

SARVAJANIK UNIVERSITY
FACULTY OF SCIENCE



SARVAJANIK
UNIVERSITY

INCLUSIVE | INTEGRATED | INNOVATIVE

Faculty of Science

B. Sc. (Hons) Chemistry

DETAILED CURRICULUM

(W.E.F. 2024-25)

SARVAJANIK UNIVERSITY
FACULTY OF SCIENCE

Semester 4

B.Sc. (Hons) Chemistry Semester 4			
Sr. No.	Category	Course Title	Course Type
1	Major	Physical Chemistry-1	Compulsory
2		Industrial Chemicals and Environment	Compulsory
3		Organic Chemistry-2	Compulsory
4	Minor	Fundamentals of Agroforestry	Elective
		Analytical chemistry-I	
		Criminalistics-1	
		Introduction to Industrial Fermentation Processes	
		Fundamentals of Industrial Safety	
		Introduction to Clinical Laboratories and GLP	
5	SEC	Forest Mensuration	Elective
6	VAC	Indian Knowledge Systems (Parampara : Sustainable Practices of Bharat)	Elective
		Indian Knowledge Systems (Vedic Microbiology)	
		Indian Knowledge Systems (Tark evam Krutrim Buddhimata)	
7	AEC	Environmental Studies	Compulsory

Faculty: Science	Department: Chemistry
Program: B.Sc.	Semester - 4
Subject: Physical Chemistry - 1	Type: Major
Credits: 04	
Course description: This Course Paper proposes to teach about: The physical states of matter: solid, liquid, gases – their physical properties and relative behaviour at varying conditions of temperature, pressure, volume, constitutive properties, chemical kinetics and nuclear chemistry.	
Student learning outcome: After completing this course, the students will be able to learn: Characteristics and parameters, properties and behaviour of gases, liquids, solutions, solids, constitutive properties of liquids, chemical kinetics and nuclear chemistry- principles and laws, theories-equations and applications in different fields.	

Reference Books:

- General Chemistry, John C. Kotz, Paul M. Treichel, John R. Townsend, 1st Edition, 3rd Reprint, 2011, Brooks/Cole, Cengage Learning.
- University Chemistry, Bruce H. Mahan, 3rd Edition, 13th Reprint, 1998, Narosa Publishing House.
- Text Book of Engineering Chemistry, O.P. Aggarwal, 3rd Edition, 2001, Khanna Publishers.
- Essentials of Physical Chemistry, Arun Bahl, B.S. Bahl, G.D. Tuli, 1st Revised Edition 2008, Reprint 2016, S. Chand and Company Limited.
- Chemistry for Environmental Engineering and Science, C. N. Sawyer and P. L. McCarty, G.F. Parkin, 5th Edition, 21st Reprint, 2015, McGraw Hill Education (India) Private Limited.
- Physical Chemistry, G. M. Barrow, 5th Edition, 2007, Tata McGraw Hill Publishing Company Limited.
- Physical Chemistry, R.S. Berry, 2nd Edition, 2000, Oxford University Press.
- Advanced Physical Chemistry, D.N. Bajpai, 1st Edition, 2001, S. Chand and Company.
- Arun Bahl, B.S. Bahi, G.D. Tuli; Essentials of Physical Chemistry; 1st Revised Edition (2008), Reprint (2016), S. Chand and Company Limited.

Unit 1: Gaseous State:

(06 Hours)

- General characteristics and parameters of gases
- The gas laws: Boyle's, Charles, Gay Lussac and Avogadro
- The ideal gas equation
- Applications of Gas Laws: Dalton's & Amagat's law of partial pressures, Avogadro's Principle, Graham's law of diffusion, Henry's law
- Numerical

Unit 2: Kinetic Molecular Theory and Velocities of Gases

(08 Hours)

- Assumptions of kinetic molecular theory
- Derivation of kinetic gas equation
- Kinetic gas equation in terms of kinetic energy
- Deduction of gas laws from the kinetic gas equation
- Maxwell's law of distribution of molecular velocities
- Different kinds of velocities
- Calculation of molecular velocities for different physical condition

2.8 Numerical

Unit 3: Liquid State: Constitutive Properties (10 Hours)

3.1 Surface Tension: units, origins, effects, surface energy, parachor

3.1.1 Effects of Temperature on Surface Tension

3.1.2 Determination of Surface Tension by various methods

3.1.3 Applications of surface tension

3.2 Viscosity: Units, Newton's law of viscosity

3.2.1 Effects of temperature on Viscosity of a liquid

3.2.2 Factors affecting viscosity of liquid

3.2.3 Measurement of Viscosity by various methods

3.2.4 Applications of viscosity

3.3 Refractive Index: specific and molar refraction

3.3.1 Determination of Refractive Index

3.3.2 Molar refraction and chemical constitution

3.4 Optical Activity: specific rotation

3.4.1 Measurement of optical activity

Unit 4: Introduction to Chemical Kinetics (05 Hours)

4.1 Chemical kinetics and its scope

4.2 Macroscopic and microscopic kinetics

4.3 Slow and fast reactions

4.4 Rate of reaction

4.5 Factors affecting rate of reaction

4.6 Velocity constant or rate constant

Unit 5: Solid State-I: (06 Hours)

5.1 Types of solids

5.2 Isotropy and anisotropy

5.3 The habits of a crystal

5.4 Symmetry of a crystal

5.5 Miller indices

5.6 Crystal lattice

Unit 6: Nuclear Chemistry (10 Hours)

6.1 Radioactivity and its Units, Rate of Radioactive Decay, Half-Life, Average Life, Radioactive Equilibrium, Radioactive Dating, Artificial Radioactivity, Nuclear Isomerism

6.2 Types and Properties of Radiations, Types of Radioactive Decay and The Group Displacement Law, Neutron-Proton Ratio and Nuclear Stability

6.3 Detection and Measurement of Radioactivity - Cloud Chamber, Ionisation Chamber, Geiger Muller Counter, Scintillation Counter, Film Badges

6.4 Radioactive Disintegration Series - Uranium, Thorium and Actinium

6.6 Nuclear Reactions - Fission, Fusion and Chain, Nuclear Equations - Examples

6.7 Energy Released in Nuclear Reactions - Einstein's Equation Relating Mass and Energy, Mass Defect, Nuclear Binding Energy

6.8 Nuclear Fission Process: Nuclear Energy - First Chain reaction, Atomic Bomb Nuclear Power Reactor, Light-Water Nuclear Power Plant, Breeder Reactor Nuclear Fusion Process: Solar Energy, Hydrogen Bomb, Fusion Reactor - A Source of Energy in 21st Century

Physical Chemistry Laboratory Practicals

Minimum 4 from the following list:

1. Determination of the surface tension of the given liquid at room temperature by Stalagmometer.
2. Determination of the surface tension of the given liquid at room temperature by Conductivity meter.
3. Calculate the parachor value of $-\text{CH}_2$ group.
4. Determination of the relative viscosity of given liquids with respect to water at room temperature by Ostwald's Viscometer.
5. Determination of refractive index of a given compound by refractometer.
6. Determination of optical activity of a given compound by polarimeter.

Reference Books:

1. J.B. Yadav, Advanced Physical Chemistry; 14th Edition, 1995, Goel Publishing House.
2. S.K.Bhasin, Sudha Rani, Laboratory Manual on Engineering Chemistry; 3rd Edition, 2011, Dhanpatrai Publishing Company.
3. Khosla, B. D.; Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry*, R. Chand & Co.: New Delhi (2011).

Program: B.Sc. (Hons.)	Type: Major
Subject: Industrial Chemicals and Environment	Semester- 4
Credits: 04	Department: Chemistry
Course description: This course is about the concepts of different gases and their industrial production, uses, storage and hazards. Manufacturing, applications, analysis and hazards of the inorganic chemicals, preparation of ultra-pure metals for semiconducting technology, catalyst and biocatalyst, energy and environment is also covered in this course. It gives an idea regarding wastewater as well as sludge.	
Student learning outcome: Students will be able to understand: 1. Different toxic gases and their toxicity hazards 2. Safe design systems for large scale production of industrial gases. 3. Manufacturing processes, handling and storage of inorganic chemicals. 4. Application and effect of organic solvents in industries 5. Different sources of energy 6. Generation of nuclear waste and its disposal. 7. Use of biocatalyst in chemical industries	

Reference books:

1. Manahan, S.E. (2017), Environmental Chemistry, CRC Press
2. Buchel, K.H.; Moretto, H.H.; Woditsch, P.(2003), Industrial Inorganic Chemistry, Wiley-VCH.
3. De, A.K.(2012), Environmental Chemistry, New Age International Pvt., Ltd.
4. Khopkar, S.M.(2010), Environmental Pollution Analysis, New Age International Publisher.
5. Sharma, B.K. & Gaur, H. Industrial Chemistry, Goel Publishing House, Meerut (1996)

Unit: 1 Industrial gases (08 Hrs)

- 1.1 Large scale production of Oxygen, nitrogen, argon, neon, helium, hydrogen, acetylene, carbon monoxide, chlorine, fluorine, sulphur dioxide and phosgene
- 1.2 Uses of all above gases
- 1.3 Storage of all above gases
- 1.4 Hazards in handling of all above gases

Unit: 2 Inorganic chemicals (08 Hrs)

- 2.1 Manufacture and applications of hydrochloric acid, nitric acid, sulphuric

- acid, caustic soda, borax, bleaching powder, sodium thiosulphate, hydrogen peroxide, potassium dichromate and potassium permanganate
- 2.2** Applications of hydrochloric acid, nitric acid, sulphuric acid, caustic soda, borax, bleaching powder, sodium thiosulphate, hydrogen peroxide, potassium dichromate and potassium permanganate
- 2.2** Analysis of all above chemicals
- 2.3** Hazards in handling of all above chemicals

Unit: 3 Organic solvents and environment (06 Hrs)

- 3.1** Introduction to organic solvents
- 3.2** Impact of solvents leading to environmental pollution
- 3.3** Solvents in household products and their effects
- 3.4** Remedies to reduce the pollution due to solvents

Unit-4 Environmental toxicology (08 Hrs)

- 4.1** Health and environment
- 4.2** Environmental toxicology and non-metallic compounds of B, C, N, P, S and Halogens and asbestos
- 4.3** Technologies available for defluorination
- 4.4** Environmental toxins, genes and mutations

Unit-5 Heavy metals in environment (08 Hrs)

- 5.1** Introduction of trace metals, light metal and heavy metal
- 5.2** Deadly heavy metals and their sources to environment
- 5.3** Heavy metal poisons in food
- 5.4** Metals in water and soil

Unit: 6 Energy and environment (07 Hrs)

- 6.1** Sources of energy: Coal, petrol and natural gas. Nuclear fusion / fission, solar, hydrogen, geothermal, tidal and hydel
- 6.2** Nuclear Pollution: Disposal of nuclear waste, nuclear disaster and its management
- 6.3** Bio-catalysis: Introduction to bio-catalysis
- 6.4** Importance in green chemistry and chemical industry

Practicals (Minimum four):

1. Determination of dissolved oxygen in water.

2. Determination of Chemical Oxygen Demand (COD)
3. Determination of Biological Oxygen Demand (BOD)
4. Percentage of available chlorine in bleaching powder
5. Measurement of chloride, sulphate and salinity of water samples by simple titration method. (AgNO_3 and potassium chromate)
6. Estimation of total alkalinity of water samples (CO_3 , HCO_3) using double titration method

Reference books:

1. Vowles, P.D.; Connell, D.W. (1980), Experiments in Environmental Chemistry: A Laboratory Manual, Vol.4, Pergamon Series in Environmental Science.
2. Gopalan, R.; Anand, A.; Sugumar R.W. (2008), A Laboratory Manual for Environmental Chemistry, I. K. International.

Program: B.Sc. (Hons.)	Type: Major
Subject: Organic Chemistry-II	Semester- 4
Credits: 04	Department: Chemistry
Course description: This course provides a better understanding of the organic functional groups, which include halogenated hydrocarbons and oxygen containing functional groups and their reactivity patterns. The detailed reactions mechanistic pathways for each functional group will be discussed to unravel the spectrum of organic chemistry and the extent of organic transformations.	
Student learning outcome: Students will be able: 1. To understand preparation, properties and reactions of haloarenes and oxygen containing functional groups. 2. To use the synthetic chemistry learnt in this course to do functional group transformations. 3. To understand heterocyclic compound chemistry 4. To gain theoretical understanding of chemistry of compounds having nitrogen containing functional groups	

Reference books:

1. Organic Chemistry, Volume-1,2, I.L.Finar, 6th Edn., 2002, Pearson
2. Organic Chemistry, 7th, By R.T.Morrison, R.N.Boyd, S.K. Bhattacharjee 2010, Pearson
3. Advance Organic Chemistry, Arun Bahl and B S Bahl, 2012, S.Chand
4. Organic Chemistry, W.H. Perkin and F. S. Kipping, 2012, Nabu Press
5. Arun Bahl and B. S. Bahl: Advanced Organic Chemistry, S. Chand

Unit: 1 Alcohol and phenols (08 Hrs)

- 1.1 Preparation, properties and relative reactivity of 1°, 2°, 3° alcohols
- 1.2 Preparation and properties of glycols: Oxidation by periodic acid and lead tetraacetate, Pinacol-Pinacolone rearrangement
- 1.3 Phenols: Preparation and properties; Acidity and factors effecting
- 1.4 Ring substitution reactions, Reimer–Tiemann and Kolbe’s–Schmidt reactions, Fries and Claisen rearrangements

Unit: 2 Carbonyl compounds (08 Hrs)

- 2.1 Preparation and properties; nucleophilic additions, nucleophilic addition-elimination reactions with ammonia derivatives
- 2.2 Mechanisms of Aldol and Benzoin condensation, Knoevenagel condensation,

- Claisen-Schmidt, Perkin, Cannizzaro and Wittig reaction,
2.3 Beckmann and Benzil-Benzilic acid rearrangements, haloform reaction and Baeyer Villiger oxidation, α -substitution reactions
2.4 Oxidations and reductions (Clemmensen, Wolff-Kishner, LiAlH_4 , NaBH_4 , MPV, PDC)

Unit: 3 Carboxylic acid and derivatives (08 Hrs)

- 3.1 Preparation, physical properties and reactions of monocarboxylic acids
3.2 Typical reactions of dicarboxylic acids, hydroxy acids and unsaturated acids: succinic/phthalic, lactic, malic, tartaric, citric, maleic and fumaric acids
3.3 Preparation of acid chlorides, anhydrides, esters and amides
3.4 Reactions of acid chlorides, anhydrides, esters and amides

Unit: 4 Polynuclear hydrocarbons-I (05Hrs)

- 4.1 Classification
4.2 Synthesis, Chemical Reactions and Uses:
 4.2.1 Naphthalene
 4.2.2 Anthracene
 4.2.3 Phenanthrene

Unit: 5 Heterocyclic compounds-I (08Hrs)

- 5.1 Classification and nomenclature, structure, aromaticity in 5-numbered and 6-membered rings containing one heteroatom
5.2 Synthesis, reactions and mechanism of substitution reactions of:
 5.2.1 Furan,
 5.2.2 Pyrrole (Paal-Knorr synthesis, Knorr pyrrole synthesis, Hantzsch synthesis)
 5.2.3 Thiophene

Unit: 6 Nitrogen containing functional groups (08 Hrs)

- 6.1 Preparation and important reactions of nitro compounds, nitriles and isonitriles
6.2 Amines: Effect of substituent and solvent on basicity; Preparation and properties: Gabriel phthalimide synthesis, Carbylamine reaction, Mannich reaction, Hoffmann's exhaustive methylation, Hofmann-elimination reaction;
6.3 Distinction between 1° , 2° and 3° amines with Hinsberg reagent and HNO_2
6.4 Diazonium Salts: Preparation and their synthetic applications.

Practical (Minimum four)

Organic Estimation (Any two)

- 1) Vitamin-C
- 2) Glycine
- 3) Aniline/Phenol

Organic Preparation(Single Step) (Any two):

- 1) Preparation of m-dinitrobenzene from nitrobenzene.
- 2) Preparation of benzoic acid from benzaldehyde.
- 3) Preparation of p-aminobenzoic acid from p-nitrobenzoic acid.

Reference book:

1. Vogel, A.I. Quantitative Organic Analysis, Part 3, 2012, Pearson
2. Practical Organic Chemistry, Mann, F.G. & Saunders, B.C., 2009, Pearson Education

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Faculty: Science	Department: Environmental Science
Program: B. Sc. (Hons)	Type of Subject: Minor
Subject: Fundamentals of Agroforestry	
Semester: 4	
Credits: 4	

Student Learning Outcomes (SLOs):

After completing the course, students will be able to:

1. Understand the need of agroforestry and the role of agroforestry systems in soil fertility, nutrient cycling and sustainable development
2. Aware of various governmental programs, opportunities for employment and economic reforms through agroforestry systems
3. Analyze principal challenges and Indian perspective for the agroforestry system.
4. Address multifaceted environmental and scientific issues related to various agroforestry systems.

References and Textbooks: (With Author, Edition, Publishers, ISBN)

1. P. K. Ramachandran Nair (1993): An introduction to agroforestry, Kluwer Publications, The Netherlands. ISBN: 0792321340.
2. P.S Pathak and Ram Newaj, (2012), Agroforestry, Potentials and Opportunities, Agrobios, India. ISBN: 978-81-7754-200-4
3. S.R. Reddy (2018). Principles of Agronomy. Kalyani Publishers, Ludhiana, India. ISBN: 978-9327297942
4. Handbook of Agriculture, 6th Revised Edition, Indian council of Agricultural Research, New Delhi, India. ISBN: 81-7164-050-8
5. P. L. Maliwal (2023): Principles of Organic Farming, Scientific Publishers, India. ISBN: 978-9389184501

Unit 1: Introduction and Fundamentals of Agroforestry System

07 hours

- 1.1 Agroforestry definitions, objectives, potential and distinction between agroforestry and social forestry
- 1.2 Origin and History of agriculture in India, Indus Valley Civilization
- 1.3 Crop types, Crop Cycle and factors affecting crop production
- 1.4 Social forestry – Types, Objectives and Need

Unit 2: Agroforestry Planning

07 hours

- 2.1 Classification and practices in agroforestry systems
- 2.2 Planning for agroforestry
- 2.3 Selection of tree crop species for agroforestry
- 2.4 Different national and international institutes working in the field of

Agroforestry (FAO, IBPGR, WII, ICRAF, IUCN, UNEP, NRCAF, IGFR)

Unit 3: Silviculture

08 hours

3.1 Scope of silviculture in agroforestry

3.2 Silviculture of agroforestry trees with special reference to *Acacia nilotica*, *Azadirachta indica*, *Embllica officinalis*, *Tamarindus indica* and *Madhuca latifolia*.

Unit 4: Weed Management

08 hours

4.1 Definition and classification of weeds,

4.2 Methods of weed control

4.3 Integrated Weed Management

4.2 Herbicides- Definition, types and Mode of action

Unit 5: Nursery and management

07 hours

5.1 Concept of nursery, temporary and permanent nursery

5.2 Importance of nursery and criteria for nursery site selection

5.3 Multipurpose tree species and their management, Tree architecture

Unit 6: Socio-Economical Agroforestry

07 hours

6.1 Basic principles of economics applied to agroforestry

6.2 Cost- benefits analysis, estimation of demand and supply, Supply chain management in agriculture

6.3 Role and Importance of Agricultural Finance. Financial Institutions (NABARD and Regional Rural Banks), Importance and scope of micro finance

6.3 Govt. Scheme – PM KISHAN, NBHM, MIS-PSS, National Agro-forestry Policy 2014, RKVY

6.4 Economic, social, and environmental impacts of agroforestry.

Practicals

1. Survey and study of nursery techniques of medicinal plants.
2. Identification of seeds and seedlings of multipurpose tree species.
3. Cultivation and nursery practices for *Acacia*
4. Study of life cycle of silkworm: Morphology of egg, larva, pupa and adult.
5. Sericulture map of India

Program: B.Sc. (Hons)		Type: Minor
Subject: Analytical Chemistry – 1		
Credit: 4		Semester: 4
Course description: This course paper proposes to teach about: Basic Tools and Operations of Analytical Chemistry, Separation and Purification Methods, Gravimetric Methods, Errors, Accuracy and Precision and statistical analysis of the result data.		
Student learning outcome: After completing this course, the students will be able to learn: 1. Tools of Analytical Chemistry, Isolation and Purification Methods, Principle, Reaction Mechanism, Analysis Procedure and Applications of Gravimetric Methods - Precipitation gravimetry, Electrogravimetry, Volatilization Gravimetry, Thermal Gravimetry, Errors, Types, Sources and Effects of Errors, Accuracy and Precision, Determination of Accuracy, Minimization of Errors Accuracy and Precision and statistical analysis of the result data.		

Reference Books:

1. Chemistry for Environmental Engineering and Science, C. N. Sawyer and P. L. Mc Carty, G.F. Parkin, 5th Edition, 21st Reprint, 2015, McGraw Hill Education (India) Private Limited.
2. Quantitative Analysis, R.A Day, A.L Underwood, 6th Edition, 1991, Prentice-Hall.
3. Fundamentals of Analytical Chemistry, D.A. Skoog, D.M. West, F.J. Holler and S.R. Crouch, 9th Edition, Reprint 2014, Cengage Learning.
4. Basic Concepts of Analytical Chemistry, S.M. Khopkar, 3rd Edition, 2008, New Age International Publishers.
5. King, C.J. Separation Processes, Tata McGraw - Hill Publishing Co.,Ltd., 1982.
7. Ronald W.Roussel - Handbook of Separation Process Technology, John Wiley, New York, 1987.
8. Analytical Chemistry, H. Kaur, 1st Edition, 2013, Pragati Prakashan.
9. Vogel, Arthur Israel [Textbook of quantitative chemical analysis] Vogel's textbook of quantitative chemical analysis. - 5th ed./ revised by ... G. H. Jeffery ... [et al.] 4th ed. 1978.

Unit 1: Basic Tools and Operations of Analytical Chemistry (07 Hours)

- 1.1 Equipments for Measuring Mass - Analytical Balance
 - 1.1.1 Rules for Weighing
 - 1.1.2 Types of Balance - Top-pan balance, Analytical balance, Microbalance, Ultra microbalance
 - 1.1.3 Principle of Operation and Procedure

- 1.1.4 Trouble shooting
- 1.1.5 Drift in Measurements with Analytical Balances - Causes and Avoid
- 1.2 Equipment for Measuring Volume - Graduated Glassware Measuring Cylinder, Volumetric Pipett and Burette, Digital Micropipet and Volumetric Flask, Erlenmeyer Flask, Titration Assembly, Beaker, Test Tube
- 1.3 Equipment for Distillation and Digetion- Fume Hood, Round Bottom Flask, Kjeldahl Flask, Distillation Assembly
- 1.4 Equipment for Filtration
 - 1.4.1 Filtration Assembly with Pump -
Filtration by Counterpoise method - Sintered Glass Crucible
 - 1.4.2 Filtration Concept and Terms, Types of Filter Holder and Funnel
 - 1.4.3 Filter Guide - Grade, Size, Properties and Applications of Whatman, Glass Micro Fibre and Membrane Types
 - 1.4.4 Typical Particle Size and Selection of Right Filter
- 1.5 Equipment for Heating and Drying- Crucible, Silica Crucible, Evaporating Dish, Water Bath, Hot Air Oven, Hot Plate, Heating Mantle, Muffle Furnace, Metal Cone and Desiccator

Unit 2: Seperation and Purification Methods (10 Hours)

- 2.1 Introduction & Objectives
- 2.2 Criteria for the Assessment of Degree of Purity
 - 2.2.1 Examination of Physical Properties- Melting point, freezing point, boiling point, and the freezing curve, Density, Refractive index, Specific conductivity, Optical rotation
 - 2.2.2 Empirical analysis, for C, H, N, ash, etc.
 - 2.2.3. Chemical tests
 - 2.2.4 Physical tests - Emission and atomic absorption spectroscopy, Chromatography, Electron spin resonance
 - 2.2.5 Examination of spectroscopic properties
 - 2.2.6 Electrochemical methods
 - 2.2.7 Nuclear methods
- 2.3 Techniques of Isolation and Purification of Chemicals
 - 2.3.1 Affinity purification, Adsorption, Chromatograph
 - 2.3.2 Filtration, Centrifugation, Evaporation , Liquid–liquid extraction
 - 2.3.3 Crystallization and Recrystallization
 - 2.3.4 Trituration , Distillation
 - 2.3.5 Smelting, Refining, Electrolysis, Sublimation
 - 2.3.6 Water Purification, Downstream Process, BioLeaching
- 2.4 Classification of Methods

- 2.4.1 Isolation and purification based on rate phenomena
 - 2.4.1.1 Barrier isolations
 - 2.4.1.2 Field isolations
- 2.4.2 Isolation and purification based on phase equilibria
 - Gas-liquid, Gas-solid, Liquid-solid, Liquid-liquid ,
 - Supercritical fluid-solid, Supercritical fluid-liquid
- 2.5 Sublimation
 - 2.5.1 Principle
 - 2.5.2 Apparatus
 - 2.5.3 Procedure
 - 2.5.4 Applications

Unit 3 Gravimetric Analysis -I (10 Hours)

- 3.1 Types of Precipitate - Crystalline, Curdy and Gelatinous
- 3.2 Conditions for Precipitation - Solubility, Solubility Product and Ionic Product
- 3.2 Factors affecting the solubility, solubility products and Precipitates Completeness
 - Common Ion Effect, Diverse Ion Effect, Temperature, pH, Complexation,
 - Nature of the solvent
- 3.3 The Process of Precipitation
 - Controlling Particle Size, Clustering, Nucleation, Growth
- 3.4 The Role of Different Steps involved in Precipitation Gravimetric Analysis Preparation of the test solution, Precipitation, Digestion of Precipitate Filtration of precipitate, Washing of precipitate, Drying and /or ignition of precipitate, Weighing and Calculation
- 3.5 Applications of Precipitation Gravimetric Analysis
 - Ni^{+2} as Ni-DMG, S in organic Compound as BaSO_4 , Al^{+3} as Al_2O_3

Unit 4: Gravimetric Analysis -II (06 Hours)

- 4.1 Principle, Theory, Procedure and Applications of
 - 4.1.1 Electrogravimetry - Electrogravimeter
 - 4.1.1.1 Constant Current Electrolysis
 - 4.1.1.2 Constant Potential Electrolysis
 - 4.1.2 Volatilization Gravimetry
 - 4.1.3 Thermal Gravimetry

Unit 5: Errors and Treatment in Chemical Analysis (06 Hours)

- 5.1 Types, Sources and Effects of Errors
- 5.2 Accuracy and Precision
- 5.3 Determination of Accuracy
- 5.4 Minimization of Errors

- 5.5 Significant Figures
- 5.6 Numericals

Unit 6: Statistical Analysis

(06 Hours)

- 6.1 Statistical Evaluation of Data
- 6.2 Statistical Terms: Mean, Arithmetic Mean in a Discrete Frequency Distribution
- 6.3 Mean Deviation and Relative Mean Deviation
- 6.4 Median, Mean in case of a Discrete Frequency Distribution
- 6.5 Numericals

Analytical Chemistry -Laboratory Practicals

Minimum 4 Practicals From the Following List:

1. Gravimetric estimation of Ni as Ni(Dimethyl Glyoxime)₂.
2. Gravimetric estimation of Ba as BaSO₄.
3. Purification of Organic Compound by Sublimation Technique.
4. Electrogravimetric determination of Cu.
5. Recovery of Metal from the Wastewater by Electrogravimetry.
6. Determining the Inorganic Ash content of an Organic Material-Polymer/ Any Other Sample.

Reference Books:

1. Standard Methods for Examination of Water & Wastewater – Andrew D. Eaton, Lenore S. Clesceri, Eugene W. Rice, Arnold Greenberg, 23rd Edition, 2017, published by APHA, AWWA, WEF.
2. Analytical Chemistry, H. Kaur, 1st Edition, 2013, Pragati Prakashan.
3. Vogel, Arthur Israel [Textbook of quantitative chemical analysis] Vogel's textbook of quantitative chemical analysis. - 5th ed./ revised by ... G. H. Jeffery ... [et al.] 4th ed. 1978.
4. Laboratory Manual on Engineering Chemistry, S.K. Bhasin and Sudha Rani, 3rd Edition, Reprint 2011, Dhanpat Rai Publishing Company (P) Ltd.

Program: B.Sc. (Hons)	Type: Minor
Subject: Criminalistics-1	Semester : 4
Credits: 4	
Course description: Criminalistics explores the scientific exploration and application of physical evidence within crime investigation and prosecution. This course aims to equip students with a holistic understanding of the principles, methodologies, and applications involved in analysing physical evidence within criminal investigations.	
Student learning outcomes: 1. Introduce students to the fundamental concepts of criminalistics. 2. Acquaint students with a variety of methods utilized in collecting, securing, and examining physical evidence. 3. Help students understand the crucial significance of physical evidence in investigating and resolving crimes. 4. Foster the development of critical thinking and analytical skills necessary for the interpretation of forensic evidence.	

Reference Books:

- 1) "Textbook of Forensic Science and Criminalistics" by J.K. Sharma
- 2) "Forensic Science: An Introduction" by R.N. Karmakar
- 3) "Forensic Medicine and Toxicology" by K.S. Narayan Reddy
- 4) "Handbook of Forensic Ballistics" by P.K. Das
- 5) "Forensic Science: An Introduction to Scientific and Investigative Techniques" by Stuart H. James et al.
- 6) "Crime Scene Forensics: A Scientific Method Approach" by Robert C. Shaler
- 7) "Principles of Forensic Document Examination" by Albert H. Lyter
- 8) "Forensic Science in Criminal Investigation and Trials" by B.R. Sharma
- 9) "Practical Aspects of Forensic Science" by Dr. B. N. Chattopadhyay
- 10) "Criminalistics: An Introduction to Forensic Science" by Richard Saferstein

Unit-1 Introduction to Criminalistics

(7 hours)

- 1.1 Overview of Criminalistics
- 1.2 History and Development of Criminalistics in India
- 1.3 Locard's Exchange Principle
- 1.4 Ethics in Criminalistics

Unit-2 Crime Scene Investigation-1

(7 hours)

- 2.1 Protection
- 2.2 Recognition of Evidence
- 2.3 Searches
- 2.4 Documentation
- 2.5 chain of Custody

Unit – 3 Crime Scene Investigation-2

(7 hours)

- 3.1 Collection of evidence
- 3.2 Making of evidence
- 3.3 Packaging and transport
- 3.4 Final survey and release of crime scene

3.5 Reconstruction of crime scene

Unit – 4 Blood Stain Pattern Analysis

(8 hours)

- 4.1 Biological properties of human blood
- 4.2 Formation of blood stains
- 4.3 Chemical enhancement and documentation
- 4.4 Analysing spatter stains
- 4.5 Types of patterns

Unit – 5 Trace Evidence Analysis

(8 hours)

- 5.1 Types of Trace Evidence (e.g., fibres, hairs, glass, paint, Ink, Dyes etc.)
- 5.2 Collection and Examination Techniques
- 5.3 Microscopic Analysis
- 5.4 Instrumental Analysis (e.g., SEM, FTIR)

Unit-6 Forensic Ballistics

(8 hours)

- 6.1 Introduction to Forensic Ballistics
- 6.2 Types of Firearms and Ammunition
- 6.3 Examination of Firearms and Tool marks
- 6.4 Ballistic Comparison and Identification

Practicals

Perform the following experiments: (Any Four)

(30 Hours)

1. Thin Layer Chromatography (TLC) for Separating Pigments (Simulating separation of coloured compounds from inks or dyes)
2. Chemical Tests for Identifying Fibres (Natural vs. Synthetic)
3. Microscopic examination and comparison of different types of fibres found at a simulated crime scene.
4. Analysis of various bloodstain patterns on different surfaces using mock blood samples.
5. Detection of blood stains by the Kastle–Meyer test.
6. Examination and comparison of glass fragments and paint chips using microscopy and elemental analysis.
7. Analysis of handwriting samples and forged documents using magnification and comparison techniques.

Reference Books:

1. "Practical Manual of Forensic Chemistry" by Dr. B. R. Sharma
2. "Textbook of Forensic Science and Criminalistics" by J.K. Sharma
3. "Forensic Science: Fundamentals and Investigations" by Dr. B.C. Gore
4. "Forensic Medicine and Toxicology" by K.S. Narayan Reddy
5. "Textbook of Forensic Medicine and Toxicology" by Dr. Nageshkumar G. Rao
6. "Handbook of Forensic Ballistics" by P.K. Das
7. "Practical Aspects of Forensic Science" by Dr. B. N. Chattopadhyay
8. "Forensic Science in Criminal Investigation and Trials" by B.R. Sharma

Faculty: Sciences	Department: Microbiology
Program: B.Sc. (Hons)	Type: Minor
Subject: Introduction to Industrial Fermentation Processes	
Credit: 4	Semester: 4
Course description: This course provides an in-depth exploration of the fundamentals of industrial fermentation, focusing on the design, development, and optimization of fermentation processes. Students will gain practical knowledge of microbial isolation, screening techniques, preservation methods, bioreactor design, fermentation media formulation, and industrial sterilization practices essential for bioprocess industries.	
Learning Outcomes: By the end of the course, students will be able to: 1. Understand the principles of fermentation processes. 2. Describe the key aspects of upstream and downstream processing in fermentation. 3. Isolate suitable microorganisms and apply appropriate screening techniques to identify relevant microbes, and implement storage techniques for preservation of culture. 4. Comprehend the basic design of bioreactor, able to identify and differentiate between various types of bioreactors, and classify the processes based on mode of operation. 5. Select and formulate suitable fermentation media. 6. Apply appropriate sterilization techniques for media and fermenter sterilization.	

Reference:

1. Okafor N., (2007). Modern Industrial Microbiology and Biotechnology, Science Publishers. ISBN: 9781138036147.
2. Patel, A. H., (2016). Industrial Microbiology, 2nd Ed., Trinity press; An Imprint of Laxmi Publications PVT. Ltd. ISBN: 9789385750267.
3. Richard K.M. & Durbin S.R., (2020). Fermentation and Biochemical Engineering, Vol 1, CBS Publishers & Distributors Pvt Ltd. ISBN: 9789389185911.
4. Shivkumar P. K., Joe M. M., Sukesh K., (2010). An Introduction to Industrial Microbiology, S Chand Publishers. ISBN: 9788121935197.
5. Stanbury, P.F., (2006). Principles of Fermentation Technology, 2nd Ed., Elsevier Science Ltd. ISBN: 9780750645010.
6. Waites, M.J., et al., (2001). Industrial Microbiology: An Introduction, 1st Ed., Blackwell Publishing. ISBN: 9780632053070.

Unit-1: Basics of Industrial Fermentation

(Duration: 6 Hrs)

- 1.1 Overview and Design of Fermentation Process
- 1.2 Fermentation Process Development
- 1.3 Outline of Upstream and Downstream Processing

Unit-2: Isolation and Screening of Industrially Important Strains

(Duration: 9 Hrs)

- 2.1 Isolation of Suitable Microorganisms from the Environment

2.2 Screening Techniques

2.2.1 Primary Screening: The Crowded Plate Technique, Auxanography, Enrichment Culture Technique, Use of an Indicator Dye

2.2.2 Secondary Screening

Unit-3: Preservation of Industrially Important Microbes

(Duration: 7 Hrs)

3.1 Culture Collections

3.2 Storage at Reduced Temperature

3.3 Storage in Dehydrated Form

3.4 Quality Control of Preserved Stock Cultures

Unit-4: Fermenter and Fermentation Process

(Duration: 9 Hrs)

4.1 Typical Bioreactor Design- Components & their Functions

4.2 Types of Bioreactors- Stirred and Continuous Stirred Tank Bioreactors, Bubble Column Bioreactor, Airlift Reactor, Fixed and Fluidized Bed Reactors

4.3 Types of Fermentation Processes

4.3.1 Based on Mode of Operation: Batch, Continuous and Fed-batch

4.3.2 Based on Oxygen Requirement: Aerobic and Anaerobic

4.3.3 Based on Free Water in the Medium: Submerged and Solid state and its properties

Unit-5: Fermentation Media

(Duration: 7 Hrs)

5.1 Criteria of Suitable Media

5.2 Carbon Sources

5.3 Nitrogen Sources

5.4 Precursors, Inducers, and Inhibitors

Unit-6: Industrial Sterilization

(Duration: 7 Hrs)

6.1 Principles of Sterilization

6.2 Sterilization of Equipment

6.3 Sterilization of Production Media

6.4 Sterilization of Air

List of Practicals

1. Screening of amylase producing microorganisms
2. Screening of antimicrobial compounds producing microorganisms by crowded plate & Wilkin's method.
3. Screening of organic acid producing microorganisms.
4. Demonstration of laboratory fermenter.

SARVAJANIK UNIVERSITY
FACULTY OF SCIENCE

Faculty: Science	Department: Environmental Science
Program: B. Sc. (Hons)	Type of Subject: Minor
Subject: Fundamentals of Industrial Safety	
Semester: 4	
Credits: 4	

Student Learning Outcomes (SLOs):

After completing the course, students will be able to:

1. Understand the need for safety in industries, the factors affecting accidents, chemistry and stages of fire.
2. The paper will also make students aware of various theories to industrial accidents.
3. Address various legislations, conventions and recommendations on industrial safety.

References and Textbooks: (With Author, Edition, Publishers, ISBN)

1. SHAH R.C (2018): Safety Management, Capital Offset, Gandhinagar.
2. SHAH R.C (2021): Legislations on Safety & Health, Capital Offset, Gandhinagar.
3. MISRY K.U (2012): Fundamentals of Industrial Safety & Health – I, Siddharth Prakashan, Ahmedabad.
4. MISRY K.U (2012): Fundamentals of Industrial Safety & Health – II, Siddharth Prakashan, Ahmedabad.

Unit 1: Introduction to Industrial Safety

7 Hours

- 1.1 Terminology
- 1.2 Philosophy of Safety
- 1.3 Problems of Industrial Safety
- 1.4 Concept of Safety

Unit 2: Safety Psychology

7 Hours

- 2.1 Introduction
- 2.2 Factors affecting Accident
- 2.3 Behavior Based Safety
- 2.4 Maslow's Hierarchy of Needs

Unit 3: Industrial Fire – I

8 Hours

- 3.1 Chemistry of Fire
- 3.2 Stages of Fire
- 3.3 Factors contributing to Fire
- 3.4 Classification of Fire & Extinguishers

Unit 4: Theories On Industrial Accident**8 Hours**

- 4.1 Heinrich's Theory
- 4.2 Frank Bird's Domino Theory
- 4.3 V.L Grose's Multiple Causation Theory
- 4.4 Energy Theory

UNIT 5: INDUSTRIAL ACCIDENT PREVENTION**7 Hours**

- 5.1 Types of Accident
- 5.2 Fundamentals of Accident Prevention
- 5.3 Five 'E's of Accident Prevention
- 5.4 Five Steps of Japanese 5s

UNIT 6: LEGISLATION ON FACTORIES**7 Hours**

- 6.1 Legislative Process
- 6.2 ILO Conventions & Recommendations
- 6.3 History of Factories Legislations
- 6.4 Factories Act, 1948

Practicals

1. Measurement of Noise in the surrounding environment.
2. Measurement of Temperature and Relative Humidity in ambient air.
3. Measurement of Illumination by Lux meter.
4. Submission of Report based on Fire Prevention Equipments.

Faculty: Science	Department: Microbiology
Program: B. Sc. (Hons)	Type: Minor
Subject: Introduction to Clinical Laboratories & GLP	
Credits: 4	Semester: 4
Course description: The main aim of the subject is to inform the knowledge about clinical diagnosis and clinical laboratory set up. Also add the understanding of laboratory hazards and safety precautions. This course also introduces students to various laboratory solutions and instruments. The information regarding Good laboratory practices and quality control will enhance the depth of the subject.	
Student learning outcome: At the end of the course, the students will get knowledge of 1. Basics of clinical laboratory, Standard clinical laboratory set up and its types 2. Basics of clinical laboratory organization 3. Laboratory Ethics and Code of safe laboratory practice 4. Different types of glassware & plastic ware and its use 5. Laboratory hazards and safety 6. Component and use of basic laboratory instruments 7. Good laboratory practices	

Reference Books:

1. Ochei J. & Kolhatkar A. (2000), *Medical Laboratory Science: Theory & Practice*, Tata McGraw Hill Pub. (ISBN: 9780074632239)
2. P.B. Godkar, (2014), *Textbook of Medical Laboratory Technology*, 3rd ed., Bhalani Publishing House, Mumbai, India. (ISBN: 9789381496190)
3. Mukharjee. L. K , *Medical Laboratory Technology*, Vol.1, 3rd edition, Tata McGraw Hill ISBN: (9789352606801)

Unit-1: Human health and clinical diagnosis in developing countries (Duration: 07 Hrs)

- 1.1 Human health and disease.
- 1.2 Medical care in India.
- 1.3 Various kinds of laboratories and commonly requested laboratory tests in India and other developing countries.
- 1.4 Fundamental needs for a standard clinical laboratory set up.

Unit-2: Clinical Laboratory Organization and Ethics (Duration: 07 Hrs)

- 2.1 Organization of clinical laboratories.
- 2.2 The responsibilities of clinical laboratory technician.
- 2.3 Factors reducing and increasing productivity of a Laboratory.
- 2.4 Professional Ethics of Clinical Laboratory Professional.

Unit-3: Laboratory Accidents and Safety**(Duration: 08 Hrs)**

- 3.1 Laboratory Hazards- Physical, Chemical and Biological, Accidents and Safety Measures in clinical laboratory
- 3.2 First Aid measures in clinical laboratory.
- 3.3 Biosafety level and Biosafety programme.
- 3.4 Universal work precautions for Laboratory Personnel

Unit-4: Laboratory Instruments and Equipments**(Duration: 08 Hrs)**

- 4.1 Principle, Component, Use, Care and Maintenance of:
 - 4.1.1 Colorimeter, Centrifuge, Weighing Balance
 - 4.1.2 Semi-automated analyzer
 - 4.1.3 Equipments for sterilization: Hot air oven & Autoclave
- 4.2 Use and care of common laboratory glass wares and plastic wares.

Unit-5: Good Laboratory Practices**(Duration: 07 Hrs)**

- 5.1 Sources of common errors in laboratory
- 5.2 Proficiency testing
- 5.3 Quality council of India
- 5.4 Accreditation of Clinical Laboratory: NABL
 - 5.4.1 Introduction and scope
 - 5.4.2 Aims and objectives
 - 5.4.3 Description and types of laboratory
 - 5.4.4 Qualification norms

Unit-6: Quality Control and Laboratory Solutions**(Duration: 08 Hrs)**

- 6.1 Commonly used terms in quality control
- 6.2 Various ways of maintaining internal and external quality control
- 6.3 Statistics in clinical laboratory: Central tendency, Standard deviation & Coefficient of variation
- 6.4 Preparation of Solution: Normal Solution, Molar Solution, Percent Solution, Primary Standard Solution
- 6.5 Units of Measurements

List of Practicals

- 1. Laboratory Hazards and Prevention
- 2. First Aid measures in Clinical Laboratory
- 3. Operation of Colorimeter, Centrifuge & Weighing balance
- 4. Operation of Semi-automated analyzer, Hot air oven & Autoclave
- 5. Preparation of Normal solution, Percent solution and Molar solution
- 6. Measurement of Standard deviation and Coefficient of variation from control serum samples.

SARVAJANIK UNIVERSITY
FACULTY OF SCIENCE

Faculty: Science	Department: Environmental Science
Program: B. Sc. (Hons)	Type of Subject: Skill Enhancement Course (SEC)
Subject: Forest Mensuration	
Semester: 4	
Credits: 2	

Student Learning Outcomes (SLOs):

After completing the course, students will be able to:

1. Understand and analyze use of different instrumental techniques for crop measurement.
2. Learn types of sampling techniques and its importance.
3. Analyze principles of geometric and trigonometric methods for direct and indirect measurements..
4. Address multidisciplinary structure of community and its dimentions.

References and Textbooks: (With Author, Edition, Publishers, ISBN)

1. Vikas Kumar *et. al.* (2017): Practical Manual of Forest Mensuration, Agri-Biovet Press, New Delhi, India. ISBN: 978-93-84502-45-4.
2. A. N. Chaturvedi and L. S. Khanna (2000): Forest Mensuration and Biometry, Khanna Bandhu Publishers, India. ISBN: 9788185933238.
3. G.J. Hamilton (2021): Forest Mensuration Handbook, Scientific Publishers, India. ISBN: 9789388399012

Unit 1: Introduction and Fundamentals of Forest Mensuration System 07 hours

- 1.1 Introduction, definition, objectives and scope of forest mensuration
- 1.2 Units of measurement
- 1.3 Scales of measurement (nominal, ordinal, interval and ratio scale)
- 1.4 Instruments used in forest mensuration: visual observation, sketches and utilities

Unit 2: Sampling Methods 07 hours

- 2.1 Sampling - definition, advantages, size and shape of the sampling units
- 2.2 Random sampling - simple, stratified, multistage and multiphase sampling
- 2.3 Non random sampling - Selective, systematic and sequential sampling
- 2.4 Point sampling - horizontal and vertical point sampling
- 2.5 Qualitative and quantitative characters in forest community studies

Unit 3: Tree Measurement 08 hours

- 3.1 Comparison between tape and caliper measurements
- 3.2 Bark measurements - objectives, thickness, surface area and volume.
- 3.3 Height measurements - direct and indirect methods. Height measurement employing geometric and trigonometric principles
- 3.4 Biomass measurement, Determination of age of trees, Tree growth measurements

SARVAJANIK UNIVERSITY
FACULTY OF SCIENCE

Unit 4: Experimental Forest Mensuration

08 hours

- 4.1 To study the standard rules for measurement of Diameter or Girth at breast height (DBH or GBH) of standing trees
- 4.2 To estimate the bark thickness of trees
- 4.3 Illustrating height measurement on a level ground
- 4.4 To study the form of tree (form factor and/or form ratio) for volume estimation of standing trees to prepare taper table and volume table
- 4.5 Determination of age, volume and biomass of crop
- 4.6 To find out frequency, density and abundance of given crop in a community structure

Sarvajanik University

Faculty of Science

B.Sc. (Hons)

Faculty: Science	Department: Environmental Science
Program: B.Sc. (Hons)	Type: Value Added Course (VAC)
Subject: Indian Knowledge System (Parampara: Sustainable Practices of Bharat)	Credits: 2
Semester: 4	

Reference:

1. Parampara: India's Culture of Climate Friendly Sustainable Practices by Center for Environment Education, Ministry of Environment, Forest and Climate Change, Government of India.

Unit 1: (08 hours)

1.1 Introduction

1.2 Solar and Wind Energy

1.3 Water

Unit 2: (08 hours)

2.1 Agriculture

2.2 Biodiversity

Unit 3: (07 hours)

3.1 Food

3.2 Health

Unit 4: (07 hours)

4.1 Shelter

4.2 Textile, Clothing and Lifestyle Products

Faculty: Science	Department: Microbiology
Program: B.Sc. (Hons)	Type: VAC
Subject: IKS (Vedic Microbiology)	
Credit: 02	Semester: 4
Course description: This course informs and signifies the practice followed from vedic period for management of microorganisms and provides healthy human life with scientific validation.	
Student learning outcome: 1. Able to Understand the fundamental concepts of microorganisms as presented in Vedic texts. 2. Analyze the connections between Vedic practices and their potential impact on microbial life. 3. Understand the significance of age-old practice of yajna followed in vedic period.	

Reference Books:

1. Dubey RC (2021). Vedic Microbiology: A Scientific Approach. India: Motilal Banarsidass

Unit-1: Introduction to Vedas and Cosmology.

(Duration: 08 Hrs)

- 1.1 The origin of Vedas
- 1.2 Concept of Vedic Period
- 1.3 Microbial disease described during vedic period
- 1.4 Who are the creators of the Universe?
- 1.5 Concept of atoms and molecules in vedic period
- 1.6 Scientific concept of atoms and particles

Unit-2: Pandemic / Epidemic diseases during Vedic Period

(Duration: 07 Hrs)

- 2.1 Viral diseases and its cure.
- 2.2 Expression of respect v/s Social distancing
- 2.3 Precaution for spread of infectious microorganisms

Unit-3: Elimination of pathogen by Sun rays and Eradication of Pathogen by medicinal plants

(Duration: 07 Hrs)

- 3.1 Elimination of microorganisms by sun rays
- 3.2 Germicidal properties in the sun rays
- 3.3 Occurrence and prevention of Yaksma
- 3.4 Eradication of microbes by Vaca
- 3.5 Eradication of leprosy by Prsniparni

Unit-4: Science of Agnihotra (Sacrificial Fire)

(Duration: 08 Hrs)

- 4.1 Significance of Havan/Yajna
- 4.2 Method of daily Yajna
- 4.3 Scientific validation of Agnihotra
- 4.4 Effect of Agnihotra on human health
- 4.5 Effect of Agnihotra on plant health

Sarvajanik University
Faculty of Science

Faculty: Science	Department: Computer Sci.
Program: B.Sc. (Hons)	Type: Value Added Course (VAC)
Subject: Indian Knowledge System (Tark evam Krutrim Buddhimata)	Credits: 2
Semester: 4	

References:

1. Introduction to Indian Knowledge Systems - Concepts and Application, B. Mahadevan, Vinayak Rajat Bhat, Nagendra Pava R.N., PHI Publication
2. Sivananda S. All about hinduism. Sivananda literature research institute; 1988.
3. Dharampal G. Essential Writings of Dharampal. Publications Division Ministry of Information & Broadcasting; 2017 Nov 3.
4. Bajaj J, Śrīnivāsa MD. Sanatana Bharat, jagrita Bharat= Timeless India, resurgent India: a celebration of the land and people of India. (No Title).

Unit 1: Knowledge and Logic (08 hours)

- Tarka : Indian Art of Debate
- The Knowledge Triangle
- Prameya - Dravyas, Attributes, Action
- Pramana - Means of Valid Knowledge
- Samasya - Ambiguities in existing knowledge

Unit 2: Knowledge Frameworks (07 hours)

- Deductive/Inductive KF
- Potential Fallacies in Reasoning Process
- Established Tanets in field of Study

Unit 3: Sanskrit Linguistic - I (07 hours)

- Components of Language
- Panini's work on Sanskrit Grammar
- Computational Concepts in Ashtadhyayi
- Phonetics in Sanskrit

Unit 4: Sanskrit and NLP (08 hours)

- Patterns in Sanskrit Vocabulary
- Logic for Sentence Construction
- Importance of Verbs
- Role of Sanskrit in NLP

Program: B.Sc. (Hons)	Type: Ability Enhancement Course (AEC)
Semestre: 4	
Subject: Environment Studies	
Credit: 02	Total learning hours: 30
Prerequisite: Efficacy towards understanding natural systems and its sustainability. Rationale: Sustainability is the prime goal of today's modern world. Transformation and pro-conservation actions is the prime approach to conserve the environmental values. Honourable Supreme Court of India has made it 'mandatory' to introduce a basic course on environment at the undergraduate level.	

Unit 1: Introduction to environmental studies and Natural Resources: Renewable & Non-renewable Resources • Multidisciplinary nature of environmental studies; • Scope and importance; Concept of sustainability and sustainable development. • Energy Resources: Renewable and non-renewable energy sources, use of alternate energy sources.	(6 lectures)
Unit 2 : Ecosystems & Biodiversity • Ecosystems: Basic concepts. • Forest, Grassland, Desert and Aquatic Ecosystems. • Introduction to Biodiversity. • Biodiversity Conservation.	(7 lectures)
Unit 3: Environmental Pollution & Environmental Issues • Environmental pollution : Air, water, soil and noise pollution; effects and controls • Nuclear hazards and human health risks. • Climate change, global warming, ozone layer depletion, acid rain. • Impacts on human communities and agriculture.	(7 lectures)
Unit 4: Environmental Policies/ Practices & Role of Human Communities • Environment Laws: Environment Protection Act: Air (Prevention & Control of Pollution) Act: Water (Prevention and control of Pollution) Act • Wildlife Protection Act: Forest Conservation Act. International agreements: Montreal and Kyoto protocols and Convention on Biological Diversity (CBD) • Environmental movements: Chipko, Silent valley, Bishnois of Rajasthan. • Environmental ethics: Role of Indian and other religions and cultures in environmental conservation. Field work • Visit to an area to document environmental assets: river/ forest/ flora/fauna, etc. • Visit to a local polluted site-- Urban/Rural/Industrial/Agricultural.	(10 lectures)

Reference Books:

Sr. No	Title of book /article	Author(s)	Publisher and details like ISBN	Year of Publication	Publication Edition
1.	Textbook of Environmental Studies for Undergraduate Courses	Erach Bharucha	Universities Press (India) Private Ltd, Hyderabad ISBN: 978-8173718625	2013	2 nd
2.	Environmental Studies	Dr. Suresh K Dhameja	S K Kataria & Sons New Delhi ISBN: 978-93-5014-385-8	2018	4th
3.	Basics of Environmental Studies	Prof Dr N S Varandani	LAP -Lambert Academic Publishing ,Germany ISBN: 978-3-8473-2102-6	2013	1st
4.	Environmental Studies	Anindita Basak	Darling Kindersley (India) Pvt. Ltd Pearson ISBN: 978-8131721186	2009	1st
5.	Basics of Environmental Studies	U K Khare	Tata McGraw Hill ISBN: 978-0071077781	2011	1st
6.	A Textbook of Environmental Studies	Dr. K Raghvan Nambiar	Scitech ISBN: 9788183711111	2009	1st
7.	Environmental Studies	Dr. B S Chauhan	University Science Press ISBN: 9788131803288	2008	1st
8.	Environmental Sciences	Daniel B Botkin & Edward A Keller	John Wiley & Sons ISBN: 9788126534142	2011	8th

9.	Environmental Studies	R. Rajagopalan	Oxford University Press ISBN: 978-0199459759	2015	3rd
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