ed). Lippincott Williams and Wilkins, Philadelphia.
3. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). The World of the Cell. (7th ed). Pearson Benjamin Cummings Publishing, San Francisco.
4. Lodish, H., Berk, A., Zipursky, S. L., Matsudaira, P., Baltimore, D., and Darnell, J. (2000). Molecular cell biology (4th ed.).WH Freeman, New York:
5. Cooper, G. M., and Ganem, D. (1997). The cell: a molecular approach. Nature Medicine.

110430102 Major-2 Cell Biology Practicals Credits: 4

Introduction:

Cell Biology is an essential discipline within the field of biology that explores the structure, function, and behavior of cells, the fundamental units of life. This course provides a comprehensive introduction to the fascinating world of cells, delving into their molecular makeup, intricate processes, and critical roles in living organisms.

Course Outcomes:

CO1: Demonstrate proficiency in basic laboratory techniques used in cell biology and bimolecular studies.

CO2: Analyze and interpret experimental data related to the identification and quantification of biomolecules.

CO3: Apply staining and microscopy techniques to distinguish cellular components and identify cell structures during mitosis and meiosis.

CO4: Isolate and analyze subcellular organelles such as chloroplasts using techniques like density gradient centrifugation and interpret results based on visual and experimental data.

List of Practical:

1. Study of Various Laboratory Instruments.
2. Preparation of buffers and standard solutions.
3. Differential staining of Nucleus from human WBCs.
4. To determine the total White Blood Cell count and Red Blood Cell count.
5. Preparation of Permanent slides for Mitosis (Onion Root Tip) and Meiosis (Anther squash)
6. Thin sectioning and staining of plant tissue.
7. Microscopic study of tissues and organs through sectioning, staining, and examining those sections under a microscope
8. Isolation of chloroplast from Spinach leaf using density gradient centrifugation.

Reference Books

1. Oser, B. L. (Ed.). (1984). Hawk's physiological chemistry (14th ed.). New Delhi: Tata McGraw-Hill.
2. Plummer, D. T. (1987). An introduction to practical biochemistry (3rd ed.). New Delhi: Tata McGraw-Hill.
3. Sharma, S. (2007). Experiments and techniques in biochemistry. New Delhi: Galgotia Publishing Company.
4. Thomas, L., & Schalkhammer, T. (2002). Analytical biochemistry. Weinheim: Wiley-VCH.

5. Varley, H., Gowenlock, A. H., & Bell, M. (1980). Practical clinical biochemistry (5th ed.). London: Heinemann Medical Books.
6. Willard, H. H., Merritt, L. L., Dean, J. A., & Settle, F. A. (1988). Instrumental methods of analysis (7th ed.). Belmont, CA: Wadsworth Publishing Company.

110431103 Minor-1
Introduction to Microbiology and Microbial Diversity Credits: 2

Objectives

The main aim of studying Introduction to Microbiology and Microbial Diversity is for students to:

- To learn how Van Leeuwenhoek, Spallanzani, Pasteur, Cohn, and Koch contributed to the field of microbiology.
- To impart knowledge of the basic principles of bacteriology, virology, mycology,
- To know about the roles of microorganisms in ecosystems.
- To know about the diverse groups of bacteria and their nomenclature
- Understanding Microscopy will also provide opportunities for a student to develop diagnostic skills in microbiology, including the practical application.

Course Outcomes:

CO1: To enrich students' knowledge and train them in the pure microbial sciences

CO2: To introduce the concepts of application and research in Microbiology to inculcate sense of scientific responsibilities and social and environment awareness

Unit: 1 (A) History of Development of Microbiology- I

- Development of microbiology as a discipline, Spontaneous generation vs. biogenesis. Contributions of Anton von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming

(B) History of Development of Microbiology- II

- Role of microorganisms in fermentation, Germ theory of disease, Development of various microbiological techniques and the golden era of microbiology, Development of the field of soil microbiology: Contributions of Martinus W. Beijerinck, Sergei N. Winogradsky, Selman A.Waksman Establishment of areas of medical microbiology and immunology through the work of Paul Ehrlich, Elie Metchnikoff, Edward Jenner

Unit 2 Techniques use to study microorganisms

A) Microscopy
   I) Principles of Microscopy, magnification and resolving power
   II) Light microscopy: Simple and compound microscope, bright field and dark field microscopy
   III) Principles and applications of phase contrast, fluorescent and Electron microscopy

B) Staining
   I) Dyes and stains: Definition, acidic, basic dyes and leuco-compounds
   II) Smear: Fixation, use of mordents, intensifiers and decolourizers
   III) Mechanism of staining, Types of staining: Simple and differential staining

Reference Books

1. Atlas, R. M. (1997). Principles of microbiology (2nd ed.). Wm. C. Brown Publishers.
2. Cappuccino, J. G., & Sherman, N. (2010). Microbiology: A laboratory manual (9th ed.). Pearson Education Limited.
3. Madigan, M. T., Martinko, J. M., Dunlap, P. V., & Clark, D. P. (2014). Brock biology of microorganisms (14th ed.). Pearson.
4. Pelczar, M. J., Chan, E. C. S., & Krieg, N. R. (1993). Microbiology (5th ed.). McGraw-Hill Book Company.
5. Stanier, R. Y., Ingraham, J. L., Wheelis, M. L., & Painter, P. R. (2005). General microbiology (5th ed.). Macmillan.
6. Tortora, G. J., Funke, B. R., & Case, C. L. (2008). Microbiology: An introduction (9th ed.). Pearson Education.
7. Willey, J. M., Sherwood, L. M., & Woolverton, C. J. (2013). Prescott's microbiology (9th ed.). McGraw-Hill Education.

110431104 Minor-2
Introduction to Microbiology and Microbial Diversity Practical

Credits: 2

Course Outcomes:

CO1: Acquire technical skills laboratory equipment, tools, and materials.

CO2: Demonstrate an understanding of laboratory procedures including safety and scientific methods.

List of Practicals

1. Microbiology Good Laboratory Practices and Bio Safety.
2. To study the principles and applications of essential instruments (biological safety cabinets, autoclave, incubator, BOD incubator, hot air oven, light microscope, pH meter) used in the microbiology laboratory.
3. Preparation of culture media for bacterial cultivation.
4. Sterilization of medium using Autoclave and assessment for sterility
5. Sterilization of glassware using Hot Air Oven and review for sterility
6. Sterilization of heat-sensitive material by membrane filtration and inspection for sterility
7. Demonstration of the presence of microflora in the environment by exposing N agar to air.
8. Simple staining: Monochrome staining and Negative staining

Reference Books

1. Society for General Microbiology. (2006). *Basic practical microbiology: A manual*. Microbiology Society.
2. Patel, R. J. *Experimental microbiology: Volume 1*.
3. Patadia, A., & Varia, A.. *Basic practicals of microbiology: Volume 1*.

110432105 MDC-1 Biomolecules-1
Credits: 2

Course Introduction

Biomolecules are important for the functioning of living organisms. Cells consist of cytoplasm enclosed within a membrane, which contains many biomolecules such as carbohydrates, lipids, proteins and nucleic acids. These are building blocks of living organisms, so the presence of appropriate biomolecules is important for structure and proper function of living cells. Macro biomolecules are built from small organic compounds by linking a lot of smaller units together into a long chain. The course encompasses the structure, monomer, examples, functions, bonds of biomolecules.

Course Outcomes:

CO1: To study the chemical properties and structural diversity of carbohydrates in order to understand their biological functions and the correlation between structure and function.

CO2: To explore the chemical characteristics and varied structures of nucleic acids, highlighting how these features determine their roles in genetic information storage and transfer.

UNIT I: Carbohydrates

- Functions of carbohydrates
- Physical properties of Carbohydrates
- Chemical Properties of Carbohydrates
- Classification, Structures and Functions of Monosaccharides (glucose, fructose, galactose, ribose, deoxyribose),
- Classification, Structures and Functions of Disaccharides (lactose, sucrose, maltose),
- Classification, Structures and Functions of Polysaccharides (starch, glycogen, cellulose)

UNIT II: Nucleic Acid

- Functions of nucleic acids
- Components of nucleic acids, Nucleoside and Nucleotides, Nitrogen bases (purines and pyrimidines), Sugars of nucleic acid
- Structure of DNA
- Types of DNA structures (A-DNA, B-DNA, Z- DNA),
- Structure of RNA
- Various types of RNAs.

Reference Books

1. Nelson, D. L., Lehninger, A. L., & Cox, M. M. (2008). Lehninger principles of biochemistry (5th ed) WH Freeman Publishers.
2. Berg, JM Tymoczko, JL. Gatto, GJ., Stryer, L. (2015). Biochemistry. (8th ed.) W H Freeman and Company New York.

3. Satyanarayana U. Chakrapani U. (2013). Biochemistry.(4th edition). Elsevier and Books and Allied (P) Ltd
4. Voet, D., & Voet, J. G. (2016). Biochemistry (5th ed.). Hoboken, NJ: J. Wiley & Sons.
5. Jain JL. Jain S. Jain N. (2005). Fundamentals of Biochemistry. (6th edition). S Chand and Company Ltd
6. Rodwell VW. Bender D. Botham KM. Kennelly PJ Weil PA.(2018). Harper's Illustrated Biochemistry.(31st edition) McGraw-Hill Education

110432106 MDC-2 Biomolecules-1 Practical Credits: 2

Course Outcomes:

CO1: Demonstrate proficiency in the use of laboratory instruments, glassware, and the preparation of standard and buffer solutions using various concentration units such as molarity, normality, molality, and percent solutions.

CO2: Identify and perform qualitative and quantitative biochemical tests to detect carbohydrates and DNA and analyze their structural and functional significance.

List of Practicals

1. Study of various laboratory Instruments .
2. Study of various glasswares used in the laboratory.
3. Basic methods of calculations for preparation of standard solutions:
   a. Based on Normality
   b. Based on Molarity
   c. Based on Molality
   d. Based on percent solutions (v/v, w/v).
4. Preparation of buffer solutions.
5. Qualitative tests for Carbohydrates
   a. Qualitative tests for Monosaccharides: Glucose
   b. Qualitative tests for Monosaccharides: Fructose
   c. Qualitative tests for Monosaccharides: Galactose
   d. Qualitative tests for Disaccharides: Lactose
   e. Qualitative tests for Disaccharides: Maltose
   f. Qualitative tests for Disaccharides: Sucrose
   g. Qualitative tests for Polysaccharide: Starch
6. Qualitative tests for Sugar mixtures
   a. Qualitative tests for sugar mixtures 1: Monosaccharide + Monosaccharide
   b. Qualitative tests for sugar mixtures 2: Monosaccharide + Disaccharide
   c. Qualitative tests for sugar mixtures 3: Disaccharide + Disaccharide
   d. Qualitative tests for sugar mixtures 4: Monosaccharide/ Disaccharide + Polysaccharide
7. Estimation of reducing sugar by Cole's method.
8. Colorimetric estimation of DNA using Diphenylamine.

Reference Books

1. Indian Council of Medical Research (ICMR). (2000). A manual of laboratory techniques. ICMR Publications.
2. Jayaraman, J. (1981). Laboratory manual in biochemistry. Wiley Eastern Limited.
3. Malhotra, V. K. (1998). Handbook of practical biochemistry (2nd ed.). Jaypee Brothers Medical Publishers.
4. Mukherjee, K. L. (2004). Medical laboratory technology: Vol. 1, 2, & 3. Tata McGraw-Hill Education.

5. Plummer, D. T. (1987). An introduction to practical biochemistry (3rd ed.). McGraw-Hill.
6. Chawla, R. (2014). Clinical chemistry: Interpretation and techniques (3rd ed.). Jaypee Brothers Medical Publishers.
7. Sadasivam, S., & Manickam, A. (1996). Biochemical methods (2nd ed.). New Age International Publishers.
8. American Public Health Association (APHA). (1971). Standard methods for the examination of water and wastewater (13th ed.). APHA.
9. Varley, H., Gowenlock, A. H., & Bell, M. (1980). Practical clinical biochemistry (5th ed.). Heinemann Medical Books.

110393107 SEC Environmental Audit
Credits: 2

Objective:

The key objective of an environmental audit is to:

- Determine the performance of the existing environmental management system in place and its instrumentality.
- To identify which environmental management practices are working effectively.
- Verify compliance with the relevant laws and regulations.

Course Outcomes:

CO1: Understand the overview, objectives, and importance of environmental auditing.
CO2: Identify different types of environmental audits and their advantages.

Unit: 1. Environmental Audit Scheme

Introduction to Environmental Audit
Overview of environmental auditing
Importance of an environmental auditor
The objective of environmental auditing
Objectives
Performance analysis of available environmental management systems
Compliance measures
Types of Environmental Audits
Types of pollution applicable for environmental auditing
Environmental compliance audits
Environmental management audits
Functional environmental audits
Advantages of Environmental Auditing
Benefits of an environmental audit
Limitations of an environmental audit

Unit: 2. Auditors and their roles and responsibilities

Environmental Auditor Do
Responsible for examining and reviewing the company's environmental policies.
Plan audit methodology and procedures
Requirements to become an Environmental Auditor
Environmental Professional – Compliance Environmental Auditor (EPCEA)
Environmental Professional – Environmental Management Systems Auditor (EPEMSA)
Certified Environmental Auditor (CEA)
Duties of Environmental Auditors
Regular auditing of all environmental policies and procedures
How environmental compliance is being handled.
Steps to carry out Environment Audit

Pre–Audit Phase
Audit Phase
Post Audit Phase

References

1. Guidelines of GPCB
2. Guidelines of CPCB
3. Details Regarding Environment Audit
   https://gpcb.gujarat.gov.in/webcontroller/viewpage/details-regarding-environment-audit
4. Environment Audit Scheme
   https://www.scribd.com/document/332051048/Environment-Audit-Scheme
5. Guide on Environmental Audit:
   http://kb.icai.org/pdfs/PDFFile5b28e322df0fd2.63902464.pdf

110394108 AEC
English and Communication Skills Credits: 2

Objectives

- The course aims at inculcating a proficient level of language competency in English among students of B.Sc.
- The objective is to introduce students to Communication as a subject and its foundational theoretical concepts.
- This knowledge will help them handle various day to day situations, both in personal as well as professional world, proficiently.
- The goal is to introduce them to the basics of reading, writing, listening, and speaking communication skills.
- The main objective is to sensitize them to the nuances of basic English communication and its application for various business communication.

Course Outcomes:

CO1: Demonstrate an understanding of communication processes and apply effective communication and business etiquette in workplace and meeting scenarios.

CO2: Develop core communication skills — listening, reading, writing, and speaking — to effectively interpret, analyze, and convey information in professional and social contexts.

Unit 1 Effective Business Communication

1. Communication Skills
   a. Introduction to communication and its importance
   b. Process of Communication
2. Business Etiquette
   a. Importance of business communication and etiquettes
   b. Learning the critical aspects pertaining to workplace etiquette
3. Note-making:
   a. The ability to comprehend the gist, make drafts and concise content

Unit 2 Developing Communication Skills

1. Listening Skills
   a. Ideal process of listening and types of Listening
   b. Effective or Active Listening and techniques to become an active listener
2. Reading Skills
   a. Introduction to reading skills: Introduction and types of reading skills
   b. Comprehension Passage: Reading purposefully and understanding what is read, drawing conclusions, findings and analysis
3. Writing Skills:
   a. Translation and interpretation from Gujarati to English: Basic grammar including parts of speech and sentence structure

4. Speaking Skills
    a. Social communication: Making a request, seeking permission or information, placing and receiving an order, accepting an invitation, giving direction, lecture discussion

Activities:

1. Bring Stories to life
2. Reading photographs
3. I Spy with Words
4. Role Play

Reference Books

1. Middle School English Grammar and Composition by Wren & Martin
2. Business Communication by Meenakshi Raman, Prakash Singh
3. Business English by Pearson Publications
4. English at Workplace by Macmillan Publications
5. Basic communication skills for Technology, Andreja. J. Ruther Ford, 2nd Edition, ++Pearson Education, 2011
6. The Ace of Soft Skills: Attitude, Communication and Etiquette for success, GopalaSwamy Ramesh, 5th Edition, Pearson, 2013
7. Developing your influencing skills, Deborah Dalley, Lois Burton, Margaret, Greenhall, 1st Edition Universe of Learning LTD, 2010

110395109 VAC National Service Scheme (NSS) Credits: 2

Objectives:

The key objectives of studying NSS is to:

- Sensitize the members of National Service Society (NSS) to advocate the motto of NSS "service before self"
- Encourage the members of NSS to undertake any activity or engage in activities reflecting the motto and spirit of NSS.
- Train members of NSS the importance of offering social service to those in need especially during pandemic crisis
- Generate ideas or ways to offer social services or assistance to those in need.

Course Outcomes:

CO1: Understand the history, objectives, and organizational structure of NSS.

CO2: Sensitize to the NSS motto "service before self" and encourage social service activities.

Unit: 1. Introduction of National Service Scheme

History and its Objectives.

Organizational structure of N.S.S. at National, State, University and College Levels.

Advisory committee and their functions with special reference to college principal, Programme officer, N.S.S. group leader and N.S.S. volunteers in the implementation.

Unit: 2. National Integration & Special Programme

Need of National integration.

Various obstacles in the way of National Integration; such as caste, religion, language and provisional problems etc.

- Legal awareness
- Health awareness
- First-aid
- Career guidance
- Leadership training - cum - Cultural Programme
- Globalization and its Economic Social Political and Cultural impacts.

References

1. National Service Scheme Manual, Government of India
2. Training Programme on National Programme scheme, TISS.
3. Orientation Courses for N.S.S. Programme officers, TISS.
4. Case material as Training Aid for field workers, Gurmeet Hans.
5. Social service opportunities in Hospitals, Kapil K. Krishan, TISS.
6. Social Problems in India, Ram Ahuja.

B.Sc. Biotechnology Semester 2

110430201 Major-1 Cell Culture Techniques
Credits: 4

Course Introduction

Cell culture serves as an incredibly adaptable tool for exploring fundamental scientific and translational research inquiries. Employing cell lines in scientific investigations confers a distinctive advantage due to their uniformity, resulting in heightened data reproducibility. Within this paper, we delve into the fundamentals of establishing a cell culture laboratory for different types of cells and provide essential safety protocols for both lab personnel and the cultivated cells. Additionally, we address the issue of potential microbiological contaminants, detailing methods for prevention and early detection.

Course Outcomes:

CO1: Demonstrate fundamental microbial techniques including isolation, cultivation, staining, and anaerobic growth to analyze microbial populations and assess purity and morphology.

CO2: Apply the principles and protocols of animal tissue culture, including aseptic techniques, media selection, and cell line maintenance, while adhering to biomedical ethics and safety guidelines.

CO3: Explain the methodology and significance of plant tissue culture by identifying laboratory setup, culture media, phytohormones, and tissue differentiation processes.

CO4: Analyze the characteristics, classification, and replication of viruses and evaluate methods used in virus cultivation and enumeration in various biological systems.

UNIT I: General Microbial techniques

- Isolation and cultivation of Microorganism.
- Culturable microbial population (mixed culture).
- Concepts of pure culture techniques
- Study of colony characteristics.
- Culture Media preparation – definition of medium, solid, and liquid medium (use of plate, slant, butt, and broth).
- Anaerobic cultivation of microorganisms.
- Principles of simple (e.g., Monochrome) and Differential (e.g., Gram's) staining.

UNIT II: Animal Cell culture

- History of Animal Tissue Culture.
- Laboratory design and equipment used in animal tissue culture.
- Importance of aseptic conditions in animal tissue culture.
- Media used in animal tissue culture.
- Primary culture and cell lines (finite and continuous).

- Biomedical ethics and safety associated with animal tissue culture.
- Stem cells and applications.
- Applications of Animal tissue culture.

UNIT III: Plant Cell culture

- History of plant tissue culture.
- Benefits of plant tissue culture.
- Laboratory design and various equipment used in plant tissue culture.
- Terminology used in plant tissue culture (mother plant, explant, callus, proliferation differentiation, dedifferentiation, redifferentiation)
- Plant Tissue Culture media (Major types of media, constituents of media and their sterilization).
- Role of phytohormones in plant tissue culture.
- Applications of plant tissue culture.

UNIT IV: Cultivation of Virus

- General Characteristics and structure of viruses.
- Nomenclature of Viruses.
- Classification of Viruses (DNA viruses (Group I and II), RNA viruses (Group III, IV, and V), and Retroviruses (Group VI and VII)
- Viral Replication (TMV, T4 and λ phage),
- Lytic and lysogenic cycles.
- Methods of virus cultivation (animal cell culture, embryonated egg and live animal models)
- Methods of virus Enumeration (pfu count method, latex bead method)
- Application of virus cultivation

Reference Books

1. Bhojwani, S. S., & Razdan, M. K. (2004). Plant tissue culture: Theory and practice (Revised ed.). Elsevier.
2. Slater, A., Scott, N. W., & Fowler, M. R. (2008). Plant biotechnology: The genetic manipulation of plants (2nd ed.). Oxford University Press.
3. Reinert, J., & Bajaj, Y. P. S. (1997). Applied and fundamental aspects of plant cell, tissue, and organ culture. Narosa Publishing House.
4. Freshney, R. I. (2015). Culture of animal cells: A manual of basic technique and specialized applications (7th ed.). Hoboken, NJ: John Wiley & Sons.
5. Willey, J. M., Sherwood, L. M., Woolverton, C. J., & Prescott, L. M. (2011). Prescott's microbiology (8th ed.). New York, NY: McGraw-Hill Education.
6. Pelczar, M. J., Reid, R. D., & Chan, E. C. S. (2001). Microbiology (5th ed.). New York, NY: McGraw-Hill Education.
7. Ananthanarayan, R., & Paniker, C. K. J. (2020). Ananthanarayan and Paniker's textbook of microbiology (11th ed.). Hyderabad, India: Universities Press (India) Pvt. Ltd.
8. Stanier, R. Y., Ingraham, J. L., Wheelis, M. L., & Painter, P. R. (1978). General microbiology (5th ed.). London, UK: Macmillan Education.

110430202 Major-2

Cell Culture Techniques Practical Credits: 4

Course Outcomes:

CO1: Perform the isolation of microorganisms from various sources such as human skin, water samples, polluted sites, and sewage, using appropriate microbiological techniques and aseptic procedures.

CO2: Identify and characterize microorganisms, including Gram-negative bacteria and bacteriophages, using staining, cultural, and biochemical methods, and interpret the results accurately.

CO3: Apply plant tissue culture techniques including surface sterilization of explants, media preparation, reagent handling, and lab fumigation to maintain aseptic culture conditions.

CO4: Design and propose a functional layout for an animal tissue culture laboratory, and develop an understanding of animal cell lines through observational learning and demonstrations.

List of Practicals

1. Isolation of microorganisms from human skin.
2. Isolation of microorganisms from water samples.
3. Isolation of microorganisms from polluted Isolation of microorganisms from polluted sites.
4. Identification of Gram-negative bacteria using biochemical kit.
5. Surface sterilization methods of explants (stem, leaf, internode, root).
6. Preparation of media for plant tissue culture.
7. Preparation of reagents and perform fumigation in plant tissue culture laboratory.
8. Isolation of bacteriophage from sewage samples.
9. Design your own animal tissue culture laboratory.
10. Observation of animal cell lines (Demonstration).

Reference Books

1. Freshney, R. I. (1994). *Culture of animal cells: A manual of basic technique* (3rd ed.). Wiley-Liss.
2. Spector, D. L., Goldman, R. D., & Leinwand, L. A. (Eds.). (1998). *Cells: A laboratory manual*. Cold Spring Harbor Laboratory Press.
3. Drexler, H. G., Dirks, W. G., MacLeod, R. A. F., Quentmeier, H., Steube, K. G., Uphoff, C. C., & Schneider, U. (Eds.). (1997). *DSMZ catalogue of human and animal cell lines* (6th ed.). Deutsche Sammlung von Mikroorganismen und Zellkulturen (DSMZ).
4. Razdan, M. K. (2003). *Introduction to plant tissue culture* (2nd ed.). Science Publishers.

5. Smith, R. H. (2012). *Plant tissue culture: Techniques and experiments* (3rd ed.). Academic Press.
6. Bhojwani, S. S., & Razdan, M. K. (1996). *Plant tissue culture: Theory and practice*. Elsevier.
7. Tortora, G. J., Funke, B. R., & Case, C. L. (2006). *Microbiology: An introduction* (9th ed.). Pearson/Benjamin Cummings.

110431203 Minor-1 Bacteriology
Credits: 2

Objectives

- To requisite knowledge about the structural characteristics of bacteria
- Students will understand the structures and purposes of basic components of prokaryotic cells, especially macromolecules, membranes, and organelles. Students will also understand how these cellular components are used to generate and utilize energy in cells.
- To provide the students with a basic fundamental knowledge of how microorganisms grow and react with specific types of growth media and their biochemical reactions with media used in identification.

Course Outcomes:

CO1: Describe the structure and function of various bacterial cell components including surface appendages, surface layers, cytoplasmic organelles, and bacterial endospores.

CO2: Explain the nutritional requirements of bacteria and demonstrate the preparation and use of different types of culture media for the cultivation and growth of bacteria.

Unit 1. A) Structure of typical bacterial cell Surface appendages

i. Flagella
ii. pili and fimbriae
iii. Prosthecae and stalks

Surface layers:

i. Capsule and slime layer
ii. Cell wall
iii. Cytoplasmic membrane and mesosomes

B) Cytoplasm and cell organelles

Cytoplasm

i. Ribosome
ii. Nuclear material and Plasmid
iii. Cellular reserve food material
iv. Bacterial endospore: Spore structure, Sporulation and Spore germination

Unit 2. Introduction to Bacterial nutrition

A) Nutritional diversities in bacteria and Nutritional requirements of bacteria
1. Culture media: Principles of media formulation
2. Media ingredients
3. Types of media

B) Cultivation methods of bacteria, Growth characteristics in broth and solid media

Reference Books

1. Tortora GJ, Funke BR and Case CL. (2008). Microbiology: An Introduction. 9th edition.

Pearson Education
2. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms. 14th edition. Pearson International Edition
3. Wiley J M, Sherwood LM, and Woolverton CJ. (2013) Prescott's Microbiology. 9th Edition. McGraw Hill International.
4. Atlas RM. (1997). Principles of Microbiology. 2nd edition. WM. T. Brown Publishers.
5. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company.
6. Stanier RY, Ingraham J L, Wheelis M L, and Painter P R. (2005). General Microbiology. 5th edition. McMillan.
7. General Microbiology.5th edition. McMillan.
8. Cappucino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited

110431204 Minor-2 Bacteriology Practicals Credits: 2

Course Outcomes:

CO1: Demonstrate the preparation and use of various synthetic, complex, and specialized media for the cultivation of aerobic and anaerobic bacteria.

CO2: Perform and interpret different cultivation techniques for bacterial growth, including streak plate, spread plate, and pour plate methods, and estimate bacterial population by CFU count.

List of Practicals

1. Preparation of different media: Synthetic Media, Complex media (Nutrient Agar, McConkey agar).
2. Cultivation methods for bacteria
   - Broth culture
   - Agar slope/slant culture
   - Agar plate method
   - Streak plate method
   - Pour plate method
   - Spread plate method
3. Study of bacterial structure by structural staining
   - Endospore by Dorner's method
   - Cell wall by Dyer's method
   - Capsule by Hiss's method
   - Granule by Albert's method
4. Use of special staining technique to study bacteria
   - Spirochaetes by Fontana's method

Reference Books

1. Society for General Microbiology. (2006). *Basic practical microbiology: A manual*. Microbiology Society.
2. Patel, R. J. *Experimental microbiology: Volume 1*.
3. Patadia, A., & Varia, A.. *Basic practicals of microbiology: Volume 1*.

110432205 MDC-1 Biomolecules-2
Credits: 2

Course Introduction

Biomolecules are important for the functioning of living organisms. Cells consist of cytoplasm enclosed within a membrane, which contains many biomolecules such as carbohydrates, lipids, proteins and nucleic acids. These are building blocks of living organisms, so the presence of appropriate biomolecules is important for structure and proper function of living cells. Macro biomolecules are built from small organic compounds by linking a lot of smaller units together into a long chain. The course encompasses the structure, monomer, examples, functions, bonds of biomolecules.

Course Outcomes:

CO1: Explain the structure, classification, and functional significance of lipids and fatty acids, including their chemical properties and reactions.

CO2: Analyze the properties, classification, and structural organization of amino acids and proteins, and relate them to their biological roles.

Unit 1: Lipids

- Biological importance of Lipids
- Classification of lipids (Simple, derived and complex)
- Simple Lipids (Oils and fats, waxes)
- Complex lipids (Phospholipids, Glycolipids and Lipoproteins)
- Nomenclature of fatty acids: Alpha and Omega fatty acids, Essential and Non-essential fatty acids
- Saturated and Unsaturated Fatty Acids (MUFA, PUFA)
- Chemical reactions of fatty acids, Chemical constants of oils and fats
- Structures and Functions of - Triacylglycerols, Phospholipids, Glycolipids, Lipoproteins, Steroids

UNIT 2: Amino Acids and Proteins

- General structure of amino acids, Standard amino acids, Non-standard amino acid
- Physical and Chemical properties of amino acids.
- Biological importance of amino acids
- Classification of amino acids based on the structure, polarity, Nutritional requirement, metabolic fate.
- Structural organization of Proteins- Primary, Secondary (alpha helix, beta sheet), Tertiary and Quaternary
- Biological role of proteins

Reference Books

1. Nelson, D. L., Lehninger, A. L., & Cox, M. M. (2008). Lehninger principles of biochemistry (5th ed) WH Freeman Publishers.
2. Berg, JM Tymoczko, JL. Gatto, GJ., Stryer, L. (2015). Biochemistry. (8th ed.) W H Freeman and Company New York.
3. Satyanarayana U. Chakrapani U. (2013). Biochemistry.(4th edition). Elsevier and Books and Allied (P) Ltd
4. Voet, D., & Voet, J. G. (2016). Biochemistry (5th ed.). Hoboken, NJ: J. Wiley & Sons.
5. Jain JL. Jain S. Jain N. (2005). Fundamentals of Biochemistry. (6th edition). S Chand and Company Ltd
6. Rodwell VW. Bender D. Botham KM. Kennelly PJ Weil PA.(2018). Harper's Illustrated Biochemistry.(31st edition) McGraw-Hill Education

110432206 MDC-2 Biomolecules-2 Practical Credits: 2

Introduction:

Biomolecules are important for the functioning of living organisms. Cells consist of cytoplasm enclosed within a membrane, which contains many biomolecules such as carbohydrates, lipids, proteins and nucleic acids. These are building blocks of living organisms, so the presence of appropriate biomolecules is important for structure and proper function of living cells. Macro biomolecules are built from small organic compounds by linking a lot of smaller units together into a long chain. The course encompasses the structure, monomer, examples, functions, bonds of biomolecules.

Course Outcomes:

CO1: Demonstrate the ability to perform qualitative and quantitative biochemical assays for proteins, amino acids, and lipids using standard laboratory techniques.

CO2: Apply principles of analytical biochemistry to evaluate chemical properties such as pH, saponification value, and free fatty acid content in biological samples.

List of Practicals

1. To perform calibration of pH meter using standard solutions.
2. Estimation of protein using Biuret method.
3. Denaturation and Precipitation test of Proteins.
4. Qualitative tests for analysis of amino acids
5. Qualitative tests for analysis of proteins
6. Determination of Saponification value of given lipid sample.
7. Determination of Free fatty acid value of given lipid sample.
8. Qualitative analysis of lipids:
   a) Solubility Test
   b) Oil Spot Test
   c) Emulsification Test
   d) Saponification Test.

Reference Books

1. Indian Council of Medical Research (ICMR). (2000). A manual of laboratory techniques. ICMR Publications.
2. Jayaraman, J. (1981). Laboratory manual in biochemistry. Wiley Eastern Limited.
3. Malhotra, V. K. (1998). Handbook of practical biochemistry (2nd ed.). Jaypee Brothers Medical Publishers.

4. Mukherjee, K. L. (2004). Medical laboratory technology: Vol. 1, 2, & 3. Tata McGraw-Hill Education.
5. Plummer, D. T. (1987). An introduction to practical biochemistry (3rd ed.). McGraw-Hill.
6. Chawla, R. (2014). Clinical chemistry: Interpretation and techniques (3rd ed.). Jaypee Brothers Medical Publishers.
7. Sadasivam, S., & Manickam, A. (1996). Biochemical methods (2nd ed.). New Age International Publishers.
8. American Public Health Association (APHA). (1971). Standard methods for the examination of water and wastewater (13th ed.). APHA.
9. Varley, H., Gowenlock, A. H., & Bell, M. (1980). Practical clinical biochemistry (5th ed.). Heinemann Medical Books.

110393207 SEC

Basic Principles of Good Laboratory Operations Credits: 2

Objective

- In this study, students will enhance precision in experimental data and calculations by mastering the use of significant figures. They will analyse molecular formulas to determine the percentage of elements in organic compounds.
- Additionally, a solid understanding of concentration measures, such as normality, molarity, molality, formality, mole fraction, and various percentage concentrations, will be gained for accurate solution quantification. The comprehension of parts per million (ppm) in extremely dilute solutions will ensure nuanced understanding of concentration levels.
- Moreover, students will achieve proficiency in the Standard Operating Procedures (SOP) for instruments, ensuring correct and efficient usage, maintenance, and adherence to established protocols, thereby enhancing precision and reliability in experimental and analytical processes.

Course Outcomes:

CO1: Master SI units, derived units, conversions, and significant figures for experimental data.

CO2: Calculate percentage of elements from molecular formulas and determine molecular formulas from percentages.

Unit : 1 Fundamentals Principles

- **SI Units**
  - Definitions of the Seven Base Units
  - Derived units
  - Conversion between units
  - Significant figures
- **Percentage of elements from Molecular Formula.**
- **Identification of Molecular formula of Organic Compounds from Percentage of elements.**
- **Concentration of Solutions**
  - Normality
  - Molarity
  - Molality
  - Formality
  - Mole fraction
  - % w / w ; % w / w ; % v / v
  - ppm

Unit : 2 Standard Operating Procedures (SOP) for Instruments

- pH meter
- Conductometer
- Gerber Tube
- Desiccator

- Potentiometer
- Colourimeter
- UV-Vis Spectrophotometer
- Muffle Furnace
- Hot Air Oven
- Incubator
- BOD- Incubator
- COD-Incubator
- Ice Maker
- Kjeldahl Apparatus
- Flame Photometer
- Centrifuge
- Cooling Centrifuge
- Water bath
- UV-Chamber
- M.P. Apparatus
- Turbidimeter
- HVAS (High Volume air sampler)
- Magnetic Stirrer
- Weighing Balance

Reference Books

1. Evert, R. F., Eichhorn, S. E., Perry, J.B. (2012). Laboratory Topics in Botany. W.H. Freeman and Company.
2. Mesh, M.S., Kebede-Westhead, E. (2012). Essential Laboratory Skills for Biosciences. John Wiley & Sons, Ltd.
3. Mu, P., Plummer, D. T. (2001). Introduction to practical biochemistry. Tata McGraw Hill Education.
4. Mann, S. P. (2016). Introductory Statistics, 9th edition. Hoboken, NJ, John Wiley and Sons Inc.
5. Danniel, W.W. (1987). Biostatistics. New York, NY: John Wiley Sons.
6. Jones, A.M., Reed, R., Weyers, J. (2016). Practical Skills in Biology, 6th Edition, Pearson
7. Bisen, P.S. (2014). Laboratory Protocols in Applied Life Sciences, 1st edition. CRC Press

110394208 AEC Practical English
Credits: 2

Objectives

- The course aims at enhancing the knowledge of efficient communication in English among students of B.Sc.
- The objective is to introduce students to various elements of communication both theoretically and through various integrated tasks.
- The goal is to improve their reading, writing, listening, and speaking skills in formal as well as informal everyday interactions.
- The main objective is to shape their verbal and non-verbal behaviour as well written communication, especially in workplace.

Course Outcomes:

CO1: Demonstrate proficiency in various forms of communication—including face-to-face, interpersonal, and intra-personal—while adhering to appropriate cellphone and social media etiquette in professional contexts.

CO2: Apply critical listening, reading, writing, and speaking skills to convey ideas clearly and accurately, including the ability to summarize, paraphrase, translate, and interpret content to avoid miscommunication and plagiarism.

Unit 1 Effective Business Communication

1. Elements of Communication:
   a. Face to Face Communication
   b. Inter-personal Communication
   c. Intra-personal Communication
   d. Perspectives in Communication
2. Cell phone etiquette
   a. Learning how to handle different types of calls.
   b. Social Networking Etiquette: Working with social media sites
3. Summarization and Paraphrasing: The ability to avoid plagiarism while using reference material

Unit 2 Developing Communication Skills

1. Listening Skills
   a. A Better Listener: Deep listening, Full listening, Critical listening, Therapeutic listening
2. Reading Skills:
   a. Analytical Reading: Learning close reading, skimming, scanning, extensive reading
   b. Narration and Description: Learning the difference between narrating a story / event and describing and explaining a process / method / mechanism

3. Writing Skills:
   a. Translation and interpretation from Gujarati to English: Translating paragraphs from Gujarati to English
4. Speaking Skills
   a. Effective Communication: Essential tips to avoid miscommunication and other barriers
   b. Vocabulary: Words often misspelt, confusing words, common errors, better way of saying common words and sentence

Activities:

1. Card Pieces
2. Listen and Draw
3. Guess who am I?
4. Secret Message

Reference Books

1. Middle School English Grammar and Composition by Wren & Martin
2. Business Communication by Meenakshi Raman, Prakash Singh
3. Business English by Pearson Publications
4. English at Workplace by Macmillan Publications
5. Basic communication skills for Technology, Andreja. J. Ruther Ford, 2nd Edition, Pearson Education, 2011
6. The Ace of Soft Skills: Attitude, Communication and Etiquette for success, GopalaSwamy Ramesh, 5th Edition, Pearson, 2013
7. Developing your influencing skills, Deborah Dalley, Lois Burton, Margaret, Greenhall, 1st Edition Universe of Learning LTD, 2010

110395209 VAC Indic Knowledge System-1 Credits: 2

Objective Of the Course

This course is designed to understand and enhance the holistic understanding of Indian Knowledge System. This course provides the basic understanding of the rich Indian knowledge system and its traditions. The course will introduce to the various ancient Indian Schools and its relevance in contemporary period with the great achievements of IKS to the world. It helps in understanding and analysing the Ancient Indian knowledge system.

Course Outcomes:

CO1: Explain the foundational concepts, literature, and educational systems of Indian Knowledge Systems (IKS), including the significance of Shastras and the evolution of Bharatiya education from ancient to modern times

CO2: Analyze and illustrate the contributions of IKS in diverse domains such as mathematics, life sciences, metallurgy, architecture, Ayurveda, and traditional arts, highlighting their scientific principles and global relevance.

Unit 1: Introduction to IKS

1. Introduction to IKS & Its importance
   - Introduction & importance of IKS
   - Various IKS Systems
2. Shashtra – Foundational Literature of Bharatvarsha
   - What is Shashtra?
   - Importance of Shashtra
   - Classification of Shashtra – Vaidic & Avaidic (with examples of imp. Literature)
3. Base of IKS proliferation
   - Bhartiya Education System and its philosophy
   - History of BES from Ancient to Modern
   - Domains of Education: Gurukul, Pathshala, Vidyalay, Vishvavidyalay

Unit 2: Contribution of IKS to the World

1. Mathematics & Astronomy
   - Number System
   - Algebra & Arithmetic
   - Geometry
   - Trigonometry
   - Planetary System
   - Speed of Light
   - Eclipse
2. Life sciences
   - Physics
   - Chemistry
   - Botany
3. Metal Technology

- Mining Techniques
- Types of Metals
- Tools & Techniques for Metal Smelting with examples

4. Town planning & Temple Architecture
   - Indigenous tools & technologies for town planning & Temple Architecture
   - Science of Architecture
   - Lothal, Mohan Jo Daro, Dholavira
   - Angkorvat, Lepakshi Temple, Jagannath Puri Temple, Thanjavur Temple, Modhera and Konark Sun Temple, Hampi Temple Etc.
5. Ayurveda
   - Introduction of Ayurveda- Definition, Branches of Ayurveda, Books and Pioneers
   - Concept of Tri Dosh and importance of its Balance in the body
   - Indic Medical Science Achievement: Tools & Technology
6. Art & Traditions
   - History and Origin
   - Skill Enhancement with 64 Kala
   - Science behind our traditions and rituals

Reference Books

1. Introduction to Indian Knowledge System- Concept and Application by B. Mahadevan, Vinayak Rajat Bhat, Nagendra Pavan R.N.
2. 'Pride of India: A Glimpse into India's Scientific Heritage' by R.M. Pujari, Pradeep Kolhe, N. R. Kumar, Samskrita Bharati Publication.
3. 'Indian Contribution to science', compiled by Vijnana Bharati.
4. 'Knowledge traditions and practices of India', Kapil Kapoor, Michel Danino, CBSE, India.

B.Sc. Biotechnology Semester 3

110430301 Major-1 Bioinstrumentation
Credits: 4

Objective

1. To provide an overview of research instruments: The paper aims to introduce the different types of research instruments and techniques, including Chromatography, Electrophoresis, Radioactivity and Biosensors.
2. To understand principles of various techniques and its industrial applications.
3. To review the current advancements in research instruments: The paper aims to provide a summary of recent advances in research instruments and its applications.

Course Outcomes:

CO1: Understand the principles and applications of chromatographic and electrophoretic techniques for the separation and analysis of biomolecules.

CO2: Demonstrate the ability to prepare buffer and percentage solutions, and perform qualitative and quantitative analysis of carbohydrates, lipids, proteins, and nucleic acids.

CO3: Explain the working principles and uses of biosensors, microarrays, and radioactivity detection methods in biological research.

CO4: Interpret results obtained from spectroscopic and spectrometric techniques such as FT-IR, Raman, Mass Spectrometry, and MALDI-TOF for molecular characterization.

Unit 1: Chromatography

- Introduction to Chromatography,
- Planar chromatography: Paper and Thin Layer chromatography
- Column chromatography: Partition Chromatography
- Gel Permeation Chromatography Ion Exchange Chromatography, Affinity Chromatography, High Performance Liquid Chromatography, Gas Chromatography

Unit 2: Electrophoresis and Radioactivity

- Introduction to Electrophoresis

- Horizontal electrophoresis: Agarose gel electrophoresis, Pulsed Field gel electrophoresis
- Vertical electrophoresis: Polyacrylamide gel electrophoresis (PAGE), Isoelectric focussing and 2D-PAGE
- Geiger-Muller counter
- Scintillation counter
- Autoradiography

Unit 3: Biosensors

- Introduction to Biosensors and its components
- Types of Biosensor: Optical, Potentiometric, Amperometric, Piezoelectric, Thermal
- Applications of Biosensors
- Microarray and its applications

Unit 4: Spectroscopy and Spectrometry

- Infrared spectroscopy and spectrometry, FT-IR
- Optical rotation; circular dichroism and optical rotatory dispersion
- Raman spectroscopy and its applications
- Mass spectrometry, MS-MS
- MALDI-TOF

Reference Books

1. Wilson, K., & Walker, J. (2005). *Principles and techniques of biochemistry and molecular biology* (6th ed.). Cambridge University Press.
2. Upadhyay, A., Upadhyay, K., & Nath, N. (2002). *Biophysical chemistry: Principles and techniques* (3rd ed.). Himalaya Publishing House.
3. Freifelder, D. (1982). *Physical biochemistry: Applications to biochemistry and molecular biology* (2nd ed.). W.H. Freeman and Company.

110430302 Major-2 rDNA Technology
Credits: 4

Objectives

1. **Understand and apply molecular tools:** Identify and explain the properties of host organisms and various cloning vectors, as well as the function and application of key enzymes in recombinant DNA technology.
2. **Execute gene transfer techniques:** Classify and implement various chemical, physical, and biological gene transfer methods, understanding their mechanisms and applications.
3. **Utilize PCR and protein engineering:** Demonstrate proficiency in the principles and applications of Polymerase Chain Reaction (PCR), design primers, and perform site-directed and random mutagenesis. Understand the concepts and applications of protein engineering.
4. **Apply recombinant DNA technology in plants:** Explain the process of genetic engineering in plants, including the use of Agrobacterium vectors, Ti plasmids, and plant viruses. Identify the limitations of these methods and the techniques for direct gene transfer into plant protoplasts.

Course Outcomes:

CO1: Explain the properties of host organisms, types of cloning vectors, and enzymatic tools used in recombinant DNA technology.

CO2: Compare and apply various gene transfer techniques including physical, chemical, and biological methods.

CO3: Design and interpret experiments involving PCR, mutagenesis, and protein engineering.

CO4: Describe and assess genetic engineering strategies used in plant biotechnology.

UNIT I Tools of Recombinant DNA Technology

Molecular tools: Properties of host organisms, types of vectors: Plasmids and other cloning vectors (Bacteriophage-derived vectors, artificial chromosomes), Enzymes used in Recombinant DNA Technology: DNA and RNA polymerases, Nucleases-DNase and RNase, Exo and Endonucleases (Restriction Endonucleases, Restriction and modification system), DNA joining methods : ligases, Linkers and adapters, homopolymer tailing, alkaline phosphatase and other enzymes.

UNIT II Gene Transfer Techniques

Classification of Gene Transfer Techniques, Chemical methods: Transformation, PEG mediated gene transfer, DEAE mediated gene transfer, calcium phosphate co precipitation

method, liposome mediated gene transfer Physical method: Biolistic gene gun, Electroporation, Microinjection, Biological method: Virus mediated gene transfer.

UNIT III Polymerase Chain reaction and Protein engineering

Principle and applications of Polymerase chain reaction (PCR), primer-design, and RT-(Reverse transcription) PCR, Random and site-directed mutagenesis: Primer extension and PCR based methods of site directed mutagenesis, Random mutagenesis, Gene shuffling, production of chimeric proteins, Protein engineering concepts and examples.

UNIT IV Plant Recombinant DNA Technology

Genetic engineering in plants: Use of *Agrobacterium tumefaciens* and *A. rhizogenes*, Vectors for higher plants: Ti plasmid, Binary vector and Cointegrate Ti plasmids, Ri plasmids, Limitations of agrobacterium plasmids, Direct gene transfer into protoplasts, Plant viruses as cloning vectors.

Reference Books

1. Brown TA. (2006). Gene Cloning and DNA Analysis. 5th edition. Blackwell Publishing, Oxford, U.K.
2. Clark DP and Pazdernik NJ. (2009). Biotechnology-Applying the Genetic Revolution. Elsevier Academic Press, USA.
3. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington
4. Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7th edition. Blackwell Publishing, Oxford, U.K.
5. Sambrook J, Fritsch EF and Maniatis T. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press.

110430303 Major-3 Biotechnology Practical Credits: 4

Course Outcomes:

CO1: **Demonstrate proficiency in the use of analytical instruments** such as spectrophotometers and chromatographic systems to quantify and separate biomolecules like proteins, nucleic acids, and amino acids.

CO2: **Apply molecular biology techniques**, including DNA isolation, gel electrophoresis, and restriction digestion, for the analysis and manipulation of nucleic acids.

CO3: **Execute fundamental genetic engineering procedures** such as primer designing, PCR amplification, ligation, and transformation to express or modify genetic material.

CO4: **Critically analyze experimental data and troubleshoot laboratory protocols**, integrating theoretical knowledge of bioinstrumentation and recombinant DNA techniques for effective problem-solving in molecular biology research.

List of Practicals

Bioinstrumentation – Practicals

1. Study and Operation of Double beam spectrophotometer
2. Determination of absorption spectra and Molar Extinction Coefficient for protein
3. Estimation of quality and quantity of DNA using UV spectrophotometry
4. Molecular size determination of DNA using agarose gel electrophoresis
5. Disassembly of Biosensor
6. Separation of Amino acids by Thin Layer Chromatography
7. Separation of Amino acids by Paper Chromatography
8. Separation of mixture of biomolecules by Gel Filtration Chromatography

Recombinant DNA Technology – Practicals

1. Isolation of Genomic DNA from E.coli.
2. Agarose gel Electrophoresis of genomic DNA.
3. Designing PCR primer for browsed sequence from database.
4. PCR amplification of target gene.

5. Ligation of Lambda bacteriophage genomic DNA
6. Restriction digestion of DNA.
7. Preparation of Competent cell.
8. Transformation of Competent cell.

Reference Books

1. Glick, B. R., & Pasternak, J. J. (2003). *Molecular biotechnology: Principles and applications of recombinant DNA* (3rd ed.). ASM Press.
2. Primrose, S. B., & Twyman, R. M. (2006). *Principles of gene manipulation and genomics* (7th ed.). Blackwell Publishing.
3. Sambrook, J., Fritsch, E. F., & Maniatis, T. (2001). *Molecular cloning: A laboratory manual* (3rd ed.). Cold Spring Harbor Laboratory Press.
4. Wilson, K., & Walker, J. (2005). *Principles and techniques of biochemistry and molecular biology* (6th ed.). Cambridge University Press.
5. Upadhyay, A., Upadhyay, K., & Nath, N. (2002). *Biophysical chemistry: Principles and techniques* (3rd ed.). Himalaya Publishing House.
6. Freifelder, D. (1982). *Physical biochemistry: Applications to biochemistry and molecular biology* (2nd ed.). W.H. Freeman and Company.

110432304 MDC-1
Bioenergetics and metabolism Credits: 2

Objectives

1. Understand the metabolic processes involving amino acids, including deamination, transamination, decarboxylation, and the urea cycle.
2. Understand the biosynthesis and degradation of nitrogenous bases, detailing the de novo and salvage pathways for nucleotide biosynthesis and the catabolic pathways for purines and pyrimidines.

Course Outcomes:

CO1: Explain the structure, classification, and functional significance of lipids and fatty acids, including their chemical properties and reactions.

CO2: Analyze the properties, classification, and structural organization of amino acids and proteins, and relate them to their biological roles.

Unit 1 Carbohydrate and Lipid metabolism

Introduction to Carbohydrate and Lipid metabolism, Carbohydrate metabolism: Glycolysis, Gluconeogenesis, Krebs cycle, Electron transport chain, β-Oxidation of saturated fatty acid, α and ω- oxidation.

Unit 2 Amino acid and Nucleic acid metabolism

Introduction to Amino acid and Nucleic acid metabolism, Amino acid metabolism: Deamination (Oxidative and Non-oxidative), Transamination reactions , Decarboxylation reactions , Urea cycle. Nucleic acid metabolism: Biosynthesis of nitrogenous bases (de novo and salvage pathway), Degradation of Nitrogen bases (purine and pyrimidine)

Reference Books

1. Nelson, D. L., Cox, M. M., & Lehninger, A. L. (2008). Lehninger principles of biochemistry (5th ed.). W. H. Freeman and Company.
2. Berg, J. M., Tymoczko, J. L., Gatto, G. J., & Stryer, L. (2015). Biochemistry (8th ed.). W. H. Freeman and Company.

3. Satyanarayana, U., & Chakrapani, U. (2013). Biochemistry (4th ed.). Elsevier; Books and Allied (P) Ltd.
4. Voet, D., & Voet, J. G. (2016). Biochemistry (5th ed.). John Wiley & Sons.
5. Jain, J. L., Jain, S., & Jain, N. (2005). Fundamentals of biochemistry (6th ed.). S. Chand and Company Ltd.
6. Rodwell, V. W., Bender, D. A., Botham, K. M., Kennelly, P. J., & Weil, P. A. (2018). Harper's illustrated biochemistry (31st ed.). McGraw-Hill Education.

110432305 MDC-2

Bioenergetics and metabolism Practical Credits: 2

Course Outcomes:

CO1: Perform quantitative estimations of key nitrogenous waste products and liver enzyme activities in biological samples using biochemical techniques.

CO2: Interpret biochemical assay results to assess physiological and pathological states of biological systems.

List of Practicals

Bioenergetics and metabolism – Practicals

1. Estimation of urea in given biological sample
2. Estimation of uric acid in given biological sample
3. Estimation of Serum Glutamate Oxoglutarate Transaminase activity in the given sample
4. Estimation of Serum Glutamate Pyruvate Transaminase activity in the given sample
5. Estimation of DNA from given sample

Reference Books

1. Indian Council of Medical Research (ICMR). (2000). A manual of laboratory techniques. ICMR Publications.
2. Jayaraman, J. (1981). Laboratory manual in biochemistry. Wiley Eastern Limited.
3. Malhotra, V. K. (1998). Handbook of practical biochemistry (2nd ed.). Jaypee Brothers Medical Publishers.
4. Mukherjee, K. L. (2004). Medical laboratory technology: Vol. 1, 2, & 3. Tata McGraw-Hill Education.
5. Plummer, D. T. (1987). An introduction to practical biochemistry (3rd ed.). McGraw-Hill.
6. Chawla, R. (2014). Clinical chemistry: Interpretation and techniques (3rd ed.). Jaypee Brothers Medical Publishers.
7. Sadasivam, S., & Manickam, A. (1996). Biochemical methods (2nd ed.). New Age International Publishers.
8. American Public Health Association (APHA). (1971). Standard methods for the examination of water and wastewater (13th ed.). APHA.
9. Varley, H., Gowenlock, A. H., & Bell, M. (1980). Practical clinical biochemistry (5th ed.). Heinemann Medical Books.

110393306 SEC Basics of Nanotechnology Credits: 2

Course Objectives:

- Understand the fundamental concepts and principles of nanoscience and nanotechnology.
- Gain knowledge about the historical development and current trends in the field.
- Learn about different types of nanomaterials, including nanoparticles, nanowires, nanotubes, and thin films.
- Study the methods of synthesis and fabrication of nanomaterials.

Course Outcomes:

CO1: Understand the foundational principles of nanotechnology, including atomic-scale structure, quantum mechanical concepts, and crystal geometry relevant to nanoscale materials.

CO2: Explain the origin, classification, and physical significance of various nanomaterials, quantum structures, and confinement effects, with applications in modern nanoscience.

Unit 1:

Background to Nanotechnology: Scientific revolution, molecular and atomic size, emergence of Nanotechnology, Challenges in Nanotechnology, Carbon age :(new forms of carbon graphene sheet to CNT)

Introduction to Quantum Mechanics & Crystal structure De-Broglie hypothesis, Uncertainty Principle, Schrödinger Equation, Operator, Particle in a 1D box, Particle in a 3D box (qualitative), Crystal structure, Crystal orientation, Crystal planes, Bravais lattice, Miller Indices, Atomic Packing Density, crystal symmetry, ZnS, Diamond and NaCl crystal structure, Melting point, Coordination number, Atomic Bonding.

Unit 2:

Introduction to Nanoscience Emergence of Nanoscience with special reference to Feynman and Drexler, Role of particle size, Spatial and temporal scale, Exciton, Concept of confinement, strong and weak confinement with suitable examples, Development of quantum structures, Basic concept of quantum well, quantum wire and quantum dot. Density of states of 1D, 2D & 3D structure, surface effect.

Types of Nanomaterials Nanoclusters, Solid solutions, Thin film, Nanocomposites (Metal Oxide and Polymer based), Core Shell Nanostructure, Buckyballs, Carbon nano tubes and, Zeolites minerals, Dendrimers, Micelles, Liposomes, Block Copolymers, Porous Materials, Metal Nanocrystals, Semiconductor nanomaterials.

Reference Books

1. **Material Science & Engineering – An Introduction** (9th Edition, 2014) by William D. Callister Jr. Wiley.
2. **Nanoscale Materials** (1st Edition, 2003) by Luis M. Liz-Marzán & Prashant V. Kamat. Springer.
3. **Introduction to Nanotechnology** (1st Edition, 2003) by Charles P. Poole Jr. & Frank J. Owens. Wiley-Interscience.
4. **Nanotechnology: Basic Science and Emerging Technologies** (1st Indian Edition, 2008) by M. Wilson, K. Kannangara, G. Smith, M. Simmons & B. Raguse. Overseas Press India Pvt. Ltd., New Delhi.
5. **The Chemistry of Nanomaterials: Synthesis, Properties & Applications** (1st Edition, 2004) by C. N. R. Rao & A. Müller. Wiley-VCH.
6. **Nanostructures and Nanomaterials: Synthesis, Properties and Applications** (2nd Edition, 2011) by Guozhong Cao. Imperial College Press.
7. **Handbook of Nanostructured Materials & Nanotechnology: Optical Properties** (Vol. 4, 1st Edition, 2000) by Hari Singh Nalwa. Academic Press.
8. **Nano Fabrication Towards Biomedical Applications** (1st Edition, 2005) by C. S. S. R. Kumar, Wonbong Choi & Jo-won Lee. Wiley-VCH Verlag GmbH & Co., Weinheim.

110394307 AEC Effective Communication Skill
Credits: 2

Course Outcomes:

CO1: Demonstrate effective written communication by composing analytical paragraphs, professional emails, and academic texts with appropriate structure, clarity, and citation practices.

CO2: Apply verbal and non-verbal communication strategies to deliver structured oral presentations and speeches, incorporating audience analysis and appropriate use of audio-visual aids

Unit 1 Corporate Communication

1. Communication Style Matrix

a. Direct Communication Style
b. Spirited Communication Style
c. Systematic Communication Style
d. Considerate Communication Style

2. E-mail etiquette

a. Learning to make attachments in mail and downloading and uploading files
b. Dos and Don'ts of Personal and Professional mail

3. Analytical Paragraph

a. The ability to describe, analyze, compare and evaluate given data

Unit 2 Dynamics of Communication Sills

1. Listening Skills

a. Barriers of effective listening:
Cultural barrier, Psychological barrier, Linguistic barrier, Physical barrier, Organizational barrier

2. Reading Skills:

a. Understanding the content of a Book:
First page details, Publication details, Copyright information, Index, References and Bibliography

3. Writing Skills:

a. Academic writing: The ability to write a research-based article
b. Creating Bibliography: The ability to do in-text citation as well as creating a citation list

4. Speaking Skills

a. Preparing a speech: Self-introduction, Logical coherence, Topic and Audience
b. Oral Presentation: Audio - Visual aids, preparing materials, language, stage movement, hand movement, eye contact, overall personality, handling the audience

Activities:

1. Owner and Auction

2. Best Advertisement competition
3. Match the sound
4. Elocution competition

Reference Books

1. Soft skills and professional communication, Francis Peters SJ, 1stEdition, McGraw Hill Education, 2011
2. Developing your influencing skills, Deborah Dalley, Lois Burton, Margaret, Greenhall, 1st Edition Universe of Learning LTD, 2010
3. Middle School English Grammar and Composition by Wren & Martin
4. Business Communication by Meenakshi Raman, Prakash Singh
5. English at Workplace by Macmillan Publications
6. Basic communication skills for Technology, Andreja. J. Ruther Ford, 2nd Edition, Pearson Education, 2011
7. The Ace of Soft Skills: Attitude, Communication and Etiquette for success, GopalaSwamy Ramesh, 5th Edition, Pearson, 2013
8. Developing your influencing skills, Deborah Dalley, Lois Burton, Margaret, Greenhall, 1st Edition Universe of Learning LTD, 2010

110395308 VAC Climate Change
Credits: 2

Course Objectives:

- Understand the concepts of global warming, climate change, and the evolution of Earth's atmosphere.
- Study the impacts of climate change on weather patterns, agriculture, biodiversity, and human health.
- Learn about ozone layer depletion, its causes, effects, and mitigation measures.
- Explore environmental policies, international agreements like the Montreal and Kyoto protocols, and climate change mitigation strategies.

Course Outcomes:

CO1: Understand the basics of climate and weather systems, including Earth's energy balance.

CO2: Identify causes of climate change, both natural and anthropogenic, and their impacts.

Unit: 1. Introduction to Climate Change and its Impacts

- Global warming and climate change Evolution and development of Earth's atmosphere; atmospheric structure and composition.
- Significance of atmosphere in making the Earth, the only biosphere.
- Trends of global warming and climate change; drivers of global warming and Global Warming Potential (GWP) & climate change.
- Impact of climate change on atmosphere, weather patterns, sea level rise, agricultural productivity and biological responses - range shift of species, **CO2:** fertilization and agriculture.
- Impact on economy and spread of human diseases.

Unit: 2. Policies and Mitigation

- Ozone layer depletion, environmental policy & agreements Ozone layer or ozone shield.
- Importance of ozone layer; ozone layer depletion and causes; Chapman cycle.
- Process of spring time ozone depletion over Antarctica.
- Ozone depleting substances (ODS); effects of ozone depletion.
- Mitigation measures and international protocols. Environmental policy debate.
- International agreements; Montreal protocol 1987; Kyoto protocol 1997.
- Convention on Climate Change; carbon credit and carbon trading; clean development mechanism.

Reference Books

1. Barry, R. G. 2003. Atmosphere, Weather and Climate. Routledge Press, UK.
2. Gillespie, A. 2006. Climate Change, Ozone Depletion and Air Pollution: Legal Commentaries with Policy and Science Considerations. Martinus Nijhoff Publishers.
3. Manahan, S.E. 2010. Environmental Chemistry. CRC Press, Taylor and Francis Group.
4. Maslin, M. 2014. Climate Change: A Very Short Introduction. Oxford Publications.
5. Mathez, E.A. 2009. Climate Change: The Science of Global Warming and our Energy Future. Columbia University Press.
6. Mitra, A.P., Sharma, S., Bhattacharya, S., Garg, A., Devotta, S. &Sen, K. 2004. Climate Change and India. Universities Press, India.

Philander, S.G. 2012. Encyclopedia of Global Warming and Climate Change (2nd edition). Sage Publications.

B.Sc. Biotechnology Semester 4

110430401 Major-1
Environmental Biotechnology Credits: 4

Introduction:

Environmental Biotechnology is an interdisciplinary field that applies biological principles and techniques to address environmental challenges. This course provides comprehensive insight into the biological management of environmental pollutants and sustainable technological interventions. Students will explore key concepts such as the detection and control of water pollution, various bioremediation strategies for contaminated environments, the role of microorganisms in biofuel production and mineral recovery, and the application of biotechnology in waste management and biofertilizer development. By integrating theoretical knowledge with practical applications, the course equips students to understand and develop eco-friendly solutions to real-world environmental problems, contributing to sustainable development and resource conservation.

Course Outcomes:

CO1: Understand the sources and measurement techniques of water pollution, and demonstrate the ability to detect pathogenic organisms in potable water using standard microbiological tests.

CO2: Explain the principles and applications of bioremediation techniques for soil and water contaminated with oil spills, heavy metals, pesticides, and toxic chemicals.

CO3: Analyze the role of microorganisms in the production of biofuels and in the recovery of minerals through bioleaching and Microbial Enhanced Oil Recovery (MEOR).

CO4: Apply environmental biotechnological approaches in waste treatment and biofertilizer production for sustainable agricultural and municipal management.

Objective

1. To provide an overview of research instruments: The paper can aim to introduce the different types of research instruments, including Chromatography, Electrophoresis, Radioactivity and Biosensors.

2. To describe the principles and methods of instrument development: The paper can aim to explain the principles and methods of developing research instruments.

3. To review the current advancements in research instruments: The paper can aim to provide a summary of recent advances in research instruments and its applications.

Unit 1 Water pollution

- Sources of Water Pollution

● Measurement of Water Pollution (BOD, COD, TOC),

● Detection of Pathogenic organisms in potable water (Indicator organisms, Standard qualitative procedure: Presumptive test/MPN test, confirmed and completed tests for fecal coliforms, Membrane filter technique, IMViC)

Unit 2 Bioremediation

● Types of Bioremediations

○ In-situ remediation

○ Ex-situ Bioremediation

● Bioremediation of soil & water contaminated with oil spills, heavy metals

● Phyto-remediation.

● Degradation of pesticides and other toxic chemicals by microorganisms- degradation of aromatic and chlorinated hydrocarbons and petroleum products.

Unit 3 Biofuels and Mineral recovery

● Biofuels: Bioethanol, Biomethane Biohydrogen and Biodiesel

● Microbial Enhanced Oil Recovery (MEOR)

● Mechanism of Bioleaching (Direct and Indirect Bioleaching)

● Process of Bioleaching (Dump leaching, Heap leaching)

Unit 4 Applications of Environmental Biotechnology

● Treatment of municipal waste and Industrial effluents.

● Treatment of Liquid wastes: Preliminary treatment, Primary treatment, secondary treatment and tertiary treatment.

● Bio-fertilizers o Symbiotic and asymbiotic nitrogen fixing bacteria o Phosphate Solubilizing Bacteria o Potassium Mobilizing bacteria o Algal and fungal biofertilizers (VAM)

Reference Books

1. Bhattacharyya, B. C., & Banerjee, R. (2007). Environmental biotechnology. Oxford University Press.
2. Evans, G. M., & Furlong, J. C. (2003). Environmental biotechnology: Theory and application. Wiley-Blackwell.
3. Scragg, A. (2005). Environmental biotechnology (2nd ed.). Oxford University Press.
4. Atlas, R. M., & Bartha, R. (1998). Microbial ecology: Fundamentals and applications (4th ed.). Pearson Education.

5. Agarwal, S. K. (2005). Environmental biotechnology. APH Publishing Corporation.
6. American Public Health Association (APHA), American Water Works Association (AWWA), & Water Environment Federation (WEF). (1985). Standard methods for the examination of water and wastewater (16th ed.). American Public Health Association.
7. Garg, V. K., Bishnoi, M. S., & Malik, C. P. (2002). Introductory text on environmental policies and laws. Kalyani Publishers.
8. Satyanarayana, U. (2008). Biotechnology (1st ed., Reprinted). Books and Allied (P) Ltd.
9. Singh, B. D. (2004). Biotechnology: Expanding horizons. Kalyani Publishers.

110430402 Major-2 Bioprocess Technology Credits: 4

Objective

1. To provide an overview of bioprocess technology: The paper can aim to introduce the principles of bioprocess technology, including the basic concepts, process design, and optimization.

2. To describe the different types of operations bioprocess: The paper can aim to explain the different types of bioprocesses, type reactors, scale up process and downstream processing.

Course Outcomes:

CO1: Explain the principles of microbial growth, culture systems, and bioreactor design, including various types and components.

CO2: Demonstrate the operational aspects of bioreactors, including sterilization techniques, inoculation procedures, aeration, and monitoring and control systems.

CO3: Analyze the formulation of fermentation media and the process of inoculum development for bacterial, yeast, and fungal systems.

CO4: Evaluate the various stages of downstream processing and methods for the recovery and purification of fermentation products.

Unit 1: Bioreactors

● Introduction to fermentation, Principle of Microbial growth and Culture systems (Batch, continuous and fed batch culture)

● Bioreactor design: Parts & Functions

● Bioreactor: Material, Containments

● Types of Bioreactors: Stirred Tank Reactor, Air-lift, Hollow fiber, Membrane reactors.

● Introduction to Scale up process, Upstream and Downstream

Unit 2: Operation of Bioreactor

● Sterilization (Sterilization of media, Use of high-pressure steam: principle, batch and continuous sterilization process)

● Inoculation and Sampling

● Aeration

● Control Systems (pH, Temperature, Dissolved Oxygen, Foam Control, Gas control)

● Cleaning

Unit 3: Substrate of Bioreactor (Fermentation media and Inoculum development)

● Principles of media formulation

● Media ingredients: water, carbon sources, nitrogen sources, minerals, growth factors, buffers, chelators, precursors, inducers, inhibitors, antifoam agents

● Inoculum development: Principles for development of seed culture for bacterial, yeast and fungal process

Unit 4 Downstream processing

● Stages in downstream processing

● Cell removal by Foam separation, Sedimentation, Filtration, Centrifugation

● Cell Disruption methods: Physical, Chemical and Enzymatic

● Concentration by Evaporation, Liquid-liquid extraction, Membrane filtration, Precipitation, and Adsorption.

● Recovery/Purification of fermentation product by Chromatography and Ultrafiltration

● Formulation of purified fermentation product: Crystallization and Drying.

Reference Books

1. Principles of Fermentation Technology, Stanbury P F, Whitaker A and Hall SJ, (1995),

2nd edition, Pergamon Press, London, UK

2. Industrial Microbiology: An Introduction, Waites, M J and Morgan N L, (2002),

Blackwell Science

3. Biotechnology: A Textbook of Industrial Microbiology, Crueger W and Crueger A,

(2000), 2 nd edition, Panima Publishing Corporation, New Delhi, India

4. Fermentation Microbiology and Biotechnology, El-Mansi E M T, Bryce CFA, Dahhou B,

Sanchez S, Demain AL, Allman AR (eds), (2011), 3 rd edition, CRC Press; Taylor and

Francis Group, Boca Raton

5. Industrial Microbiology, Casida LE, Jr. (1968), Wiley Eastern Ltd, New Delhi, India

110430403 Major-3 Biotechnology Practical Credits: 4

Course Outcomes:

CO1: Apply analytical techniques to evaluate key water quality parameters such as BOD, COD, hardness, total solids, and total dissolved solids in wastewater samples.

CO2: Demonstrate microbial techniques for bioremediation by assessing dye decolourization and performing IMViC tests for microbial identification.

CO3: Evaluate the effect of various aeration conditions on oxygen transfer rates using the sulphite oxidation method.

CO4: Perform fermentation processes for the production and estimation of industrially important products such as citric acid and ethanol.

List of Practicals

Environmental Biotechnology

1) Determination of Biochemical Oxygen Demand.

2) Determination of Chemical Oxygen Demand.

3) To determine the amount of hardness present in a wastewater sample by EDTA method.

4) To estimate Total Solids and Total Dissolved Solids in the Waste water.

5) Measurement of Decolourization of dye effluent by microbial activity.

6) To perform IMViC test for identifying and differentiating bacteria of Enterobacteriaceae family.

Environmental Biotechnology

1. Determine the effect of aeration parameters on Oxygen Transfer Rate (OTR) by Sulphite oxidation.

    1.1. Static condition

    1.2. Shaking condition

    1.3. Sparging condition

2. Extraction and purification of citric acid from the culture medium of Aspergillus niger.

3. Production of ethanol by yeast.

4. Estimation of alcohol concentration in the given sample.

Reference Books

1. Bhattacharyya, B. C., & Banerjee, R. (2007). Environmental biotechnology. Oxford University Press.
2. Evans, G. M., & Furlong, J. C. (2003). Environmental biotechnology: Theory and application. Wiley-Blackwell.
3. Scragg, A. (2005). Environmental biotechnology (2nd ed.). Oxford University Press.
4. Wilson, K., & Walker, J. (2005). *Principles and techniques of biochemistry and molecular biology* (6th ed.). Cambridge University Press.
5. Stanbury, P. F., Whitaker, A., & Hall, S. J. (1995). Principles of fermentation technology (2nd ed.). Pergamon Press.
6. Waites, M. J., Morgan, N. L., Rockey, J. S., & Higton, G. (2001). Industrial microbiology: An introduction. Blackwell Science.
7. Crueger, W., & Crueger, A. (2000). Biotechnology: A textbook of industrial microbiology (2nd ed.). Panima Publishing Corporation.
8. El-Mansi, E. M. T., Bryce, C. F. A., Dahhou, B., Sánchez, S., Demain, A. L., & Allman, A. R. (Eds.). (2011). Fermentation microbiology and biotechnology (3rd ed.). CRC Press, Taylor & Francis Group.
9. Casida, L. E., Jr. (1968). Industrial microbiology. Wiley Eastern Ltd.

110431404 Minor-1 Microbial Analysis of Food Credits: 2

Learning objectives:

- Describe how microorganisms interact with food substrates and influence fermentation, spoilage, and safety.
- Perform laboratory techniques for isolating, identifying, and quantifying microorganisms in food and dairy products.
- Assess the impact of microbial contamination on food safety and quality, including methods for detection and control.

Course Outcomes:

CO1: Information regarding substrate for microorganisms in food and its role in spoilage.

CO2: Information regarding involvement of microorganisms in different types of food related infections.

Unit I Microbial Spoilage of Food **Teaching Hours: 15**

[A] Food as a substrate for microorganisms

[B] Contamination of food from soil, water, air and during handling & processing

[C] Microbial flora of food: Meats, Eggs, Fruits & Vegetables, Milk (biochemical, temperature and pathogenic types of microorganisms)

[D] Factors affecting microbial growth in food: Intrinsic and Extrinsic

[E] Microbial spoilage of food:

1. Biochemical changes: Putrefaction, Fermentation, Rancidity
2. Spoilage of fresh foods, fresh milk, canned foods

Unit II Food Infection and Poisoning **Teaching Hours: 15**

[A] Food infections: Microorganism involved, source of infection, incubation period and characteristics in brief:

1. Bacterial infections: *Salmonella sp., Shigella sp, Vibrio sp., Campylobacter jejuni, Listeria monocytogenes*

2. Viral infections: Rotavirus, Hepatitis A, Poliovirus

3. Protozoal infections: Entamoeba

[B] Food poisoning:

1. Bacteria as poisoning agent: *Staphylococcus aureus, Clostridium botulinium*

2. Molds as poisoning agents: *Claviceps purpurea, Aspergillus flavus, Fusarium moniliformis.*

[C] Microbiological examination of foods

1. Generalized scheme for microbiological examination of foods

2. Microscopic techniques

3. Culture Techniques

Reference Books

1. Pelczar Jr, M J, Chan E C S, Krieg N R, (1986), Microbiology: AnApplication Based Approach, 5th edn. McGraw-Hill Book Company, NY

2. Frazier W C and Westhoff D C (2018), Food Microbiology, 5th edn. McGraw-Hill Book Company, NY, Adapted by N. M. Vanitha, with special emphasis on Food of Indian Origin.

3. Prescott L, Harley J P, and Klein D A, (2008), Microbiology, 7th edn. Wm C. Brown - McGraw Hill, Dubuque, IA.

110431405 Minor-2 Microbiology Practical
Credits: 2

Course Outcomes:

CO1: Apply appropriate microbiological techniques such as standard plate count, MPN, MBRT, RRT, and fecal coliform testing for the quantitative and qualitative analysis of microbial load in soil, water, food, and milk samples.

CO2: Identify and differentiate specific groups of microorganisms through microscopic examination, staining methods, and the study of permanent slides, including acid-fast bacteria, Clostridium spp., Fusarium spp., Amoeba, and Spirulina.

Microbial analysis of food

1. Standard plate count of food and milk sample

2. Determination of microbial load by use of MBRT of raw, boiled and pasteurized milk

3. Determination of microbial load by use of RRT of milk sample

4. Detection of Acid-fast bacteria in milk

5. Study of permanent slides: Acid fast bacteria, *Clostridium spp., Fusarium spp, Amoeba, Spirulina*

Reference Books

1. Society for General Microbiology. (2006). *Basic practical microbiology: A manual*. Microbiology Society.
2. Patel, R. J. *Experimental microbiology: Volume 1*.
3. Patadia, A., & Varia, A.. *Basic practicals of microbiology: Volume 1*.

110393406 SEC Biostatistics
Credits: 2

Course Outcomes:

CO1: Explain the fundamental concepts, scope, types of data, sampling methods, and tools used in biostatistics, and effectively represent data using textual, tabular, and graphical formats.

CO2: Compute and interpret measures of central tendency (mean, median, and mode) and measures of dispersion (range, variance, standard deviation) for grouped and ungrouped data, and evaluate their merits and limitations in biological data analysis.

Unit 1: Analysis of Biochemical data

- Introduction and scope in biostatistics
- Kinds of data and variables based on nature (numerical discrete continuous, categorical ordinal and nominal)
- Based on source primary and secondary data
- Sampling Methods: Random and Non-Random Methods
- Representation of data: Textual, Tabular, and Graphical Methods
- Tools and software used in Biostatistics.
- Applications of Biostatistics

Unit 2: Central Tendency and Dispersion

- Measurement of central tendency: Mean, Mode, Median, grouped data, ungrouped data; merits and demerits.
- Measures of dispersion: Range, Variance and Standard Deviation of grouped and ungrouped data; merits and demerits

Reference Books

1. Rosner, B. A. (2006). *Fundamentals of biostatistics* (6th ed.). Brooks/Cole, Cengage Learning.
2. Khan, I. A., & Khanum, A. (n.d.). *Fundamentals of biostatistics* (5th ed.). Ukaaz Publications.
(Note: Year of publication not clearly available; consider checking the actual book for the correct year.)

3. Mahajan, B. K. (2010). *Methods in biostatistics for medical students and research workers* (7th ed.). Jaypee Brothers Medical Publishers.
4. Rastogi, V. B. (2009). *Fundamentals of biostatistics*. Ane Books Pvt. Ltd.
5. Kothari, C. R. (2004). *Research methodology: Methods and techniques* (2nd ed.). New Age International Publishers.
6. Bosu, O., & Thukral, S. K. (n.d.). *Bioinformatics: Databases, tools and algorithms*. Oxford Book Company.
   (Note: Year not clearly available online; verify from the actual book if possible.)
7. Mount, D. W. (2004). *Bioinformatics: Sequence and genome analysis* (2nd ed.). Cold Spring Harbor Laboratory Press.
8. Attwood, T. K., & Parry-Smith, D. J. (1999). *Introduction to bioinformatics*. Pearson Education Limited.

110394407 AEC
Life Skills and Personality Development Credits: 2

Course Outcomes:

CO1: Demonstrate professional grooming, dressing etiquette, and effective interpersonal skills tailored to diverse formal and corporate settings.

CO2: Develop and present well-structured written documents including reports, resumes, and formal letters using appropriate tone, format, and language conventions.

Unit 1 Corporate Communication

1. **Dressing and Grooming Skills**:

a. To become aware of diverse style of dressing and handling your personality at different occasions

2. **Report Writing:**

a. The ability to document and explain data obtained through graphs and charts

Unit 2 Dynamics of Communication Skills

1. **Listening Skills**

a. Feedback: Providing feedback and Appropriate responding

2. **Reading Skills**

a. Pronunciation: Phonetics- study of speech sound, and learning silence letters

3. **Writing Skills**

a. CV/ Resume writing: The ability to write an application for a job with a covering letter

b. Formal Letters: The ability to write a letter of request, complaint, apology, order, etc.

4. **Speaking Skills**

a. Interview skills: Body language, dressing sense, polite responses, asking the right question in right way, preparation strategy, understanding the organization

Activities:

1. Mock Product designing and selling

2. Act it out
3. Writing Real Letters
4. Mock Interview

Reference Books

1. Letters for All Occasion by A S Myers

2. Spoken English by V. Shasikumar and P V Dhanija

3. Soft skills and professional communication, Francis Peters SJ, 1stEdition, McGraw Hill Education, 2011

4. Developing your influencing skills, Deborah Dalley, Lois Burton, Margaret, Greenhall, 1st Edition Universe of Learning LTD, 2010
5. Middle School English Grammar and Composition by Wren & Martin
6. Business Communication by Meenakshi Raman, Prakash Singh
7. English at Workplace by Macmillan Publications
8. Basic communication skills for Technology, Andreja. J. Ruther Ford, 2nd Edition, Pearson Education, 2011
9. The Ace of Soft Skills: Attitude, Communication and Etiquette for success, GopalaSwamy Ramesh, 5th Edition, Pearson, 2013
10. Developing your influencing skills, Deborah Dalley, Lois Burton, Margaret, Greenhall, 1st Edition Universe of Learning LTD, 2010

110395408 VAC Indic Knowledge System-2 Credits: 2

Objective Of the Course

This course is designed to understand and enhance the holistic understanding of Indian Knowledge System. This course provides the basic understanding of the rich Indian knowledge system and its traditions. The course will introduce to the various ancient Indian Schools and its relevance in contemporary period with the great achievements of IKS to the world. It helps in understanding and analyzing the Ancient Indian knowledge system.

Course Outcomes:

CO1: Describe and interpret the foundational vocabulary, philosophical principles, and textual traditions of Indian Knowledge Systems (IKS), including the methods of studying Shastras and techniques of manuscript preservation.

CO2: Analyze and evaluate the historical contributions of IKS in science & technology, trade, administration, and arts, with experiential understanding through practices such as yoga, mantra chanting, and indigenous technologies.

Unit-1 Understanding of IKS

o Unique aspects of IKS: Idea Vs Ideology, IKS in present perspective

o Vocabulary related to IKS – Dharma, Sanatan, Moksha, Karma etc.

o Science of Sastra

Shruti & Smriti Parampara

Methods to Study Shashtra

Overview of Shastrartha Parampara

o Manuscriptology: Art of preserving Knowledge

Script & Language, Sanskrit Language and it's importance

Manuscripts: It's History, types and Its

preservation Techniques

Famous Manuscript repositories

Unit-2 Contribution of IKS in

o Science & Technology

Astronomy

Encryption Method used in ancient India

Introduction to Yantra Shashtra – Vaimanik

Shashtra

Textile Technologies

Agriculture Technologies

Forest Management and Water management techniques

o Trade & Commerce

Concept of Indic Economy (ArthVyavastha)

Trade and Commerce

o Administration & Governance

Concept Introduction: Indic Administration

Administrative Structure in Ancient India

Niti Sashtra (Law & Orders)

o Fine Art & Performing Art

Performing Art: Bhav, Ras, Types, Process, Famous Literature, Famous Art & Artists

Fine Art: Types, Process, Famous Literature,

Famous Art and Artists

Case Studies Local Art & Tradition

o Experiential sessions

Introduction to Ashtang Yog and practice of Yogasan & Pranayam

Methods of Chanting the Mantra and Chanting Practice

Reference Books

1. Introduction to Indian Knowledge System- Concept and Application by B. Mahadevan, Vinayak Rajat Bhat, Nagendra Pavan R.N.
2. R.M. Pujari, Pradeep Kolhe, N. R. Kumar, 'Pride of India: A Glimpse into India's Scientific Heritage', Samskrita Bharati Publication.
3. 'Indian Contribution to science', compiled by Vijnana Bharati.
4. 'Knowledge traditions and practices of India', Kapil Kapoor, Michel Danino, CBSE, India.