

SARVAJANIK UNIVERSITY
FACULTY OF SCIENCE



Faculty of Science

B. Sc. (Honors)

Biotechnology

DETAILED CURRICULUM

(W.E.F. 2024-25)

SARVAJANIK UNIVERSITY
FACULTY OF SCIENCE

Semester 4

B.Sc. (Hons) Biotechnology Semester 4			
Sr. No.	Category	Course Title	Course Type
1	Major	Microbial, Animal and Plant Taxonomy	Compulsory
2		Plant Anatomy and Physiology	Compulsory
3		Applied Environmental Microbiology	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

Name of Faculty: Science	Department: Biotechnology
Program: B.Sc. (Hons)	Type: Major
Subject: Microbial, Animal and Plant Taxonomy	Semester: 4
Credits: 04	
Course description: This course introduces students to the principles and methods of taxonomy as applied to microorganisms, animals, and plants. Through lectures, laboratory exercises, and fieldwork, students will learn about the classification, identification, and diversity of microbial, animal, and plant taxa.	
Student learning outcome: At the end of the course, students will be able to: 1. Understand the principles and significance of taxonomy in biology. 2. Learn about the classification systems used for microorganisms, animals, and plants. 3. Gain proficiency in the identification and classification of organisms using morphological, anatomical, physiological, and molecular characteristics. 4. Explore the evolutionary relationships and diversity of organisms across different taxa. 5. Develop practical skills in field identification, specimen preparation, and taxonomic classification.	

References and Textbooks:

1. John P. Harley, Donald A. Klein, Microbiology- Lansing Prescott, 10th Edition, McGraw Hill Publication. ISBN-13-978-1259281594
2. Pelczar, Chan and Krieg. (Indian edition) Microbiology, 5Ed., Tata-McGraw-Hill, ISBN: 9780074623206
3. Sharma O.P. Plant Taxonomy 2nd edition, Tata Mc Grew Hill Education Private Ltd. 2009, ISBN: 9780070141599
4. Sivarajan, V.V. Introduction to the principles of plant taxonomy 2nd ed. Cambridge Univ. Press. 1995. ISBN: 0521355877

UNIT-1: Microbial Taxonomy

(7 hrs)

- 1.1 Basis of microbial classification
- 1.2 Taxonomic ranks
- 1.3 Characterization for classification
 - 1.3.1 Classical characteristics
 - 1.3.2 Molecular characteristics (Introduction only)
- 1.4 Three domains of life
- 1.5 Bergey's Manual of Systematic Bacteriology (Introduction only)

Unit-2 : Diversity of Microorganisms

(8 hrs)

- 2.1 Major physiological groups of *Archaea*
- 2.2 Major groups of photosynthetic bacteria

- 2.3 Characteristics of selected *Gamma* γ -*Proteobacteria*
- 2.4 Families of facultatively anaerobic Gram Negative Rods
- 2.5 Characteristics of selected members of Class- *Clostridia* and *Bacilli*
- 2.6 Characteristics of Actinobacteria
- 2.7 Classification scheme of *Fungi* as per Alexopoulos

Unit 3 – Invertebrates (08 hours)

- 3.1 Introduction - Definition of invertebrates & non-chordates, general characters of invertebrates, brief outline of classification of Invertebrates
- 3.2 General Characters of Phylum Protozoa & Porifera
- 3.3 General Characters of Phylum Cnidaria & Helminthes
- 3.4 General Characters of Phylum Annelida & Arthropoda
- 3.5 General Characters of Phylum Mollusca & Echinodermata

Unit 4 - Chordates (07 hours)

- 4.1 Introduction: Definition of Chordates, General characters of chordates, brief outline classification of chordates
- 4.2 General characters of class Pisces
- 4.3 General characters of Amphibia
- 4.4. General characters of Reptilia
- 4.5 General characters of Aves & Mammals

Unit-5- Plant Taxonomy

- 5.1 Introduction, need and importance of plant taxonomy
- 5.2 Types of classification systems-artificial, natural and phylogenetic.
- 5.3 Brief comparison of important systems of classification: Linnaeus', Bentham & Hooker's, Engler and Prantl's system, APG IV System (2016).
- 5.4 Merits and demerits of classification system

Unit-6 - Understanding Nomenclature and Molecular Taxonomy

- 6.1 Pressing, drying, mounting and labeling of specimen
- 6.2 Introduction to Herbaria and Botanical gardens, Important herbaria and botanical gardens of India.
- 6.3 Introduction to International code of botanical nomenclature (ICBN), Important rules of nomenclature: ranks and priority, type method, citation of author, valid publication, rejection of names. Botanical names.
- 6.4 Molecular Taxonomy and its principle

Practicals:

- 1) Study of Animal Specimen – one from each invertebrate & chordate phylum/ class
- 2) An “animal album” containing photographs, cut outs, with appropriate write up about the above mentioned taxa. Different taxa/ topics may be given to different sets of students for this purpose.
- 3) Study of morphology (vegetative and floral characters) of Fabaceae, Liliaceae and Solanaceae family using specimen/ permanent slides/ photographs
- 4) Mounting of a properly dried and pressed specimen of any wild plant with herbarium label

Reference:

1. Patel, Rakesh J. and Patel Kiran, R., "Experimental Microbiology Vol. I and Vol. II".
a. Aditya Prakashan, Ahmedabad. (2009)
2. Ashish S Verma, Surajit Das & Anchal Singh “Laboratory Manual for Biotechnology” (2015), ISBN : 9789383746224
3. Invertebrate Zoology by E L Jordan & Dr. P S Verma , S Chand pub.
4. Modern Textbook of Zoology Invertebrates by RL Kotpal, Rastogi publications
5. Chordate Zoology by E L Jordan & Dr. P S Verma, S Chand pub., 4th Edition
6. Modern Textbook of Zoology Vertebrates by R L Kotpal, Rastogi publications, 4th Edition
7. A manual of Practical Zoology Chordates by P S Verma, S Chand Pub.
8. Cell Biology, Genetics, Molecular Biology, Evolution & Ecology by P S Verma & V K Agarwal, S. Chand Pub.
9. Animal Behaviour by Dr V. K Agarwal, S Chand Pub.
10. Animal Behaviour by M.P. Arora, Himalayan Pub.
11. Practical Zoology: Invertebrates by S S Lal, Rastogi Publications
12. Practical Zoology: Vertebrates by S S Lal, Rastogi Publications
13. Practical Zoology Volume III by S S Lal, Rastogi Publications
14. B.P Pandey, Modern Practical Botany-Vol. I, S Chand & Company, ISBN: 9788121904605
15. B.P Pandey, Modern Practical Botany-Vol. II, 5th Edition, S Chand & Company, ISBN: 978-8121909204
16. B.P Pandey, Modern Practical Botany-Vol. III, 2nd Edition, S Chand & Company, 978-8121935081

Name of faculty: Science	Department: Biotechnology
Program: B.Sc. (Hons)	Type: Major
Subject: Plant Anatomy and Physiology	Semester: 4
Credits: 4	
Course description: The main objective of this course will be to inculcate strong fundamentals on modern and classical aspects of Plant biology. Further it will create a platform for higher studies in plant physiology, plant morphology, metabolic processes, nutrient assimilation and stress physiology.	
Student learning outcome: After completion of this course the students will be able to 1. Understand plant morphology 2. Understand basics of floral morphology 3. Understand the morphology, structure and functions of various parts of plants and significance of morphological modifications 4. Learn the complex regulations and changes for stress physiology in plants 5. Learn different types of tissues and their role of mineral nutrition and solute transport in different organs of plants	

References and Textbooks:

1. Salisbury, P.B. & Ross, C.W. (1992). Plant Physiology 4th Edition, Wadsworth Publishing, California. ISBN: 9788123910437
2. Hopkins, W.G. (1995). Introduction to Plant Physiology 4th Edition, John Wiley & Sons, New York. ISBN: 978-0470247662
3. Pandey, S.N. & Sinha, B.K. (2016). Plant Physiology 4th Edition, Vikas Publishing House Pvt. Ltd, New Delhi, ISBN: 9788125918790
4. Verma, S.K. & Verma, M. (2012). A Text book of Plant Physiology, Biochemistry and Biotechnology, S.Chand & Company, Ltd., New Delhi. ISBN: 9788121906272
5. Noggle, G.R. & Fritz, G.J. (1986). Introductory Plant Physiology. Prentice-Hall of India Pvt Ltd, New Delhi. ISBN: 9780135020968
6. Devlin, R.M. & Witham, F.H. (1986). Plant Physiology. CBS Publishers & Distributors, New Delhi. ISBN: 9780871507655
7. Lincoln Taiz, Eduardo Zaiger, Ian Moller, Angus Murphy. (2018) Plant Physiology 6th Edition, Sinauer Associates Inc. Publishers. ISBN: 9781605357454

Unit 1: Tissues and types (8 hrs)

- 1.1 Meristematic tissue and Classification of Meristems
- 1.2 Apical meristems of Stem and Root
- 1.3 Permanent tissue and classification types Simple, Complex and Secretory tissues
- 1.3 Anatomical differences of dicot and monocots leaf and roots

UNIT-2: Plant-Water Relations

(7 hrs)

- 2.1 Structure, properties and role of water in plants
- 2.2 Diffusion, Osmosis, Osmotic potential, water potential, Turgor pressure, Wall pressure, Chemical pressure, diffusion pressure deficit, Plasmolysis and role of osmosis in plants
- 2.3 Mechanism of absorption of water, Osmotic and non-osmotic theories of active water absorption, uptake and transport, Ascent of sap theories, Transpiration mechanism and its regulation, Factors influencing transpiration rate
- 2.4 Stomatal structure – mechanism of stomatal movement; anti-transpirants

Unit 3: Mineral nutrition and Solute transport

(8 hrs)

- 3.1 General roles of mineral elements in plants, Essential and non-essential elements
- 3.2 Function and deficiency symptoms of macro and micro elements, Hydroponics and Aeroponics
- 3.3 Ion transport in roots, Mechanism of Mineral Salt absorption: Passive and active absorption
- 3.4 Transport proteins in membrane: Channel proteins, Carrier proteins and their types, Pumps and active transport

Unit-4: Photosynthesis

(8 hrs)

- 4.1 Structure of chloroplast, Photosynthetic pigments, Absorption spectra and Action spectra
- 4.2 Light reaction: Role of PS I and PS II, Cyclic, non-cyclic and pseudo-cyclic photophosphorylation
- 4.3 Dark reaction: Calvin cycle (C₃ plants), Hatch and Slack Cycle (C₄ plants), Crassulacean acid metabolism (CAM cycle)
- 4.4 Photorespiration: Warburg effect, Site of photorespiration and its significance

Unit-5: Growth and Growth Regulation

(7 hrs)

- 5.1 Growth and factors affecting plant growth
- 5.2 Physiological role of Phytohormones, Auxins, Kinetin, Gibberellins, ABA and Ethylene: action and their application
- 5.3 Physiology of flowering: Photoperiodism, long day, short day and day neutral plants
- 5.4 Phytochrome: Mode of action, mechanism and phytochrome mediated physiological responses

Unit-6:Dormancy and Stress Physiology

(7 hrs)

- 6.1 Flowering hormone, concept of Florigen, Vernalization and de-vernalization
- 6.2 Seed dormancy: Introduction, Factors responsible for seed dormancy, Mechanism of seed dormancy
- 6.3 Methods of breaking seed dormancy, Structure and germination of seeds, condition essential for germination
- 6.4 Stress physiology: Moisture, Temperature, Radiation, Salinity stress. Mechanism of stress injury and stress resistance

Practicals:

1. Determination of osmotic potential of plant cell sap by plasmolytic method using leaves of *Rhoeo* / *Tradescantia* and by potato osmoscope experiment
2. Structure of stomata (dicot & monocot) using specimen/permanent slides/ Photographs.
3. Determination of rate of transpiration using cobalt chloride method.

Reference and Textbooks for Practical:

1. R. Sivakumar, P. Boominathan, C.N Chandrasekar, Practical Plant Physiology, Narendra Publishing, ISBN: 9789384337247
2. N.K. Gupta, M.K. Sangha, Manju Bala, Sunita Gupta, Practical In Plant Physiology And Biochemistry, Scientific Publishers (India), ISBN: 978-9386102638

SARVAJANIK UNIVERSITY
FACULTY OF SCIENCE

Faculty: Science	Department: Environmental Science
Program: B. Sc. (Hons)	Type of Subject: Major
Semester: 4	Subject: Applied Environmental Microbiology
Credits: 4	

Student Learning Outcomes (SLOs):

1. Basic understanding of microbiology of air, water and soil
2. Knowing microbial hazards of environmental origin
3. Knowing treatment of drinking water
4. Having basic concept of indicator microorganisms
5. Learning sampling and cultural methods for the detection of microorganisms in environmental samples

References and Textbooks:

1. Pepper IL, Gerba CP, Gentry TJ, Maier RM, editors. Environmental microbiology. Academic press; 2011 Oct 13. 978-0123705198
2. Pelczar, Chan and Kreig, Microbiology, 5th, Tata McGraw Hill
3. Prescott, Harley and Klein, Microbiology, 10th McGraw Hill

UNIT-1: MICROBIAL ECOLOGY AND MAJOR BIOGEOCHEMICAL CYCLES

(8 hrs)

- 1.1 Microbial ecology and Ecosystem: Introduction and Characteristics
- 1.2 Population interactions: Different types of Positive, Neutral and Negative interactions **Ref: Prescott**
- 1.3 Microbiology of Rumen ecosystem **Ref : Prescott**
- 1.4 Methods in microbial ecology **Ref : Brock**
- 1.5 Carbon cycle **Ref : Prescott**
- 1.6 Sulfur cycle **Ref: Prescott**
- 1.7 Nitrogen cycle **Ref: Prescott**
- 1.8 Phosphorus cycle **Ref: Prescott**

UNIT 2: AEROMICROBIOLOGY

(7 hrs)

Ref: Maier

- 2.1 Introduction to Aero microbiology
- 2.1 Origin and types of microorganisms in air
- 2.2 Microbiological analysis of air

UNIT 3: SOIL MICROBIOLOGY (8 hrs)

Ref: Subbarao

- 3.1 Physical and chemical properties of soil
- 3.2 Microorganisms in soil
- 3.3 Microbiological analysis of soil
- 3.4 Rhizosphere and Phyllosphere microflora
- 3.5 Soil microorganisms associations with vascular plants
- 3.6 Nitrogen fixation

UNIT 4: AQUATIC MICROBIOLOGY (7 hrs)

Ref: Maier

- 4.1 The aquatic environment
- 4.2 Freshwater ecosystems: Springs, Streams and rivers, Ponds, Lakes, Estuaries
- 4.3 Marine ecosystems: Mangroves Deep seas and subterranean
- 4.4 Water zonations, Upwelling and Eutrophication

UNIT 5: MICROBIOLOGY OF DRINKING WATER (7 hrs)

Ref: Pelczar

- 5.1 Sources
- 5.2 Drinking water purification: Single-Dwelling supply and Municipal supply
- 5.3 Microbiological analysis of drinking water
- 5.4 Role of Indicator organisms **Ref: Maier**
- 5.5 W.H.O. microbiological standards for drinking water

UNIT 6: MICROBIOLOGY OF WASTE TREATMENT (8 hrs)

Ref: Maier

- 6.1 Types of waste: Domestic and Industrial
- 6.2 Sludge processing: Landfills, Composting and Anaerobic sludge digesters
- 6.3 Wastewater treatment: Primary, Secondary and Tertiary
- 6.4 Microbiological analysis of waste

Practicals:

- 1. Analysis of Air Microbiota by settling plate technique.
- 2. Isolation and enumeration of heterotrophic bacteria from soil.
- 3. Isolation of Nitrogen fixing bacteria. (aerobic, microaerophilic, anaerobic).
- 4. Bacteriological analysis of water. (Quantitative, Presence-Absence test, Detection and Enumeration of Coliforms) (BGLB,Endo*)

SARVAJANIK UNIVERSITY
FACULTY OF SCIENCE

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 Digestion- 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: Separation 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
----	--------------------------	----------------	---	------	-----