SNDT Women's University, Mumbai

Undergraduate Degree / UG Programme (Syllabus as Per NEP) - Faculty of Science & Technology

Bachelor of Science (Environmental Studies)

B.Sc. In - EVS

As Per NEP – 2020

Semester – I to VI

Syllabus (W.E.F. Academic Year 2025-26)

Terminologies

Vertical	Full-form/Definition	Remarks	Related to Major and Minor Courses
Major (Core)	Subject comprising Mandatory and Elective Courses, Major Specific IKS, Vocational Skill Courses, Internship/ Apprenticeship, Field Projects, Research Projects connected to Major	Minimum 50% of total credits corresponding to Three/Four - year UG Degree- Mandatory Courses	Related to the Major
Minor Course	Course from same or different Faculty	Minimum 18-20 Credits to be completed in the first three years of UG Programme	Related to the Minor
OEC	Open Elective Courses/ Generic courses	10-12 credits to be offered in I and/or II year. Faculty-wise baskets of OEC to be prepared	OEC is to be chosen compulsorily from faculty other than that of the Major
VSC	Vocational Skill Courses, including Hands on Training corresponding to the Major and/or Minor Subject	8-10 credits, to be offered in first three years, wherever applicable vocational courses will include skills based on advanced laboratory practical's of Major	Related to the Major or Minor
SEC	Skill Enhancement Courses	06 credits, to be offered in I and II year, to be selected from the basket of Skill Courses approved by university	Related to the Major or Minor any relevant Skill
AEC	Ability Enhancement Courses	08 credits, to be offered in I and II year, English: 04 Credits to be earned in Sem - I, Modern Indian Language of 04 credits to be offered in II year	NA

VEC	Value Education Courses	Understanding India, Environmental science/education, Digital and technological solutions, Health & Wellness, Yoga education, sports, and fitness	NA
IKS	Indian Knowledge System	Generic IKS Course: basic knowledge of the IKS to be offered at First Year level	Major-Specific IKS Courses: advanced information about the major, part of the major credit to be offered at second- or third-year level
OJT	On-Job Training (Internship/Apprenticeship)	Corresponding to the Major Subject	Related to the Major
FP	Field projects	Corresponding to the Major Subject	Related to the Major
CC	Co-curricular Courses	Health and Wellness, Yoga education sports, and fitness, Cultural Activities, NSS/NCC and Fine/ Applied/Visual/ Performing Arts	NA
CE	Community Engagement and service		Related to Major
RP	Research Project	corresponding to the Major Subject	Related to Major

Programme Template

Programme	B.Sc.
Specialization	Environmental Science
Preamble	Environmental science is an interdisciplinary field that explores the relationships between humans and the natural environment. It combines knowledge from biology, chemistry, physics, geology, and social sciences to understand how natural systems work, how human activities affect these systems, and how we can address environmental challenges such as climate change, pollution, biodiversity loss, and resource depletion. By studying environmental science, we gain insights into the impact of our actions and develop sustainable solutions to protect the planet for current and future generations.
Programme Specific Outcomes (PSOs)	After completing this program, the Learner will ● Demonstrate a comprehensive knowledge of ecological systems, environmental processes, and the interrelationships between the atmosphere, hydrosphere, lithosphere, and biosphere. ● Apply scientific principles and methods to analyze environmental issues, conduct field and laboratory investigations, and interpret environmental data effectively. ● Identify, assess, and propose sustainable solutions to contemporary environmental challenges such as pollution, climate change, waste management, and biodiversity loss. ● Understand national and international environmental policies, laws, and management strategies for natural resource conservation and environmental protection. ● Integrate concepts from biology, chemistry, physics, and social sciences to develop a holistic view of environmental issues and their socio-economic impacts. ● Effectively communicate environmental concepts, findings, and solutions through written reports, presentations, and community engagement initiatives. ● Utilize modern tools, technologies, and Geographic Information Systems (GIS) for environmental monitoring, data analysis, and impact assessment.
Eligibility Criteria for Programme	1. 12th Standard (Science Stream)

Intake (For SNDT WU Departments and Conducted Colleges)	40

Structure with Course Titles

AEDP - B. Sc. In Environmental Studies

Semester - I

SN	Courses	Type of Course	Credits	Marks	Int	Ext
	Semester I					
10135611	Introduction of Environmental Science (Th)	Major (Core)	4	100	50	50
10135602	Environmental Chemistry-I (Th)	Major (Core)	2	50	50	0
10435611	Ecotourism and Sustainable Development (Th)	OEC	4	100	50	50
10635601	Environmental Science (Pr)	VSC S1 **(Related to Major)**	2	50	50	0
10735611	Basics of Computer Applications and Statistics in Environmental Science (Th)	SEC **(Any One)**	2	50	0	50
10735612	Vermicomposting (Th)					
10810111	English For Academic Writing - Paper I (For Students of English Medium)	AEC (English) **(Any One)**	2	50	0	50
10810112	English Language and Literature - I (For Students of Non-English medium)					
	Ability Enhancement Course (AEC) Link: https://www.sndt.ac.in/pdf/academics/syllabus-as-per-nep/aec-syllabus/ug-degree/ability-enhancement-course.pdf					

	(Available on Website)					
11051111	Inception of India Knowledge System **IKS Link:** https://www.sndt.ac.in/pdf/academics/syllabus-as-per-nep/iks-syllabus/ug-degree/inception-of-indian-knowledge-system.pdf (Available on Website)	IKS (Generic)	2	50	0	50
10952111	Introduction to Indian Constitution **Link:** https://www.sndt.ac.in/pdf/academics/syllabus-as-per-nep/vec-syllabus/ug-degree/introduction-to-indian-constitution.pdf (Available on Website)	VEC	2	50	0	50
11450121	Basics of National Service Scheme	CC **(Any One)**	2	50	50	0
11450221	National Cadets Corps. (NCC) Studies - I					
11450322	Health and Wellness					
11450421	Performing Arts Exploration					
	Co-Curricular Course (CC) Link: https://www.sndt.ac.in/pdf/academics/syllabus-as-per-nep/cc-syllabus/ug-degree/co-curricular-course-as-per-nep-2020-semester-i-syllabus.pdf (Available on Website)					
			22	**550**	**250**	**300**

Semester – II

SN	Courses	Type of Course	Credits	Marks	Int	Ext
	Semester II					
20135611	Ecology (Th)	Major (Core)	4	100	50	50
20135612	Atmospheric and Aquatic Chemistry (Th)	Major (Core)	2	50	0	50
20635601	Ecology (Pr)	VSC S2 **(Related to Major)**	2	50	50	0
20635602	Atmospheric and Aquatic Chemistry (Pr)	VSC S3 **(Related to Minor)**	2	50	50	0
20435611	Green Movement (Th)	OEC	4	100	50	50
20735601	Soil Quality Assessment (Th)	SEC	2	50	50	0
20810111	English For Academic Writing - Paper II (For Students of English Medium)	AEC (English) **(Any One)**	2	50	0	50
20810112	English Language and Literature - II (For Students of Non-English medium)					
	Ability Enhancement Course (AEC) Link: https://www.sndt.ac.in/pdf/academics/syllabus-as-per-nep/aec-syllabus/ug-degree/ability-enhancement-course.pdf (Available on Website)					

20952111	Environment Awareness **Link:** https://www.sndt.ac.in/pdf/academics/syllabus-as-per-nep/vec-syllabus/ug-degree/environment-awareness.pdf (Available on Website)	VEC	2	50	0	50
21450121	Volunteerism and National Service Scheme	CC **(Any One)**	2	50	50	0
21450221	National Cadets Corps. (NCC) Studies - II					
21450323	Yoga Education					
21450421	Fine Art					
	Co-Curricular Course (CC) Link: https://www.sndt.ac.in/pdf/academics/syllabus-as-per-nep/cc-syllabus/ug-degree/co-curricular-course-as-per-nep-2020-semester-ii-syllabus.pdf (Available on Website)					
			22	**550**	**300**	**250**

Semester - III

SN	Courses	Type of Course	Credits	Marks	Int	Ext
30135611	Environmental Pollution (Th)	Major (Core)	4	100	50	50
30135612	Conservation of Forest, Wildlife and Biodiversity (Th)	Major (Core)	4	100	50	50
30135613	Natural Recourses and Energy Management (Th)	Major (Core)	2	50	0	50
30335611	Chemistry of Industrial Pollution (Th)	Minor Stream	4	100	50	50
30435611	Health, Safety and Environmental Management (Th)	OEC	2	50	0	50
	Modern Indian Language **Ability Enhancement Course (AEC) Link:** https://sndt.ac.in/pdf/academics/syllabus-as-per-nep/aec-syllabus/ug-degree/aec-semester-iii.pdf (Available on Website)	AEC **(Any One)**	2	50	50	0
30810301	रचनात्मक लेखन (Hindi)					
30810401	मराठी भाषेचा परिचय - भाग १ (Marathi)					
30810501	Contemporary Sanskrit Nyaya (Sanskrit)					
30810201	શીખો ગુજરાતી – પ્રાથમિક ભાગ ૧: લિપિ પરિચય, શ્રવણ અને વાચન કૌશલ્ય (Gujarati)					

30135604	Urban Environmental Ecosystem (Th)	Major (Core)	2	50	50	0
	Co-Curricular Course (CC) Link: https://sndt.ac.in/pdf/academics/syllabus-as-per-nep/cc-syllabus/ug-degree/co-curricular-course-as-per-nep-2020-semester-iii-syllabus.pdf (Available on Website)	CC **(Any One)**	2	50	50	0
31450121	Social issues Advocacy and Action					
31450221	National Cadets Corps. (NCC) Studies – III					
31450321	Traditional Sports and Fitness					
31450421	Unfolding The Beauty of Indian Music					
			22	**550**	**300**	**250**

Semester – IV

SN	Courses	Type of Course	Credits	Marks	Int	Ext
40135611	Solid and Hazardous Waste Management (Th)	Major (Core)	4	100	50	50
40135612	Water Resources and Treatment (Th)	Major (Core)	4	100	50	50
40335611	Geosphere and Geochemistry (Th)	Minor Stream	4	100	50	50
40435611	Hazard and Disaster Management (Th)	OEC	2	50	0	50
40735611	Bamboo Innovations & Applications (Th)	SEC	2	50	0	50
	Modern Indian Language **Ability Enhancement Course (AEC) Link:** https://sndt.ac.in/pdf/academics/syllabus-as-per-nep/aec-syllabus/ug-degree/aec-semester-iv.pdf (Available on Website)	AEC **(Any One)**	2	50	0	50
40810411	मराठी भाषेचा परिचय - भाग २ (Marathi)					
40810411	सूचना प्रौद्योगिकी और हिंदी भाषा (Hindi)					
40810511	वाल्मिकीकिरामयणे अयोध्याकाण्ड: (Sanskrit)					
40810211	શીખો ગુજરાતી - ભાધ્મમિક (Gujarati)					
40335602	Environmental Biochemistry (Th)	Minor Stream	2	50	50	0

	Co-Curricular Course (CC) Link: https://sndt.ac.in/pdf/academics/syllabus-as-per-nep/cc-syllabus/ug-degree/co-curricular-course-as-per-nep-2020-semester-iv-syllabus.pdf (Available on Website)	CC **(Any One)**	2	50	50	0
41450122	Personality and Leadership Development through National Service Scheme					
41450121	NSS Volunteers under National service scheme special camp					
41450221	National Cadets Corps. (NCC) Studies – IV					
41450421	Theatre & Dance					
			22	**550**	**250**	**300**

Semester – V

SN	Courses	Type of Course	Credits	Marks	Int	Ext
	Waste Water Management (Th)	Major (Core)	4	100	50	50
	Engineering aspects of pollution control (Th)	Major (Core)	4	100	50	50
	Indian Knowledge Systems: Environmental Perspectives (Th)	IKS (Major Specific)	2	50	0	50
	Global Climate Change: Science and Impacts (Th)	Minor Stream	4	100	50	50
	Elements of Green Chemistry (Th)	Minor Stream	4	100	50	50
	Monitoring and analysis of environmental component (Pr)	VSC-4	2	50	50	0
	Watershed Management (Th)	Major (Core)	2	50	50	0
			22	**550**	**300**	**250**

Semester – VI (AEDP)

SN	Courses	Type of Course	Credits	Marks	Int	Ext
	Remote Sensing and GIS (Th)	Major (Core)	4	100	50	50
	Field Project (Pr)	FP	4	100	50	50
	Environmental Impact Assessment (Th)	Major (Elective)	4	100	50	50
	Environmental Research Method and Data Analysis (Th)	Major (Elective)	4	100	50	50
	On Job Training (Pr)	OJT	4	100	50	50
	Community Engagement (Pr)	CE	2	50	0	50
			22	**550**	**250**	**300**

Course Syllabus

Semester - I

.1.1 Major (Core)

Course Title	**Introduction of Environmental Science (Th)**
Course Credits	4
Course Outcomes	After going through the course, learners will be able to
	1. Understand the basic concept of Environmental Science and Atmospheric Science
	2. Comprehend the Atmospheric Chemistry and Components of Environment.
	3. Understand the basic concept of climatology
	4. Understand the meteorology
Module 1 (Credit 1) - Basics of Environmental Science	
Learning Outcomes	After learning the module, learners will be able to,
	1. Explain the basics of Environmental Science along with components of environment.
	2. Explicate the importance of Environmental Education.
Content Outline	• Definition, Types, Classification of environment, Components and principles of environment. Scope and need for environmental science, Multidisciplinary nature of environmental science, Environmental ethics. • Goals, Objectives and principles of environmental education, formal and non-formal environmental education, importance of environmental education, environmental awareness, Environmental days.
Module 2 (Credit 1)-Basics of Atmospheric Environment	
Learning Outcomes	After learning the module, learners will be able to,
	1. Explain Atmospheric Science and its composition and structure
	2. Explain photochemical reaction in atmosphere and their effects

Content Outline	• Composition and Structure of atmosphere (temp)**,** hydrosphere – distribution of water, hydrological cycle, lithosphere – Internal structure of Earth, types of rocks, Biosphere- Boundaries of biosphere. • photochemical reactions in the atmosphere, temperature inversion and lapse rate, smog formation, types of smog (sulphur and photochemical smog), adverse effect of smog on human being, aerosol, Acid Rain
Module 3 (Credit 1) – Basics of Climatology	
Learning Outcomes	After learning the module, learners will be able to,
	1. To understand the key elements of climate and difference between climate and weather
	2. Explain the elements of climate and effects of climate
Content Outline	• Climatology: Definition, Aims and Objectives. Difference between weather and climate. Condensation. Forms of condensation. Precipitation. Forms of precipitation. Clouds and its classification. • Movement of earth around sun, Different elements of climate like: Pressure Wind, Temperature, Humidity and Precipitation, Different Climatic Zones, Effects of climate on man and animal, Macro-micro climate, Factors influencing Macro-micro climate, application of climatology
Module 4 (Credit 1) – Basics of Meteorology	
Learning Outcomes	After learning the module, learners will be able to,
	1. To understand the meteorological parameters
	2. Explain the weather and climate forecasting
Content Outline	• Meteorology: Definition. Primary meteorological parameters and their measurement: temperature, wind direction and speed. Secondary meteorological parameters and their measurement: humidity, precipitation, pressure and solar radiation. • Weather forecasting: methods, types, role of satellite in weather forecasting.

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

Module 1 - Basics of Environmental Science

Project 1: Environmental Awareness program

Description: Students will explore the intricate relationship between humans and the natural environment. The program is designed to help students understand key environmental concepts, identify local and global environmental issues and develop the

knowledge and skills needed to make responsible decisions for a sustainable future. Also, perform the action and field-oriented projects-tree planting campaigns, Campus clean-up drives, Environmental awareness campaigns (Plays, Posters, debates), Nature walks and biodiversity observation, visits to eco-parks, recycling centers, water treatment plant, Environmental surveys and audit (e g. School waste audit).

Module 2 - Basics of Atmospheric Environment

Project 1: Measuring the pH of Rainwater – Exploring Acid Rain

Description: Students will collect rainwater samples during or shortly after a rainfall. They will then measure the pH using pH strips or a digital pH meter to determine if the rainwater is acidic. The students will relate their findings to atmospheric chemical reactions involving sulfur dioxide (SO_2) and nitrogen oxides (NO_x), which form sulfuric and nitric acids in the atmosphere. To investigate the acidity of local rainwater and understand the chemical processes leading to acid rain formation due to atmospheric pollutants.

Module 3 - Basics of Climatology

Project 1: Recording and Analyzing Local Weather Data

Description: Students will collect daily weather data (temperature, humidity, wind speed, and cloud cover) for 7 consecutive days from their local area using mobile apps, weather websites, or school instruments. They will organize the data into a chart and analyze patterns in relation to basic climatological concepts such as diurnal temperature variation, humidity trends, and cloud types. To help students understand the difference between weather and climate, learn how weather elements are observed and recorded, and interpret short-term atmospheric conditions.

Module 4 - Basics of Meteorology

Project 1: Measuring and Analyzing Relative Humidity Over Time

Description: Students will measure and record relative humidity at a fixed time each day over 5 to 7 days using a digital hygrometer, psychrometer, or reliable weather apps/websites. They will then analyze the variation in humidity and explore its relationship with temperature, cloud formation, and human comfort levels. To help students understand the concept of relative humidity, how it varies with time and weather conditions, and its impact on both weather phenomena and daily life.

Reference Books:

1. Text Book of Environment: K M Agrawal, P.K.Sikdar, and S.C.Deb, Mc'Millan Publication, Mumbai.

2. Man and Environment: M.C.Dash and P.C.Mishra, Mc'Millan Publication, Mumbai.

3. Environmental Science: S.C.Santra, New Central Book Pvt.Ltd, Kolkatta.

4. Environmental Problems and Solution: D.K.Asthana, S.Chand Publication,New Delhi.

5. Environmental Chemistry: S.S.Dara, S.Chand Publication,New Delhi.

6. Environmental Chemistry: B.K.Sharma, Goel Publication,Meerut.

7. Environmental Chemistry: A.K.Dey,New Age International Publishers,2001.
8. Man and Environment: P.R.Trivedi and Gurdeep Raj,Akashdeep Publishing House,New Delhi.

9. Fundamentals Concepts in Environmental Studies: Dr.D.D.Mishra, S.Chand Publication,New Delhi.

10. Climatology: D.S.Lal,Sharda Pustak Bhavan,Allahabad,2003.

11. A Textbook of Environmental Studies: Dr S.Satyanarayan, Dr S.Zade, Dr S Sitre and Dr P.U.Meshram,Allied Publishers, New Delhi.

Semester - I

.**1.2 Major (Core)**

Course Title	**Environmental Chemistry (Th)**
Course Credits	2
Course Outcomes	After going through the course, learners will be able to
	1. Explain the fundamental concepts of environmental chemistry and its role in understanding natural processes and pollution.
	2. Identify and describe the chemical composition of air, water, and soil, along with their natural cycles.
Module 1 (Credit 1) - Basics of General Chemistry	
Learning Outcomes	After learning the module, learners will be able to,
	1. Understand the fundamental concepts of atomic structure, chemical bonding, and periodic properties.
	2. Apply the principles of chemical reactions, stoichiometry, and thermodynamics to solve numerical and conceptual problems.
Content Outline	• Molecular weight, Equivalent Weight, Molarity, Normality, Oxidation and Reduction Reactions; Brief idea of Metals and Nonmetals; Aromatic & Aliphatic compounds, Saturated and unsaturated hydrocarbons. • Stoichiometry; Chemical equilibrium; Acid-base reactions (acidity, alkalinity, buffer and buffer capacity).
Module 2 (Credit 1) Soil Chemistry	
Learning Outcomes	After learning the module, learners will be able to,
	• Explain the chemical composition and properties of soils, including minerals, organic matter, and pore water chemistry.
	• Analyze the role of soil chemistry in plant growth, soil fertility, and crop productivity.
Content Outline	• Soil composition; relation between organic carbon and organic matter; inorganic and organic, components in soil; soil humus; cation and anion exchange reactions in soil; nitrogen, phosphorus and potassium pathways in soil.

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

Module 1 – Basics of General Chemistry

Project 1: pH scale chart

Description: Students will prepare a pH scale chart by testing different household and laboratory solutions (e.g., lemon juice, soap water, vinegar, baking soda solution) using pH paper or a pH meter. They will record readings, classify substances as acidic, neutral, or basic, and present the data in a colorful chart. This activity helps students understand acids, bases, and pH, develop practical measurement skills, and relate chemical concepts to everyday life applications.

Module 2 – Soil Chemistry

Project 1: Determination the pH of different soil samples

Description: Students will determine the pH of different soil samples collected from various locations (e.g., garden, farmland, roadside) using a pH meter or pH indicator paper. They will compare results and discuss how soil pH influences nutrient availability and plant growth. This activity helps students connect chemical properties of soil with agricultural and environmental applications.

Reference Books:

1. Text Book of Environment: K M Agrawal, P.K.Sikdar, and S.C.Deb, Mc'Millan Publication, Mumbai.
2. Man and Environment: M.C.Dash and P.C.Mishra, Mc'Millan Publication, Mumbai.
3. Environmental Science: S.C.Santra, New Central Book Pvt.Ltd, Kolkatta.
4. Environmental Problems and Solution: D.K.Asthana, S.Chand Publication,New Delhi.
5. Environmental Chemistry: S.S.Dara, S.Chand Publication,New Delhi.
6. Environmental Chemistry: B.K.Sharma, Goel Publication,Meerut.
7. Environmental Chemistry: A.K.Dey,New Age International Publishers,2001.
8. Man and Environment: P.R.Trivedi and Gurdeep Raj,Akashdeep Publishing House,New Delhi.
9. Fundamentals Concepts in Environmental Studies: Dr.D.D.Mishra, S.Chand Publication,New Delhi.
10. Climatology: D.S.Lal,Sharda Pustak Bhavan,Allahabad,2003.
11. A Textbook of Environmental Studies: Dr S.Satyanarayan, Dr S.Zade, Dr S Sitre and Dr P.U.Meshram,Allied Publishers, New Delhi.

Semester - I

.1.3 Open Elective Courses (OEC)

Course Title	**Ecotourism and Sustainable Development**
Course Credits	4
Course Outcomes	After going through the course, learners will be able to
	1. Understand the concepts, principles, and significance of ecotourism in environmental conservation.
	2. Analyze ecotourism planning and management practices for minimizing environmental impacts.
	3. Evaluate the role of community participation and policy frameworks in promoting sustainable ecotourism.
	4. Assess Indian ecotourism initiatives and case studies for their contribution to biodiversity conservation and sustainable development.
Module 1 (Credit 1) – Introduction to Ecotourism	
Learning Outcomes	After learning the module, learners will be able to,
	1. Define ecotourism and explain its principles and objectives.
	2. Identify natural resources and ecosystems suitable for ecotourism.
Content Outline	• Concept, definition, and principles of ecotourism, Evolution and scope of ecotourism, Difference between ecotourism, mass tourism, and sustainable tourism, Ecotourism resources: forests, wildlife, wetlands, coastal and mountain ecosystems, Role of ecotourism in environmental conservation
Module 2 (Credit 1)- Sustainable Development and Tourism	
Learning Outcomes	After learning the module, learners will be able to,
	1. Explain the concept and pillars of sustainable development.
	2. Describe the environmental, economic, and socio-cultural impacts of tourism.

Content Outline	• Concept and pillars of sustainable development, Sustainable Development Goals (SDGs) and tourism, Environmental, economic, and socio-cultural impacts of tourism, Carrying capacity and limits of acceptable change, Role of tourism in rural development and livelihood generation
Module 3 (Credit 1) – Ecotourism Planning and Management	
Learning Outcomes	After learning the module, learners will be able to,
	1. Understand ecotourism planning principles and site selection criteria.
	2. Explain the role of community participation and stakeholders in ecotourism management.
Content Outline	• Ecotourism planning and site selection, Environmental impact of ecotourism activities, Ecotourism management practices and guidelines, Community participation and indigenous knowledge, Role of government, NGOs, and private sector in ecotourism
Module 4 (Credit 1) – Ecotourism in India and Case Studies	
Learning Outcomes	After learning the module, learners will be able to,
	1. Describe ecotourism policies and initiatives in India and analyze successful Indian ecotourism case studies.
	2. Evaluate challenges and future prospects of ecotourism in India.
Content Outline	• Ecotourism policy and initiatives in India, Protected areas, biosphere reserves, and ecotourism, Case studies of successful ecotourism projects in India, Challenges and future prospects of ecotourism, Ecotourism as a tool for biodiversity conservation.

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

Module 1 – Introduction to Ecotourism

Project 1: Identification of Ecotourism Resources

Description: Students identify local or regional ecotourism sites (forests, wildlife sanctuaries, wetlands, coastal or hill ecosystems) and briefly describe their ecological importance and ecotourism potential. Learning Outcome: Identifies natural resources suitable for ecotourism and appreciates their conservation value. Evaluation Criteria: Relevance of site selection, ecological understanding, and clarity of description.

Module 2 – Sustainable Development and Tourism

Project 1: Tourism and Sustainable Development Goals (SDGs)

Description: Students prepare a short assignment explaining the concept of sustainable development and analyze how tourism contributes to selected Sustainable Development Goals (SDGs) such as poverty alleviation, environmental protection, and community development. Learning Outcome: Understands the link between tourism and sustainable development in environmental, social, and economic contexts. Evaluation Criteria: Concept clarity, relevance to SDGs, and logical presentation.

Module 3 – Ecotourism Planning and Management

Project 1: Ecotourism Site Planning

Description: Students select a potential ecotourism site (forest, wetland, hill station, or wildlife area) and prepare a brief site planning report that includes: Site selection criteria, Potential environmental impacts, Mitigation measures and management strategies. Learning Outcome: Applies principles of ecotourism planning and understands environmental considerations in site selection. Evaluation Criteria: Relevance of site, clarity of planning, consideration of ecological impacts, and practicality of management strategies.

Module 4 – Ecotourism in India and Case Studies

Project 1: Case Study Analysis

Description: Students select a successful Indian ecotourism project (e.g., Periyar Wildlife Sanctuary, Sunderbans, Jim Corbett, or Kaziranga) and prepare a brief case study report highlighting: Objectives of the project, Environmental and socio-economic benefits, Challenges faced and lessons learned. Learning Outcome: Analyzes real-life ecotourism projects in India and evaluates their contribution to conservation and local livelihoods. Evaluation Criteria: Relevance of case study, clarity of analysis, and understanding of ecological and social impacts.

Reference Books:

1. TIES (The International Ecotourism Society). *Ecotourism Principles, Practices and Policies*.
2. M. Honey. *Ecotourism and Sustainable Development: Who Owns Paradise?* Island Press.
3. R. Buckley. *Ecotourism: Principles and Practices*. CABI Publishing.
4. Weaver, D. *Ecotourism*. John Wiley & Sons.
5. Bharucha, E. *Textbook of Environmental Studies*. Universities Press.
6. UNWTO. *Tourism and Sustainable Development Goals*.

Semester - I

.1.4 Vocational Skill Courses (VSC)

Course Title	**Environmental Science (Lab)(Pr)**
Course Credits	2
Course Outcomes	After going through the course, learners will be able to,
	1. Evaluate data against standard environmental quality parameters (BIS/WHO/ CPCB norms) to determine pollution levels.
	2. Use appropriate tools and techniques to collect, analyze, and interpret environmental data.
	3. Perform field surveys, sampling, and biodiversity assessments in local ecosystems or polluted areas.
	4. Reflect on laboratory and fieldwork to promote environmental ethics and sustainable practices in daily life.
Module 1 (Credit 1) – Environmental Science Practical I (Part A)	
Learning Outcomes	After learning the module, learners will be able to,
	1. Understand the concepts of water sampling with preservation techniques
	2. Understand the physical and chemical properties of water samples with water quality standards.
	3. Understand the water sampling and preservation techniques.
	4. Understand the principle, working and application of the instruments.
Content Outline	• To study the Safety Measures with in the Laboratory • Ground water and surface water sampling and preservation Techniques • To Study of Water Quality Standards • To study the physical properties of water sample. • To study the chemical properties of water sample • To study the principle, working operation and application of pH & EC Meter • To study the principle, working operation and application of Turbidity Meter

Module 2 (Credit 1) Environmental Science Practical I (Part B)	
Learning Outcomes	After learning the module, learners will be able to,
	1. To determine the pH, electrical conductivity of water which help to understand the nature of particular water.
	2. Estimate the solids from water to evaluate their effects on humans.
Content Outline	• Determination of temperature of the atmosphere. • Measurement of atmospheric pressure by barometer. • Measurement of relative humidity by psychrometer. • Measurement of wind velocity using anemometer. • Determination of pH of the water. • Determination of electrical conductivity of the water. • Determination of turbidity of the water

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

1. **Project 1: Determination of relative humidity**

   Design an experiment to determine the percentage of relative humidity. A psychrometer consists of two thermometers: a dry bulb (measuring air temperature) and a wet bulb (covered with a moist cloth). When air passes over the wet bulb, evaporation causes cooling, lowering its temperature. The difference between dry and wet bulb temperatures is used to determine relative humidity with the help of a psychrometric chart or table. A larger temperature difference indicates lower humidity, while a smaller difference suggests higher humidity.

2. **Project 2: Determination of Electrical Conductivity**

   Electrical Conductivity (EC) is a measure of a solution's ability to conduct electricity, which depends on the concentration of dissolved salts (ions). To determine EC, a conductivity meter is used. The probe is immersed in a water or soil extract sample, and the meter displays the conductivity in micro-Siemens per centimeter (μS/cm) or milli Siemens per centimeter (mS/cm). Higher EC values indicate higher salinity. This method is widely used to assess water quality, soil fertility, and environmental health

3. **Project 3: Water Quality Standards**

   This activity involves understanding and comparing water quality parameters (such as pH, turbidity, dissolved oxygen, electrical conductivity, hardness, and presence of contaminants) against established standards set by agencies like BIS (Bureau of Indian Standards) or WHO (World Health Organization). By analyzing these parameters in local water samples, students can assess whether the water is safe for drinking, domestic, agricultural, or industrial use, promoting awareness of public health and environmental safety.

4. Project 4: Physico-chemical properties of water

Physico-chemical properties of water refer to the physical and chemical characteristics that determine water quality and usability. Key physical properties include temperature, color, odor, turbidity, and total dissolved solids (TDS), while chemical properties include pH, electrical conductivity (EC), dissolved oxygen (DO), hardness, alkalinity, chlorides, nitrates, and phosphates. Analyzing these parameters helps assess whether water is suitable for drinking, irrigation, industrial use, and supports environmental monitoring and pollution control.

Reference Books:

1. APHA (American Public Health Association, American water works Association and water pollution control federation), Standard methods for the examination of water and waste water, Publication Health Association, washington, DC, USA.

2. Guidelines for Water Quality Monitoring,2007, CPCB, New Delhi,
   ICMR, Indian council of Medical Research Manual of standard of Quality of Drinking water supplies. 2nd Ed. Special Report series No. 44, New Delhi.

3. Sharma B.K., (2001), Water Pollution, Goal publishing house, Meerut.

4. Pandey S.K. Tiwari S., (2009), Physico- chemical analysis of ground water of selected area of Ghazipur city-A case study, Nature and science. Vol. 7(1), pp 17 - 20

5. ICMR, Indian council of Medical Research Manual of standard of Quality of Drinking water supplies. 2nd Ed. Special Report Series No. 44, New Delhi.

6. Reza. R. and Singh G., (2009), Physico- chemical Analysis of Ground water in Angul-Talcher region of Orissa, India, Journal of American Science, Vol.5(5), pp 53 - 58

Semester - I

.1.5 A. Skill Enhancement Course (SEC)

Course Title	**Basics of Computer Applications and Statistics in Environmental Science**
Course Credits	2
Course Outcomes	After going through the course, learners will be able to,
	1. Understand basic computer concepts and their applications in Environmental Science.
	2. Use basic computer tools for environmental data collection, organization, and presentation.
	3. Understand fundamental statistical concepts used in environmental and ecological studies
	4. Interpret environmental data for decision-making in pollution monitoring and environmental management.
Module 1 (Credit 1) –Basics of Computer Applications in Environmental Science	
Learning Outcomes	After learning the module, learners will be able to,
	1. Explain the basic components of a computer system and their functions and identify commonly used software applications in Environmental Science.
	2. Use computers for storing, managing, and retrieving environmental data and apply spreadsheet software to enter and organize environmental data.
Content Outline	• Introduction to computers and their applications in Environmental Science • Basic components of a computer system: hardware and software • Operating systems and application software • Role of computers in environmental data collection and management • Introduction to spreadsheets for environmental data handling • Preparation of tables, graphs, and charts for environmental parameters • Use of computers in pollution monitoring and environmental management

Module 2 (Credit 1)- Basics of Statistics for Environmental Science	
Learning Outcomes	After learning the module, learners will be able to,
	1. Define statistics and explain its importance in Environmental Science and Calculate measures of central tendency such as mean, median, and mode.
	2. Represent environmental data graphically using bar diagrams, histograms, and pie charts and interpret simple statistical results in environmental and ecological contexts.
Content Outline	• Introduction to statistics and its importance in Environmental Science • Types of data and methods of data collection • Classification and tabulation of data • Measures of central tendency: mean, median, and mode • Measures of dispersion: range and standard deviation • Graphical representation of data: bar diagram, histogram, pie chart • Basic statistical applications in environmental and ecological studies

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

Module 1 – Basics of Computer Applications in Environmental Science

Project 1: Environmental Data Entry Using Spreadsheet

Description: Students enter given environmental data (e.g., water quality parameters such as pH, DO, BOD) into a spreadsheet and organize it in tabular form. Learning Outcome: Develops basic data handling and organization skills. Evaluation Criteria: Accuracy of data entry, proper formatting, organization.

Module 2 – Basics of Statistics for Environmental Science

Project 1: Statistical Analysis of Environmental Data

Description: Students are provided with simple environmental data (e.g., pH values of water samples, air quality parameters, or soil nutrient values). They classify and tabulate the data and calculate measures of central tendency (mean, median, and mode). Learning Outcome: Applies basic statistical tools to analyze environmental data. Evaluation Criteria: Accuracy of calculations, proper tabulation, interpretation of results.

Reference Books:

1. Rajaram, V. – *Computer Applications in Environmental Sciences*, PHI Learning

2. Sinha, P.K. & Sinha, P. – *Computer Fundamentals*, BPB Publications

3. Basandara, S.K. – *Computer Today*, Galgotia Publications

4. Goon, A.M., Gupta, M.K. & Dasgupta, B. – *Fundamentals of Statistics*, World Press

5. Sundarraj, N., Rangaswamy, R. & Nagaraj, S. – *Biostatistics*, Saras Publications

6. Zar, J.H. – *Biostatistical Analysis*, Pearson Education

7. Palanisamy, M (1989) A Text Book of Statistics, Paramount Publication, Palani

8. Vittal, R.R (1986) Business Mathematics and Statistics, Murugan Publications

9. Gupta, S.P. (1996) Statistical Methods, Sulthan chand and Sons Publications, New Delhi.

10. Byron S Gottfried (1996) Programming with C, Hill Publishing Co, New Delhi.

11. Sanjay Saxena (2003) A First course in computers, Vikas publishing house Pvt. Ltd, New Delhi.

Semester - I

.1.5 B. Skill Enhancement Course (SEC)

Course Title	**Vermicomposting (Th)**
Course Credits	2
Course Outcomes	After going through the course, learners will be able to,
	1. Explain the concept, principles, and importance of vermicomposting in sustainable waste management.
	2. Identify earthworm species used in vermicomposting and describe their role in organic matter decomposition.
	3. Understand vermicomposting techniques for converting organic waste into nutrient-rich manure.
	4. Promote vermicomposting as an eco-friendly, low-cost, and livelihood-oriented technology.
Module 1 (Credit 1) –Concepts and Techniques of vermicomposting	
Learning Outcomes	After learning the module, learners will be able to,
	1. Identify commonly used earthworm species and their biological characteristics.
	2. Understand the steps and techniques involved in vermicomposting (bed preparation, feeding, moisture and temperature control).
Content Outline	• Concept and importance of vermicomposting • Biology and ecology of earthworms • Common species used in vermicomposting (Eisenia fetida, Eudrilus eugeniae, etc.) • Raw materials for vermicomposting • Vermicomposting methods: pit, bed, and tank methods • Environmental benefits of vermicomposting • Role of vermicomposting in waste management
Module 2 (Credit 1)- Vermicompost Production, Quality, and Applications	
Learning Outcomes	After learning the module, learners will be able to,
	1. Describe factors affecting vermicomposting efficiency, such as pH, moisture, and waste type.

	2. Evaluate the economic and environmental benefits of vermicomposting.
Content Outline	• Process of vermicompost preparation • Factors affecting vermicomposting (temperature, moisture, pH) • Harvesting and storage of vermicompost • Physico-chemical characteristics of vermicompost • Use of vermicompost in agriculture and soil health improvement • Vermicomposting as a sustainable livelihood and entrepreneurship opportunity • Health, safety, and maintenance practices

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

Module 1 – Concepts and Techniques of vermicomposting

Project 1: Design and Establishment of a Vermicomposting Unit
Description: Students will explore: Practical steps and techniques involved in vermicomposting. Activity Description: Students design and set up a small vermicomposting unit (using a pot, bucket, or pit) with biodegradable waste. They document earthworm species used, bedding material, moisture control, feeding schedule, and maintenance practices through photographs or a brief report. Learning Focus: Vermicomposting techniques, process management, hands-on skill development.

Module 2 – Vermicompost Production, Quality, and Applications

Project 1: Assessment of Vermicompost Quality Parameters
Description: Students will explore: The quality and nutrient composition of vermicompost. Activity Description: Students collect vermicompost samples (prepared by them or obtained locally) and assess physical properties (color, texture, odor) and basic chemical parameters such as pH, moisture content, and nutrient indicators (N, P, K – based on available data or simple tests). Results are presented in a report or tabular format. Learning Focus: Vermicompost quality, nutrient assessment, analytical and observation skills.

Reference Books:

1. Edwards, C.A. & Arancon, N.Q. – *Vermiculture Technology: Earthworms, Organic Wastes, and Environmental Management*

2. Bhawalkar, U.S. – *Vermiculture Bioconversion of Organic Waste*

3. ICAR Publications – Manuals on Vermicomposting

4. FAO – *Organic Waste Management and Vermicomposting*

5. P.K. De – *Environmental Chemistry* (for environmental relevance)

Course Syllabus

Semester – II

.2.1 Major (Core)

Course Title	**Ecology (Th)**
Course Credits	4
Course Outcomes	After going through the course, learners will be able to
	1. Understand the fundamental concepts of ecology and environmental biology, including ecosystem structure, function, and biodiversity.
	2. Explain the interrelationship between organisms and their environment, including population dynamics, food webs, and ecological succession.
	3. Evaluate the impact of human activities on natural ecosystems and explore sustainable development practices.
	4. Apply knowledge of environmental biology in conservation strategies and natural resource management.
Module 1 (Credit 1) - Basics of Ecology	
Learning Outcomes	After learning the module, learners will be able to,
	1. Understand the Ecology and its allied branches
	2. Explain the basic concepts of Ecology and environmental factors: Abiotic and Biotic
Content Outline	• Definition, subdivision and modern branches of ecology, ecology spectrum, scope of ecology. Application and significance of ecology to human beings. • Abiotic Factors: Temperature: effect of temperature on plants and animals, Adaptation to meet extreme temperature. Light: Zonation in marine habitat, effects of light on plants and animals, Microclimate and fire. • Biotic Factor: Inter specific relationship Positive: Mutualism (symbiosis), commensalism, proto- cooperation Negative: Parasitism, predation, competition, Antibiosis, Neutralism.

Module 2 (Credit 1) Population Ecology	
Learning Outcomes	After learning the module, learners will be able to,
	1. 1.Define key concepts in population ecology, including population size, density, dispersion, age structure, and carrying capacity.
	2. 2.Distinguish between different patterns of population distribution and growth (e.g., exponential and logistic growth).
Content Outline	• Definition and types, characteristic of population: Natality, mortality, population density, population dispersal and dispersion, population fluctuation, population growth curve (S & J) shaped curve, Biotic potential, Environmental resistance, concept of carrying capacity. • population growth: geometric, exponential, logistic, density-dependent; limits to population growth; deterministic and stochastic models of population dynamics; ruderal, competitive and stress-tolerance strategies.
Module 3 (Credit 1) – Community ecology	
Learning Outcomes	After learning the module, learners will be able to,
	1. Define ecological communities and describe their structure, composition, and types.
	2. Understand concepts such as species richness, species diversity, dominance, and ecological niches within a community.
Content Outline	• Definition, characteristic of community, community structure, ecological dominants and indicators, Ecotone and edge effect, ecological equivalents, keystone species, • Ecological Succession: Definition and types, Causes, process, pattern, and significance of ecological succession. Micro succession. climax community concepts, examples of succession. ecological niche; types of niches
Module 4 (Credit 1) – Ecosystem	
Learning Outcomes	After learning the module, learners will be able to,
	1. Define the concept of an ecosystem and identify its major components: biotic and abiotic.
	2. Describe trophic levels, food chains, food webs, and ecological pyramids.

Content Outline	• Concept, components, and types of ecosystems, Structure of ecosystems: producers, consumers, decomposers. Function of ecosystems: energy flow (food chains, food webs, ecological pyramids). • Ecosystem boundary; ecosystem function; ecosystem metabolism; primary production and models of energy, biotic accumulation; ecosystem losses; nutrient supply and uptake.

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

Module 1 – Basics of Ecology

Project 1: Exploring a Local Ecosystem: Mapping Biotic and Abiotic Components

Description: Students will be able to identify ecological components, understand interdependence among organisms, and relate basic ecological principles to a real environment. Students will visit a nearby natural or semi-natural area (such as a park, garden, pond, or forest patch), Observe and list biotic components (plants, animals, insects, microorganisms). Note abiotic factors (temperature, light, soil type, humidity, water availability). Identify relationships such as producers, consumers, decomposers, and note any symbiotic interactions. To help students understand the structure and functioning of an ecosystem by identifying and analyzing its biotic (living) and abiotic (non-living) components in a real-world setting.

Module 2 – Population Ecology

Project 1: Population Count and Density Estimation in a Local Area

Description: Students will learn to collect ecological data, apply basic statistical concepts, and understand population dynamics in a natural context. Students will select a specific small area (e.g., a garden, park, or campus lawn). Choose a species to observe (e.g., ants, grasshoppers, sparrows, or a specific plant like dandelions). Divide the area into quadrats (e.g., 1m × 1m squares) using strings or markers. Count the number of individuals of the chosen species in each quadrat. Calculate the average population density using the formula: Population Ecology= Total individuals counted/Total No. of quadrant. Record data, interpret patterns, and reflect on factors affecting population size (e.g., food, space, human activity). To introduce students to basic methods of population estimation and help them understand concepts like density, distribution, and limiting factors.

Module 3 – Community ecology

Project 1: Observation and Analysis of Species Interactions in a Local Ecosystem

Description: Students will be able to identify and describe ecological interactions, recognize their roles in community structure, and understand the balance of natural ecosystems. Students will visit a nearby natural area (such as a garden, park, or forest edge) and observe interactions between species within a plant or animal community. They will: Identify at least 3 types of species interactions, Competition (e.g., plants competing for sunlight), Predation (e.g., birds feeding on insects), Mutualism (e.g., bees pollinating flowers), Commensalism or Parasitism Record the species involved, the type of interaction, and where/how it occurred. Submit a short report, diagram, or photo log describing their

observations and explaining the ecological significance of these interactions. To help students understand how species interact and coexist within a biological community.

Module 4 – Ecosystem

Project 1: Field Visit to a Local Ecosystem and Report on Its Components

Description: Students will be able to identify ecosystem components, understand interdependence, and explain how energy and matter flow through natural systems. Students will visit a local ecosystem such as a pond, park, forest patch, or farmland and identify and list the biotic components (plants, animals, insects, microorganisms). Note the abiotic components (soil, sunlight, water, temperature, air). Observe and describe basic interactions (e.g., predator-prey, pollination, decomposition). Draw a simple food chain or food web based on their observations. Submit a short report or poster describing how energy flows and how components are interconnected in the ecosystem. To provide hands-on experience in observing and understanding ecosystem structure and function.

Reference Books:

1. Odum, E.P. *Fundamentals of Ecology*. W.B. Sounders.

2. Pandit, M.K., White, S.M.& Pocock, M.J.O. 2014. The contrasting effects of genome size, chromosome number and ploidy level on plant invasiveness: a global analysis. *New Phytologist* 203: 697-703.

3. Groom. B. & Jenkins. M. 2000.*Global Biodiversity: Earth's Living Resources in the 21st Century.* World Conservation Press, Cambridge, UK.

4. Gurevitch, J., Scheiner, S. M., & Fox, G. A. 2002. *The Ecology of Plants*. Sinauer associates incorporated.

5. Loreau, M. & Inchausti, P. 2002. *Biodiversity and Ecosystem functioning: Synthesis and Perspectives.* Oxford University Press, Oxford, UK.

6. Smith, T. M., & Smith, R. L. (2015). Elements of Ecology. Pearson.

7. Molles, M. C. (2019). Ecology: Concepts and Applications. McGraw-Hill Education.

8. Krebs, C. J. (2009). Ecology: The Experimental Analysis of Distribution and Abundance. Pearson.

9. Chapman, J. L., & Reiss, M. J. (2005). Ecology: Principles and Applications. Cambridge University Press.

10. Begon, M., Harper, J. L., & Townsend, C. R. (2006). Ecology: From Individuals to Ecosystems. Wiley-Blackwell.

Semester – II

.2.2 Major (Core)

Course Title	**Atmospheric and Aquatic Chemistry (Th)**
Course Credits	2
Course Outcomes	After going through the course, learners will be able to
	• Evaluate the effects of toxic chemicals and hazardous substances on the environment and human health.
	• Analyze the sources, types, and chemical transformations of environmental pollutants.
Module 1 (Credit 1) – Atmospheric Chemistry	
Learning Outcomes	After learning the module, learners will be able to,
	1. Explain the chemical composition of the atmosphere and the role of major and trace gases.
	2. Interpret air chemistry data to assess environmental and health impacts.
Content Outline	• Classification of elements, particles, ions and radicals in the atmosphere; Chemical process for formation of inorganic and organic particulate matters in air; PM-lO, PM-2.5, Sulphur Oxides, Nitrogen Oxides, Carbon Oxides, VOCs (Volatile Organic Compounds), PAHs (Polycyclic Aromatic Hydrocarbons), Peroxyacetyl nitrate (PAN) and Ozone Hole, Environmentalist's role in air pollution research and policy-making
Module 2 (Credit 1)- Aquatic Chemistry	
Learning Outcomes	After learning the module, learners will be able to,
	1. Describe the chemical properties of water and its role as a universal solvent in environmental processes.
	2. Understand the processes of precipitation, complexation, adsorption, and redox reactions involving heavy metals.

Content Outline	• Basics of Water Pollution: Water resources, Definition of water pollution, Types of water pollutants, Co, Cu, Ni, Fe-physical and chemical properties. • Water quality parameters (e.g., pH, dissolved oxygen, turbidity etc) ▪ Nutrient pollution (eutrophication) and its effects on aquatic ecosystems ▪ Heavy metal contamination in water bodies▪ Persistent organic pollutants (POPs) in water and their bioaccumulation.

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

Module 1 –Atmospheric Chemistry

Project 1: Air quality monitoring experiment

Description: Students will conduct an air quality monitoring experiment by measuring the concentration of particulate matter ($PM_{2.5}$ or PM_{10}) in different locations (e.g., roadside, park, classroom) using a portable air quality sensor. They will compare the results, analyze variations, and relate them to potential pollution sources. This activity helps students connect atmospheric chemistry concepts with real-world environmental conditions.

Module 2 – Aquatic Chemistry

Project 2: Measurement of pH and Alkalinity of Water

Students will measure the pH and alkalinity of different water samples using a pH meter and titration method. They will relate these parameters to buffering capacity, aquatic productivity, and pollution effects. These activities help students connect aquatic chemistry concepts with real environmental conditions and water quality assessment.

Reference Books:

1. Text Book of Environment: K M Agrawal, P.K.Sikdar, and S.C.Deb, Mc'Millan Publication, Mumbai.
2. Man and Environment: M.C.Dash and P.C.Mishra, Mc'Millan Publication, Mumbai.
3. Environmental Science: S.C.Santra, New Central Book Pvt.Ltd, Kolkatta.
4. Environmental Problems and Solution: D.K.Asthana, S.Chand Publication,New Delhi.
5. Environmental Chemistry: S.S.Dara, S.Chand Publication,New Delhi.
6. Environmental Chemistry: B.K.Sharma, Goel Publication,Meerut.
7. Environmental Chemistry: A.K.Dey,New Age International Publishers,2001.
8. Man and Environment: P.R.Trivedi and Gurdeep Raj,Akashdeep Publishing House,New Delhi.
9. Fundamentals Concepts in Environmental Studies: Dr.D.D.Mishra, S.Chand Publication,New Delhi.
10. Climatology: D.S.Lal,Sharda Pustak Bhavan,Allahabad,2003.
11. A Textbook of Environmental Studies: Dr S.Satyanarayan, Dr S.Zade, Dr S Sitre and Dr P.U.Meshram,Allied Publishers, New Delhi.

Semester – II

.2.3 Vocational Skill Courses (VSC-2)

Course Title	**Ecology (Lab)(Pr)**
Course Credits	2
Course Outcomes	After going through the course, learners will be able to,
	1. Apply scientific methods to analyze environmental samples (water, air, soil, and biodiversity) through laboratory and field-based experiments.
	2. Collect, record, and interpret field data related to ecosystems, pollution sources, natural resources, and human impacts on the environment.
	3. Assess the physico-chemical and biological characteristics of environmental samples and draw conclusions regarding environmental quality and sustainability.
	4. Develop critical thinking and problem-solving skills to identify local environmental problems and propose viable solutions based on field and lab observations.
Module 1 (Credit 1) –Planktonology	
Learning Outcomes	After learning the module, learners will be able to,
	1. Define and classify plankton into phytoplankton, zooplankton and bacterioplankton based on structure, function and habitat.
	2. Explain the ecological role of plankton in aquatic ecosystems, including primary productivity, energy flow and nutrient cycling.
	3. Apply plankton sampling, preservation and counting methods for ecological and environmental assessment.
	4. Evaluate the role of plankton as indicators of water quality, eutrophication and environmental pollution.

Content Outline	• Sampling of planktons. • Identification of Zoo-planktons • Identification of Phyto-planktons. • Quantitative estimation of phytoplankton by Sedgwick Rafter cell method. • Quantitative estimation of Zooplanktons by Sedgwick Rafter cell method. • To determine the minimize size of the quadrat by Species area curve. • Measurement of the Primary productivity of the given area by harvest method. • Measurement of the Primary productivity of the given water body by Light and Dark bottle method.
Module 2 (Credit 1) -Water and Waste water Analysis	
Learning Outcomes	After learning the module, learners will be able to,
	1. Estimate Chloride, Alkalinity, Acidity, free CO2, Total solids, and dissolved solids, suspended solids of water and wastewater sample.
	2. Interpret DO levels as indicators of aquatic ecosystem health.
Content Outline	• Estimation of Total solids, dissolved solids, suspended solids of surface water • Estimation of Acidity of water. • Estimation of Chloride of surface water sample by Argentometric method • Determination of Colour of the given surface water sample by Visual comparison method. • Estimation of Alkalinity of lake water sample. • Determination of Total Hardness of ground and surface water. • Estimation of free chlorine in the surface water sample • Determination of Dissolved Oxygen in the lake/pond water sample by Winkler's method with Azide modification

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

Project 1: Determination of Primary Productivity of Water Body by Light and Dark Bottle Method

The Light and Dark Bottle Method is used to measure the primary productivity of a water body by assessing changes in dissolved oxygen (DO) due to photosynthesis and respiration. Three bottles are used: one measured immediately (initial), one exposed to light (photosynthesis + respiration), and one kept in the dark (only respiration). By comparing DO levels in each, students can calculate gross and net primary productivity, indicating the rate at which aquatic plants and phytoplankton produce oxygen and organic

matter. By comparing DO levels in the initial, light, and dark bottles, one can calculate Gross Primary Productivity (GPP) and Net Primary Productivity (NPP), providing insight into the photosynthetic activity of aquatic organisms.

Project 2: Microscopic Identification of Plankton

Students will collect water samples from a pond or lake and observe them under a microscope. Using identification keys or charts, they will identify phytoplankton and zooplankton based on shape, size, and structural features. These activities help students understand aquatic biodiversity and the ecological role of planktons.

Project 3: Determination of Dissolved Oxygen

Collect a water sample from a nearby pond, lake, or river and determine its Dissolved Oxygen (DO) level using the Winkler's method. This involves chemical fixation of oxygen and titration to calculate DO in mg/L. The activity helps students evaluate the health and quality of the water body, understand the role of DO in supporting aquatic life, and recognize its importance as an indicator of pollution or organic load in natural waters.

Project 4: Determination of Free CO_2

Determine the free carbon dioxide (CO_2) present in a water sample using titration with standard sodium hydroxide (NaOH) and phenolphthalein as an indicator. The endpoint is indicated by the appearance of a faint pink color. This activity helps students understand the role of free CO_2 in aquatic ecosystems, its effect on pH and buffering capacity, and its importance in assessing water quality and biological productivity**.**

Reference Book:

1. Agarwal, K.C. 2001 Environmental Biology, Nidi Publ. Ltd. Bikaner.
2. Mishra, D. D., 2008. Fundamental Concepts of Environmental Studies, S. Chand Publishers, N. Delhi, 271.
3. Eugene P. Odum and Gary W. Barrett (1953), Fundamentals of Ecology (5th edn), brooks/cole, US
4. Charles Krebs (2013), Ecology: Pearson New International Edition (6th Edin).
5. Krishnan, M. S. 1982. *Geology of India and Burma*. CBS Publishers & Distributors.
6. Singh K.P. and J.S. Singh (1992). Tropical Ecosystems: Ecology and Management. Wiley Eastern Limited, Lucknow, India.
7. Singh, J.S. (ed.) 1993. Restoration of Degraded Land: Concepts and Strategies. Rastogi Publications, Meerut.
8. Smith, R.L. (1996). Ecology and Field Biology, Harper Collins, New York.
9. Botkin, D.B. and Keller, E.A. 2000. Environment Science: Earth as a living planet. Third Edition. John Wiley and Sons Inc.
10. E. P. Odum (1996) Fundamentals of Ecology, Nataraj Publisher, Dehra Dun.
11. Standard methods for examination of water and waste water , American Public Health Association.
12. A comprehensive laboratory manual for Environmental Sciences and Engineering By P.R. Sreemahadevan Pillai. New Age International Publishers.
13. Chemical and biological methods for water pollution studies By R.K. Trivedi
14. Handbook of water and waste water analysis By S.K. Maiti.
15. Soil and air analysis by S.K. Maiti.
16. A Manual of Water and Wastewater Analysis: Dr D.S. Ramteke and Dr C.A. Moghe,Published by NEERI, Nagpur, 1996.

17. Laboratory Manual of Environmental Chemistry: Dr Snita Hooda and Dr Sumanjeet Kaur, S.Chand and Co. Ltd. New Delhi.1997.
18. Physico-chemical Examination of Water Industrial Effluents: N. Manivaskaram, Pragti Prakashan, Meerut (U.P) 1996.
19. Chemical and Biological Methods of Water Pollution Studies: R.K. Trevedi and P.K. Goel, Enviro Media Publication.

Semester – II

.2.4 Vocational Skill Courses (VSC-3)

Course Title	**Atmospheric and Aquatic Chemistry (Pr)**
Course Credits	2
Course Outcomes	After going through the course, learners will be able to,
	1. Demonstrate proper sampling and analytical techniques for atmospheric and aquatic environments.
	2. Determine important water quality parameters including pH, dissolved oxygen, alkalinity, hardness, and nutrients.
	3. Apply standard laboratory and field methods to assess atmospheric and aquatic chemical characteristics.
	4. Develop skills in data recording, analysis, reporting, and environmental awareness through hands-on experiments.
Module 1 (Credit 1) –Analysis of Atmospheric Environment	
Learning Outcomes	After learning the module, learners will be able to,
	1. Demonstrate proper methods for sampling air and handling atmospheric monitoring instruments.
	2. Measure key atmospheric parameters such as temperature, humidity, and solar radiation.
	3. Apply air quality standards and indices to evaluate environmental and health impacts.
	4. Develop practical skills in observation, data analysis, and scientific reporting related to atmospheric environment studies.
Content Outline	• Measurement of Light Intensity by Lux meter • Measurement of Solar Constant • Estimation of particulate matter by Dust Fall method. • Measurement of UV radiation by UV meter. • Determination of Wind Direction. • Measurement of rain fall by Rain Guage • Measurement of relative humidity by psychrometer

Module 2 (Credit 1) Analysis of Aquatic Environment	
Learning Outcomes	After learning the module, learners will be able to,
	1. Demonstrate proper techniques for collection, preservation, and handling of water samples.
	2. Measure and analyze key physico-chemical parameters such as pH, temperature, turbidity, dissolved oxygen, alkalinity, and hardness.
	3. Apply water quality standards to evaluate suitability for drinking, irrigation, and aquatic use.
	4. Develop skills in data recording, analysis, and scientific reporting in aquatic environmental studies.
Content Outline	• Determination of pH of the given water sample. • Determination of TDS of the given water sample. • Determination of Turbidity of the water sample. • Determination of Chloride of the water sample by Argentometric Titration • Determination of Total Hardness of water sample by EDTA method. • Determination of Nitrate of water sample by Spectrophotometer. • Determination of Iron of the water sample by Spectrophotometer.

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

Project 1: To measure the Light Intensity

Description: Students will measure light intensity at different locations (classroom, open ground, shaded area) and at different times of the day using a lux meter. They will record the readings, compare variations, and analyze how factors such as time, cloud cover, and surroundings influence light intensity. This activity helps students understand solar radiation patterns and their environmental significance.

Project 2: Measurement of Relative Humidity

Description: Students will measure the relative humidity of air at different times of the day using a psychrometer (wet and dry bulb thermometer) or a digital hygrometer. They will record the readings, calculate the relative humidity, and analyze variations with respect to temperature, weather conditions, and time of day. This activity helps students understand the concept of humidity, its measurement, and its significance in weather, climate, and human comfort.

Project 3: Estimation of Chloride in Water

Description: Students will determine the chloride content in a water sample using the argentometric (silver nitrate) titration method. They will record the volume of silver nitrate required to reach the endpoint and calculate the chloride concentration in mg/L. This activity helps students understand the significance of chloride in water quality, its sources, and its impact on aquatic life and human health.

Project 4: Determination of Iron in Water

Description: Students will determine the concentration of iron (Fe) in water samples using a colorimetric method (e.g., using 1,10-phenanthroline as a reagent) or a water testing kit. They will record absorbance values, calculate iron concentration, and compare results with permissible limits for drinking water. This activity helps students understand the significance of iron in water quality, its sources, and potential impacts on human health and aquatic ecosystems.

Reference Book:

1. Soil and air analysis by S.K. Maiti.
2. A Manual of Water and Wastewater Analysis: Dr D.S. Ramteke and Dr C.A. Moghe,Published by NEERI, Nagpur.
3. Standard methods for examination of water and waste water, American Public Health Association.
4. Chemical and Biological Methods of Water Pollution Studies: R.K. Trevedi and P.K. Goel, Enviro Media Publication.
5. A comprehensive laboratory manual for Environmental Sciences and Engineering By P.R. Sreemahadevan Pillai. New Age International Publishers.
6. Chemical and biological methods for water pollution studies By R.K. Trivedi
7. Handbook of water and waste water analysis By S.K. Maiti.
8. Laboratory Manual of Environmental Chemistry: Dr Snita Hooda and Dr Sumanjeet Kaur, S.Chand and Co. Ltd. New Delhi.
9. Physico-chemical Examination of Water Industrial Effluents: N. Manivaskaram, Pragti Prakashan, Meerut (U.P) 1996.
10. Handbook of water and waste water analysis By S.K. Maiti.
11. A Manual of Water and Wastewater Analysis: Dr D.S. Ramteke and Dr C.A. Moghe,Published by NEERI, Nagpur.
12. Laboratory Manual of Environmental Chemistry: Dr Snita Hooda and Dr Sumanjeet Kaur, S.Chand and Co. Ltd. New Delhi.1997.
13. Physico-chemical Examination of Water Industrial Effluents: N. Manivaskaram, Pragti Prakashan, Meerut (U.P).
14. Chemical and Biological Methods of Water Pollution Studies: R.K. Trevedi and P.K. Goel, Enviro Media Publication.

Semester - II

.2.5 Open Electives Course (OEC)

Course Title	**Green Movement**
Course Credits	4
Course Outcomes	After going through the course, learners will be able to
	1. Understand the concept, evolution, and significance of green movements in environmental conservation.
	2. Explain major green movements in India and their role in protecting natural resources and community rights.
	3. Evaluate the influence of green movements on environmental policies, legislation, and sustainable development.
	4. Develop awareness of citizen participation, environmental ethics, and future challenges in green activism.
Module 1 (Credit 1) – Introduction to Green Movement	
Learning Outcomes	After learning the module, learners will be able to,
	1. Define the Green Movement and explain its objectives and importance.
	2. Identify the causes leading to the emergence of green movements.
Content Outline	• Concept and meaning of Green Movement, Evolution of environmental awareness and conservation ethics, Causes for the emergence of green movements, Environmental degradation and the need for conservation movements, Role of individuals, communities, and civil society.
Module 2 (Credit 1)- Major Green Movements in India	
Learning Outcomes	After learning the module, learners will be able to,
	1. Analyze the role of local communities in Indian environmental movements.

	2. Assess the environmental and social impacts of these movements.
Content Outline	• Chipko Movement, Appiko Movement, Silent Valley Movement, Narmada Bachao Andolan, Bishnoi Movement and other grassroots initiatives
Module 3 (Credit 1) – Global Green Movements and Environmental Organizations	
Learning Outcomes	After learning the module, learners will be able to,
	1. Identify the role of international environmental organizations and NGOs.
	2. Understand the contribution of media, activism, and public participation in global environmental movements.
Content Outline	• Green movements across the world, Role of international environmental movements, Environmental NGOs and pressure groups, Green political parties and environmental activism, Media and public participation in green movements.
Module 4 (Credit 1) – Green Movement, Policy and Sustainable Development	
Learning Outcomes	After learning the module, learners will be able to,
	1. Examine the influence of green movements on environmental laws and policies.
	2. Evaluate future challenges and prospects of green movements in the context of global environmental issues.
Content Outline	• Influence of green movements on environmental policies, Environmental legislation and public interest litigation, Green movement and sustainable development, Role of youth, education, and technology in green activism, Challenges and future of green movements.

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

Module 1 – Introduction to Green Movement

Project 1: Concept and Importance of Green Movements

Description: Students prepare a short-written assignment explaining the concept, objectives, and significance of green movements, highlighting how they contribute to environmental conservation and awareness. Learning Outcome: Understands the basic concepts and importance of green movements in protecting natural resources and

promoting environmental consciousness. Evaluation Criteria: Concept clarity, relevance of examples, and quality of presentation.

Module 2 – Major Green Movements in India

Project 1: Study of a Specific Green Movement

Description: Students prepare a short report on a specific Indian green movement (e.g., Chipko Movement, Appiko Movement, Silent Valley Movement, or Narmada Bachao Andolan) covering: Objectives and causes of the movement, Key participants and methods of protest, Environmental and social outcomes. Learning Outcome: Analyzes the objectives, strategies, and impacts of major Indian green movements. Evaluation Criteria: Clarity of explanation, accuracy of historical and environmental information, and presentation quality.

Module 3 – Global Green Movements and Environmental Organizations

Project 1: Study of an International Green Movement

Description: Students prepare a short report on a prominent international green movement (e.g., Earth Day, Greenpeace, Fridays for Future, or Extinction Rebellion), covering: Objectives and causes, Key strategies and campaigns, Environmental and social impacts. Learning Outcome: Analyzes the objectives, strategies, and global significance of green movements. Evaluation Criteria: Clarity of explanation, accuracy of information, and relevance of examples.

Module 4 – Green Movement, Policy and Sustainable Development

Project 1: Green Movement and Environmental Policies

Description: Students prepare a short assignment explaining how green movements have influenced environmental policies and legislation in India and globally. Include examples such as Forest Conservation Act, Wildlife Protection Act, Environmental Impact Assessment policies, and international agreements like the Paris Agreement. Learning Outcome: Understands the link between environmental activism, policy-making, and sustainable development. Evaluation Criteria: Clarity of explanation, relevance of policies cited, and understanding of impact on society and environment.

Reference Books:

1. Ramachandra Guha. *Environmentalism: A Global History*. Oxford University Press.
2. Ramachandra Guha & Madhav Gadgil. *Ecology and Equity*. Penguin India.
3. Anil Agarwal & Sunita Narain. *Towards Green Villages*. Centre for Science and Environment (CSE).
4. Erach Bharucha. *Textbook of Environmental Studies*. Universities Press.
5. Vandana Shiva. *Staying Alive: Women, Ecology and Development*. Zed Books.
6. Centre for Science and Environment (CSE). *State of India's Environment Reports*

Semester – II

.2.6 Skill Enhancement Course (SEC)

Course Title	**Soil Quality Assessment**
Course Credits	2
Course Outcomes	After going through the course, learners will be able to,
	1. Understand the concept and importance of soil quality in sustainable agriculture and environmental management.
	2. Apply standard soil sampling techniques for accurate soil quality assessment.
	3. Analyze soil quality parameters such as pH, texture, organic matter, nutrients, and salinity.
	4. Recommend soil management and conservation practices to improve and maintain soil quality.
Module 1 (Credit 1) –Soil Quality Concepts and Soil Sampling	
Learning Outcomes	After learning the module, learners will be able to,
	1. Explain the significance of soil quality assessment in environmental protection and sustainable land management.
	2. Differentiate between soil quality and soil fertility.
Content Outline	• Concept and definition of soil quality • Soil quality vs soil health • Importance of soil quality in agriculture and environmental sustainability • Physical, chemical, and biological indicators of soil quality • Factors affecting soil quality (land use, pollution, management practices) • Principles and methods of soil sampling • Soil sample collection, preparation, storage, and precautions
Module 2 (Credit 1)- Soil Quality Analysis, Interpretation, and Management	
Learning Outcomes	After learning the module, learners will be able to,
	1. Analyze soil quality parameters such as pH, organic carbon, nutrients, salinity, and texture.
	2. Recommend soil management strategies based on soil quality assessment results.

Content Outline	• Assessment of physical properties: texture, structure, bulk density (overview) • Assessment of chemical properties: soil pH, electrical conductivity, organic carbon • Nutrient status of soil (macro- and micronutrients – introductory) • Soil contamination, salinity, and alkalinity • Interpretation of soil quality data • Soil quality improvement practices: organic manures, compost, vermicompost, and conservation measures

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

Module 1 – Soil Quality Concepts and Soil Sampling

Project 1: Assessment of Soil Quality Indicators

Description: Students will explore: Key physical, chemical, and biological indicators used to assess soil quality. Activity Description: Students collect soil samples from different land-use areas (agricultural field, garden, roadside, forest area) and identify soil quality indicators such as color, texture, structure, moisture, and presence of organic matter. Observations are recorded in a tabular format with interpretation. Learning Focus: Soil quality concepts, indicator identification, observation and analytical skills.

Module 2 – Soil Quality Analysis, Interpretation, and Management

Project 1: Soil Quality Testing and Analysis

Description: Students will explore: Measurement and evaluation of important soil quality parameters. Activity Description: Students analyze collected soil samples for pH, electrical conductivity, organic carbon, and major nutrients (N, P, K) using standard laboratory or demonstration methods. The results are recorded in tables and compared with standard soil quality ranges. Learning Focus: Soil quality analysis, laboratory skills, data recording and accuracy.

Reference Books:

1. Brady, N.C. & Weil, R.R. – *The Nature and Properties of Soils*
2. Biswas, T.D. & Mukherjee, S.K. – *Textbook of Soil Science*
3. Tandon, H.L.S. – *Methods of Analysis of Soils, Plants, Waters and Fertilizers*
4. Doran, J.W. & Parkin, T.B. – *Defining and Assessing Soil Quality*
5. ICAR Publications – Soil Testing and Soil Quality Assessment Manuals
6. P.K. De – *Environmental Chemistry*

Course Syllabus

Semester - III

.3.1 Major (Core)

Course Title	**Environmental Pollution (Th)**
Course Credits	4
Course Outcomes	After going through the course, learners will be able to
	1. Understand the types, sources, and characteristics of environmental pollutants in air, water, soil, and noise.
	2. Analyze the physical, chemical, and biological impacts of pollution on ecosystems, human health, and the environment.
	3. Apply monitoring and analytical techniques to assess pollution levels and environmental quality.
	4. Interpret environmental policies, standards, and legislation related to pollution prevention and control.
Module 1 (Credit 1) – Environmental Pollution	
Learning Outcomes	After learning the module, learners will be able to,
	1. Identify and classify various types of environmental pollutants in air
	2. Apply environmental monitoring techniques to measure pollution levels using practical tools and analytical methods.
Content Outline	• Environmental Pollution: Definition, types, Classification of Pollutants- on the basis of physical properties and forms of their existence, Primary and secondary pollutants, degradable and non-degradable pollutants. • Air Pollution: Sources, Effects (Human health, vegetation and animals, Building material and structures), Indoor pollution, vehicular pollution, Bhopal gas tragedy, Air Quality Standards- NAAQS, AQI, Air pollution control measures
Module 2 (Credit 1)-Water Pollution	
	After learning the module, learners will be able to,

Learning Outcomes	1. Identify major pollutants in water such as organic waste, heavy metals, and pathogens.
	2. Analyze the causes, sources, and effects of water pollution on ecosystems and human health.
Content Outline	• Water Pollution: sources, effect of water pollution on flora and fauna, human beings and materials, Eutrophication, Heavy metal pollution- Minamata episode, Nitrate in groundwater and Blue baby Syndrome, water pollution control measures, water quality indices. • Thermal Pollution: Causes, effects and control measures. • Oil pollution: Definition, sources, effects on marine life, birds and man.
Module 3 (Credit 1) – Noise and Radiation Pollution	
Learning Outcomes	After learning the module, learners will be able to,
	1. Understand sources and types of noise pollution in urban and industrial environments.
	2. Understand the effects of radiation on living organisms and the environment.
Content Outline	• Noise Pollution: Sources and effects, Decibel scale, control measures of noise pollution. Ambient noise level of monitoring. • Radioactive Pollution: Types and sources of radiations, biological effects and control measures of radiations, E-waste (sources and its health effect), recycling and disposal methods.
Module 4 (Credit 1) – Soil Pollution	
Learning Outcomes	After learning the module, learners will be able to,
	1. Understand sources of soil contamination, including heavy metals, pesticides, and industrial waste.
	2. Analyze the impact of soil pollutants on plant growth, soil fertility, and ecosystem health.
Content Outline	• Soil Pollution: Definition, sources and types, soil pollutants- metals, inorganic ion and salts, organic substances, effects of soil pollution on soil health and productivity, effects of pesticides, soil pollution control measures, • Soil Contamination: Major routes of contamination of soil. Acidification. Salination. Detrimental effects of soil pollutants. Effects of industrial pollutants, sewage and domestic waste,

	heavy metals, modern agro-technology, diseases caused by soil pollutants.

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

Module 1 – Environmental Pollution

Project 1: Monitoring Environmental and Air Pollution

Description: Students will conduct a basic air quality and environmental pollution survey in their campus or nearby area. They will Measure particulate matter (dust) levels using a dust fall jar or simple collection method. Observe sources of air pollution such as vehicles, industrial emissions, or biomass burning. Record and analyze data for noise levels, visible smoke, or odorous emissions. Prepare a short report linking observations to potential environmental and health impacts. This activity helps students understand the sources, measurement, and effects of air and environmental pollution and develop skills in field-based environmental monitoring.

Module 2 – Water Pollution

Project 1: Assessment of Water Pollution

Description: Students will collect water samples from nearby sources (pond, lake, river, or tap water) and analyze key water quality parameters such as: pH – to determine acidity or alkalinity. Dissolved Oxygen (DO) – using the Winkler method. Turbidity – visually or using a turbidity meter. Presence of pollutants – such as nitrate, phosphate, or chloride using simple titration or test kits. They will record the data, compare it with standard limits, and discuss the sources and effects of water pollution. This activity helps students understand water quality assessment, sources of pollution, and its impact on human health and aquatic ecosystems.

Module 3 – Noise and Radiation Pollution

Project 1: Assessment of Noise Pollution

Description: Students will measure noise levels at various locations (e.g., roadside, market, residential area, or campus) using a sound level meter. They will record the decibel (dB) readings, compare them with permissible limits, and identify major sources of noise in the area. This activity helps students understand the intensity and sources of noise pollution, its impact on human health, and the importance of noise control measures.

Module 4 – Soil Pollution

Project 1: Assessment of Soil Pollution

Description: Students will collect soil samples from different sites (e.g., garden, roadside, agricultural land) and analyze key soil quality parameters such as: pH – to determine soil acidity or alkalinity. Electrical Conductivity (EC) – to assess salinity levels. Organic Carbon – to understand nutrient content. Presence of heavy metals (e.g., iron, lead) using simple laboratory tests or kits. They will record observations, compare results from different sites, and discuss potential sources of soil pollution and its effects on plants and the environment. This activity helps students understand soil contamination, its causes, and implications for agriculture and ecosystem health.

Reference Book:

1. Text Book of Environment: K M Agrawal, P.K.Sikdar, and S.C.Deb, Mc'Millan Publication, Mumbai.
2. Man and Environment: M.C.Dash and P.C.Mishra, Mc'Millan Publication, Mumbai.
3. Environmental Science: S.C.Santra, New Central Book Pvt.Ltd, Kolkatta.
4. Environmental Problems and Solution: D.K.Asthana, S.Chand Publication,New Delhi.
5. A Text book of Environmental Chemistry and Pollution Control: S.S.Dara, S.Chand and Company Ltd,New Delhi.
6. Environmental Chemistry: B.K.Sharma, Goel Publication,Meerut.
7. Environmental Chemistry: A.K.Dey,New Age International Publishers,2001.
8. Man and Environment: P.R.Trivedi and Gurdeep Raj,Akashdeep Publishing House,New Delhi.
9. Fundamentals Concepts in Environmental Studies: Dr.D.D.Mishra, S.Chand Publication,New Delhi.
10. Environmental Pollution: Khitoliya,R.K. S.Chand Publication,New Delhi.
11. Air pollution and it's Control: Rao,M.N and Rao, H.V.N., Tata McGraw-Hill Publishing Company, New Delhi.
12. Principles of Environmental Chemistry,3rd edition, J.E.Girard, Jones and Bartlett Learning Company, Burlington
13. The Science of Environmental Pollution,3rd edition, Frank.R.Spellman, CRC Press, Taylor and Francis Group.

Semester - III

.3.2 Major (Core)

Course Title	**Conservation of Forest, Wildlife and Biodiversity (Th)**
Course Credits	4
Course Outcomes	After going through the course, learners will be able to
	1. Understand the concepts of forest ecosystems, wildlife, and biodiversity, and their ecological, economic, and cultural importance.
	2. Analyze the causes and consequences of biodiversity loss, deforestation, and habitat degradation.
	3. Evaluate strategies for conservation of forests, wildlife, and endangered species.
	4. Interpret national and international policies, conventions, and legislation related to biodiversity and wildlife protection.
Module 1 (Credit 1) - Forest Conservation	
Learning Outcomes	After learning the module, learners will be able to,
	1. Analyze the causes and consequences of deforestation, forest degradation, and forest fragmentation.
	2. Promote awareness and strategies for community participation in forest protection and sustainable use of forest resources.
Content Outline	• Forest: Definition, Types of forest in India, Minor Forest products, Significance of forest, Deforestation (causes, effects and control measures), forest fires. • Forest Conservation: Social forestry, National Forest Policy, Chipko Movement, Afforestation, Forest Conservation Act,1980, Sustainable Forest Management (SFM), Joint Forest Management (JFM)
Module 2 (Credit 1)- Wildlife Conservation	
Learning Outcomes	After learning the module, learners will be able to,
	1. Analyze threats to wildlife, including habitat loss, poaching, invasive species, and climate change.

	2. Apply methods for monitoring wildlife populations and assessing ecosystem health.
Content Outline	• Wildlife: Importance of wildlife, Rare, endangered, vulnerable and extinct species of wildlife, causes of wildlife depletion, wildlife management, man-animal conflicts. • Wildlife conservation: Necessity and mode of conservation of wildlife, Project Tiger, Wildlife Protection Act,1972, Role of IUCN, UNEP and WWF in wildlife conservation.
Module 3 (Credit 1) – Biodiversity	
Learning Outcomes	After learning the module, learners will be able to,
	1. Analyze the causes and consequences of biodiversity loss, including habitat destruction, climate change, overexploitation, and invasive species.
	2. Identify key biodiversity hotspots, endemic species, and threatened species at local, national, and global levels.
Content Outline	• Biodiversity: types, causes for the loss of biodiversity, preservation strategies for biodiversity, benefits of biodiversity, Hotspots of biodiversity, Measurement of biodiversity • India as mega diversity nation, Biogeography zones of the country, Community Biodiversity Register (CBD), Biodiversity Act' 2002, Red Data Book.
Module 4 (Credit 1) – Biodiversity Conservation	
Learning Outcomes	After learning the module, learners will be able to,
	1. Evaluate strategies for biodiversity conservation, including in-situ (protected areas, biosphere reserves) and ex-situ (seed banks, botanical gardens) approaches.
	2. Develop awareness and skills to promote biodiversity conservation through sustainable practices, research, and community involvement.
Content Outline	• Biodiversity: Conservation: Approaches for Conservation of Biological Diversity, In-situ conservation, Ex-situ Conservation. • Role of local communities and traditional knowledge in conservation; Biodiversity convention; International and national efforts to conserve biodiversity.

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

Module 1 – Forest Conservation

Project 1: Field Survey on Forest Conservation

Description: Students will conduct a field survey of a nearby forest, park, or campus green area to: Identify tree species and other vegetation types present. Observe signs of forest degradation such as littering, deforestation Invasive species Record wildlife sightings or evidence of animal activity. Assess human impacts and suggest measures for forest protection and sustainable use. This activity helps students understand forest ecosystems, recognize threats to forests, and develop practical strategies for conservation and sustainable management.

Module 2 – Wildlife Conservation

Project 1: Assessment of Human Impact on Wildlife

Description: Students will conduct a field survey or case study to: Identify human activities affecting wildlife, such as poaching, habitat destruction, or pollution. Assess the severity of impacts on local animal populations. Propose measures for wildlife protection and sustainable coexistence. These activities help students connect theoretical concepts of wildlife conservation with real-world observation and problem-solving skills.

Module 3 – Biodiversity

Project 1: Biodiversity Survey and Assessment

Description: students will conduct a field survey in a local ecosystem (forest, grassland, campus, or pond) to: Identify and record plant and animal species present in the area. Assess species abundance and diversity using simple methods like quadrat sampling or species count. Analyze ecosystem health based on species richness and presence of indicator species. Discuss threats to biodiversity and suggest conservation or restoration measures. This activity helps students understand biodiversity concepts, evaluate ecosystem health, and develop skills in species identification, ecological monitoring, and conservation planning.

Module 4 – Biodiversity Conservation

Project 1: Biodiversity Conservation Assessment

Description: students will conduct a field study in a local ecosystem (forest, wetland, park, or campus green area) to: Identify plant and animal species and record their abundance. Assess the presence of threatened or endangered species in the area. Analyze human impacts such as habitat disturbance, littering, or invasive species. Propose practical conservation measures like creation of protected zones, afforestation, or community awareness initiatives. This activity helps students understand biodiversity conservation strategies, apply ecological assessment techniques, and develop skills for promoting sustainable ecosystem management.

Reference Book:

1. Ecology and Environment- P. D. Sharma, Rastogi Publication, 2001.
2. Environmental Biology and Toxicology- P. D. Sharma, Rastogi Publication, 2004.
3. Animal Ecology and Environmental Biology- H.R. Singh, Vishal Publication.

4. Environmental Biology- P.S. Varma and V.K. Agrawal, S. Chand, 2001.
5. Ecology- E.P. Odum, Oxford and IBH Publishing.
6. Environmental Ecology- P.R. Yadav, Shubhrata R. Mishra, Discovery Publishing House,2004.
7. Fundamentals of Environmental Biology- S. Arora, Kalyani Publishers, 1985
8. Plant Ecology and Soil Science- R.S. Shukla and P.S. Chandel, S. Chand Publication, 2001.
9. Environmental Management- Dr. Anand S. Bal, Himalaya Publication, 2009.
10. Maintaining Biodiversity in Forest Ecosystem- Malcolm L. Hunter Jr., Cambridge University Press, 1999
11. Cell Biology, Genetics, Molecular Biology, Evolution and Ecology- P.S. Verma, V.K. Agarwal. S. Chand Publication, 2005.
12. Environmental Science- W.Cunningham and Saigo, McGraw Hill, New York.
13. A Textbook of Environment- Agrawal, Mcmillion publication, Mumbai
14. Environmental Science and Engineering- J Glynn Henry and G W Heinke, PHI Learning Private Limited
15. Environmental Chemistry- B.K. Sharma, Goel Publication, Meerut.
16. Environmental Problems and solution- Asthana, S. Chand and Co., New Delhi.
17. Environmental Science- S. C. Santra, New Central Book Agency Pvt. Ltd., 2006.
18. A Textbook of Environmental Science- R.N. Trivedi, Anmol Publications Private Limited,1997
19. Man and Environment- P. R. Trivedi, Gurdeep Raj, Akshadeep Publishing House, New Delhi, 1997.
20. Fundamental Concepts in Environmental Studies - Dr. D. D. Mishra, S. Chand Publication,2009.

Semester - III

.3.3 Major (Core)

Course Title	**Natural Resources and Energy Management (Th)**
Course Credits	2
Course Outcomes	After going through the course, learners will be able to,
	1. Understand the types, distribution, and significance of natural resources including land, water, forest, and minerals.
	2. Identify renewable and non-renewable energy sources and their environmental impacts.
	3. Interpret national and international policies, regulations, and best practices for resource and energy management.
	4. Develop awareness and skills to promote sustainable development and conservation of natural resources through research, planning, and community participation.
Module 1 (Credit 1) – Introduction to Natural resources	
Learning Outcomes	After learning the module, learners will be able to,
	1. Understand the concept, types, and significance of natural resources, including renewable and non-renewable resources.
	2. Identify various energy sources, including fossil fuels, solar, wind, and biomass, and their environmental impacts.
Content Outline	• Introduction, Definition, Concept of Natural Resources, Classification of Natural Resources, Exhaustible & Non-exhaustible Natural Resources, Renewable resources, Non-renewable resources, valuation of natural resources, Factors influencing resource availability, distribution, and uses. Inter-relationships among different types of natural resources. Factors influencing resource availability, Need for Conservation of Natural Resources.
Module 2 (Credit 1)-Energy Management:	
Learning Outcomes	After learning the module, learners will be able to,
	1. Evaluate challenges in resource depletion, energy demand, and environmental conservation.

	2. Apply basic strategies for conservation, efficient utilization, and sustainable planning of resources
Content Outline	• Conventional and non-conventional energy resources; renewable energy sources: solar photovoltaic and solar thermal, wind energy, tidal energy, ocean energy (OTEC), geo-thermal energy; biomass gasification; energy recovery from wastes; bio-fuel; nuclear energy and management of nuclear wastes; energy conservation and energy management; national energy policy.

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

Module 1 – Introduction to Natural resources

Project 1: Local Natural Resources Survey

Description: Students will explore and document natural resources in their campus or neighborhood by: Identifying resources such as water bodies, soil types, trees, vegetation, and mineral deposits. Observing usage patterns and human impacts on these resources. Recording findings in a table or chart. Suggesting conservation measures for sustainable use and management. This activity helps students understand the types, importance, and sustainable management of natural resources through hands-on observation and analysis.

Module 2 – Energy Management

Project 1: Energy Audit and Management Survey

Description: Students will conduct an energy audit in their campus, laboratory, or household to: Identify energy sources being used (electricity, fuel, solar, etc.). Measure or estimate energy consumption of appliances, lighting, and equipment. Analyze energy efficiency and identify areas of wastage. Suggest energy-saving measures such as using renewable sources, switching to LED lighting, or reducing unnecessary usage. This activity helps students understand energy management principles, assess consumption patterns, and propose practical strategies for energy conservation and sustainable use.

Reference Books:

1. P. D. Sharma (2006) : Ecology and Environment – Rastogi Publications, Meerut
2. S. T. ngle et al. (2005) Environment Studies – Prashant Publication House, Pune
3. P. S. Verma and V. K. Agrawal, Environmental Biology (Principles of ecology), S. Chand and company ltd, New Delhi
4. H. V. Jadhav: Principles of Environment Science, Himalaya Publishing House
5. Dr. A. M. Deshmukh, Outlines of Microbiology, Krishnai Publication, Karad
6. P.C. Dubey, D.K. Maheshwari, A Textbook of biotechnology, S.Chand and Co.Ltd, New Delhi
7. S. C. Santra (2001) : Environment Science, New Central Book Agency (P) Ltd, Kolkata
8. M. Dayal; Renewable Energy – Environment and Development: Konark Pub. Pvt. Ltd.
9. S. Vandana; Alternative Energy: APH Publishing Corporation
10. S. K. Agarwal; Nuclear Energy – Principles, practice and prospects APH Publishing Corporation

11. S. Glassstone, D. Van Nastrand, Source book on atomic energy, 3rd Edition, Germany,
12. M. Eisendbud, Environmental radioactivity, Academic Press
13. E.D.Enger, B.E. Smith, Environmental Sciences- Astudy of Inter relationships, WCB Publication

Semester - III

.3.4 Minor Stream

Course Title	**Chemistry of Industrial Pollution (Th)**
Course Credits	4
Course Outcomes	After going through the course, learners will be able to
	1. Understand the chemical composition and processes involved in industrial pollution.
	2. Evaluate treatment methods and pollution control technologies for industrial wastewater, gases, and solid wastes.
	3. Identify major industrial pollutants in air, water, and soil, including their sources and chemical behavior.
	4. Develop awareness of sustainable industrial practices and the role of green chemistry in minimizing pollution.
Module 1 (Credit 1) - Introduction to Industrial Pollution	
Learning Outcomes	After learning the module, learners will be able to,
	1. Describe the types and chemical nature of common industrial pollutants.
	2. Understand the importance of pollution monitoring and environmental compliance in industries.
Content Outline	• Definition and classification of industrial pollution • Types of industries and major pollutants released • Chemical nature of industrial pollutants • Pathways of pollutants in air, water and soil • Effects of industrial pollution on human health, ecosystems and materials • Overview of pollution prevention vs pollution control
Module 2 (Credit 1)- Chemistry of Industrial Air Pollution	
Learning Outcomes	After learning the module, learners will be able to,
	1. Understand the concept of industrial pollution and its relevance to environmental chemistry.

	2. Evaluate control strategies and technologies for reducing industrial air emissions.
Content Outline	• Major air pollutants from industries • Chemical reactions involved in air pollution formation • Industrial sources: Coal mines, thermal power plants, cement, fertilizer and metallurgical industries • Industrial air pollution control methods.
Module 3 (Credit 1) – Chemistry of Industrial Water Pollution	
Learning Outcomes	After learning the module, learners will be able to,
	1. Apply laboratory techniques to assess water quality parameters like pH, BOD, COD, TDS, and heavy metal concentration**.**
	2. Evaluate industrial wastewater treatment methods, including primary, secondary, and tertiary treatments**.**
Content Outline	• Characteristics of industrial wastewater • Chemical pollutants in industrial effluents: Acids, alkalis, heavy metals, dyes, phenols, cyanides • Water quality parameters: pH, BOD, COD, DO, TDS • Chemistry of wastewater treatment: Primary, secondary and tertiary treatment • Chemical treatment methods: coagulation, precipitation, oxidation, neutralization • Industrial effluent treatment plant (ETP) – basic design concept
Module 4 (Credit 1) – Industrial Solid Waste & Hazardous Waste Management	
Learning Outcomes	After learning the module, learners will be able to,
	1. Understand the types, sources, and composition of industrial solid and hazardous wastes.
	2. Evaluate treatment and management strategies, including recycling, recovery, incineration, and landfilling.
Content Outline	• Types of industrial solid and hazardous wastes • Chemistry of toxic and hazardous wastes • Heavy metal pollution: sources, toxicity and chemical behavior • Fly ash, slag, red mud – composition and environmental impact • Chemical methods of waste minimization and recycling • Principles of cleaner production and sustainable industrial practices • Environmental regulations related to industrial pollution (brief overview).

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

Module 1 – Introduction to Industrial Pollution

Project 1: Survey of Industrial Pollution Sources

Description: Students will conduct a survey or case study of nearby industries or an industrial area to: Identify different types of industrial pollution (air, water, solid, and hazardous waste). List major pollutants released and their possible chemical nature. Assess environmental and health impacts on surrounding areas. Suggest basic pollution prevention and control measures adopted by industries. This activity helps students understand the concept, sources, and impacts of industrial pollution and builds awareness about environmental responsibility and sustainable industrial practices.

Module 2 – Chemistry of Industrial Air Pollution

Project 1: Analysis of Industrial Air Pollution

Description: Students will conduct a case study or field-based observation of an industrial area or a specific industry to: Identify major industrial air pollutants such as SO_2, NO_x, CO, particulate matter, and VOCs. Study the chemical nature and sources of these pollutants from industrial processes. Explain atmospheric chemical reactions involved in acid rain, smog formation, or secondary pollutants. Assess environmental and health impacts of industrial air emissions on nearby communities. Suggest air pollution control measures such as scrubbers, electrostatic precipitators, or cleaner production methods. This activity helps students understand the chemistry behind industrial air pollution, its impacts, and control strategies through practical exploration and real-world examples.

Module 3 – Chemistry of Industrial Water Pollution

Project 1: Chemical Analysis of Industrial Water Pollution

Description: Students will explore the chemistry of industrial wastewater through a case study or laboratory investigation by: Selecting an industry (textile, paper, tannery, sugar, chemical, etc.) and identifying its wastewater characteristics. Identifying major chemical pollutants such as acids/alkalis, dyes, organic matter, nutrients, and heavy metals. Analyzing water quality parameters (pH, colour, turbidity, BOD, COD, chloride, or metals) using standard methods or reported data. Studying chemical reactions involved in wastewater contamination and treatment. Suggesting suitable treatment methods (primary, secondary, and tertiary) for pollution control. This activity helps students understand the chemical nature, behavior, and treatment of industrial water pollutants and connects theory with real-world industrial practices.

Module 4 – Industrial Solid Waste & Hazardous Waste Management

Project 1: Assessment of Industrial Solid and Hazardous Waste Management

Description: Students will carry out a case study or field-based survey of an industry or industrial area to: Identify types of solid and hazardous wastes generated (slag, fly ash, chemical residues, sludge, solvents, etc.). Classify wastes based on their chemical nature and hazardous characteristics (toxic, corrosive, flammable, reactive). Study methods of storage, handling, and disposal adopted by the industry. Assess environmental and health risks associated with improper waste management. Suggest waste minimization, recycling, and safe disposal strategies in line with environmental regulations. This activity helps students understand industrial waste characteristics, management practices, and the importance of safe and sustainable hazardous waste handling.

Reference Books:

1. Environmental Chemistry – A.K. De
2. Principles of Environmental Chemistry – James E. Girard
3. Industrial Pollution Control– W.W. Tyler
4. Environmental Pollution and Control – P.K. Goel
5. Pollution: Causes, Effects and Control – R.M. Harrison
6. Air Pollution: Its Origin and Control" – Kenneth Wark, Cecil F. Warner, Wayne T. Davis
7. Water Pollution: Characteristics, Effects and Control" – B.K. Sharma, R.C. Trivedy
8. Industrial Water Quality – A.K. Biswas & C.T. King
9. Handbook of Industrial Chemistry: Organic Chemicals – James G. Speight (Ed.)
10. Hazardous Chemicals: Agents of Risk and Change – Edited by Harry S. Hertz, etc.
11. Wastewater Engineering: Treatment and Reuse– Metcalf & Eddy
12. Green Chemistry: Theory and Practice– Paul T. Anastas & John C. Warner
13. Environmental Engineering: Fundamentals, Sustainability, Design" – James R. Mihelcic & Julie B. Zimmerman

Semester - III

.3.5 Open Electives Course (OEC)

Course Title	**Health, Safety and Environmental Management**
Course Credits	4
Course Outcomes	After going through the course, learners will be able to
	1. Understand the integrated concepts of health, safety, and environmental management in workplaces and society.
	2. Identify occupational and environmental hazards and apply basic risk assessment and control measures.
	3. Explain environmental management practices and pollution control strategies for sustainable development.
	4. Appreciate the role of HSE management systems in promoting safety culture, sustainability, and corporate responsibility.
Module 1 (Credit 1) – Introduction to Health, Safety and Environment	
Learning Outcomes	After learning the module, learners will be able to,
	1. Define health, safety, and environment and explain their interrelationship.
	2. Understand the importance of HSE in sustainable development.
Content Outline	• Concept, scope, and importance of HSE, Relationship between health, safety, and environmental protection, Occupational health hazards: physical, chemical, biological, ergonomic, psychosocial, Environmental hazards and pollution impacts on human health, Safety culture and sustainable development.
Module 2 (Credit 1)- Safety Management and Risk Control	
Learning Outcomes	After learning the module, learners will be able to,
	1. Identify causes of industrial accidents and unsafe practices.
	2. Explain safety control measures including engineering controls, administrative controls, and PPE.

Content Outline	• Types and causes of industrial accidents, Hazard identification and risk assessment (HIRA), Safety control measures: engineering, administrative, and PPE, Fire safety, electrical safety, and chemical safety, Emergency preparedness and disaster management.
Module 3 (Credit 1) – Environmental Management and Pollution Control	
Learning Outcomes	After learning the module, learners will be able to,
	1. Explain environmental management systems and pollution control methods.
	2. Understand waste management practices and cleaner production concepts.
Content Outline	• Environmental management systems (EMS) and ISO 14001, Industrial pollution: air, water, soil, and noise, Waste management: solid, hazardous, biomedical, and e-waste, Cleaner production and green technologies, Environmental monitoring and auditing.
Module 4 (Credit 1) – HSE Legislation, Standards and Sustainability	
Learning Outcomes	After learning the module, learners will be able to,
	1. Explain the role of international standards and agencies in HSE management.
	2. Relate HSE practices to sustainability, CSR, and future environmental challenges.
Content Outline	• National and international HSE laws and regulations, Factories Act, 1948 and OSH Code, 2020 (overview), Environmental laws: EPA 1986, Water Act, Air Act, Role of regulatory agencies (CPCB, SPCB, ILO, WHO), Corporate social responsibility (CSR), sustainability, and future challenges in HSE.

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

Module 1 – Introduction to Health, Safety and Environment

Project 1: Identification of Occupational and Environmental Hazards

Description: Students identify common occupational hazards (physical, chemical, biological, ergonomic, psychosocial) and environmental hazards (air, water, soil, noise pollution) in a selected workplace or community setting and prepare a brief report. Learning Outcome: Recognizes different types of occupational and environmental hazards

and their potential impacts on health and safety. Evaluation Criteria: Accuracy of hazard identification, relevance to setting, and clarity of description.

Module 2 – Safety Management and Risk Control

Project 1: Safety Audit Exercise

Description: Students perform a mini safety audit of a laboratory, office, or industrial setup, noting safety practices, potential hazards, and areas for improvement, and prepare a brief audit report. Learning Outcome: Understands the practical aspects of safety management and identifies areas requiring corrective measures. Evaluation Criteria: Observation accuracy, clarity of report, and practical recommendations for improvement.

Module 3 – Environmental Management and Pollution Control

Project 1: Identification of Pollution Sources and Control Measures

Description: Students identify major sources of pollution (air, water, soil, noise) in a selected area (industry, campus, or locality) and suggest appropriate pollution control measures for each type. Learning Outcome: Identifies pollution sources and applies basic pollution control strategies for environmental protection. Evaluation Criteria: Accuracy of pollution source identification, suitability of control measures, and clarity of presentation.

Module 4 – HSE Legislation, Standards and Sustainability

Project 1: Study of HSE Laws and Standards

Description: Students prepare a short assignment explaining major HSE legislations and standards such as the Factories Act, 1948, Occupational Safety, Health and Working Conditions Code, 2020, Environmental Protection Act, 1986, and ISO 14001 / ISO 45001, highlighting their objectives and significance. Learning Outcome: Understands the legal and regulatory framework governing health, safety, and environmental management. Evaluation Criteria: Coverage of key laws and standards, clarity of explanation, and relevance to workplace safety and sustainability.

Reference Books:

1. Goetsch, D. L. *Occupational Safety and Health for Technologists, Engineers, and Managers*. Pearson.
2. Hughes, P. & Ferrett, E. *Introduction to Health and Safety at Work*. Routledge.
3. Rao, M. N. & Rao, H. V. N. *Environmental Management*. McGraw-Hill Education.
4. Peavy, H. S. & Row, K. *Environmental Engineering*. McGraw-Hill.
5. WHO & ILO Publications on Health, Safety and Environment.
6. ISO Standards: ISO 14001 (Environmental Management Systems), ISO 45001 (Occupational Health and Safety).

Semester - III

.3.7 Major (Core)

Course Title	**Urban Environmental Ecosystem (Th)**
Course Credits	2
Course Outcomes	After going through the course, learners will be able to,
	1. Understand the structure, function, and components of urban ecosystems, including biotic and abiotic interactions.
	2. Analyze the impact of urbanization on biodiversity, natural resources, and ecosystem services.
	3. Evaluate strategies for sustainable urban development, including green spaces, water management, and pollution control.
	4. Develop awareness and skills to promote sustainable living, resource conservation, and resilience in urban ecosystems.
Module 1 (Credit 1) –Urban Environmental Systems-Concepts and Structure	
Learning Outcomes	After learning the module, learners will be able to,
	1. Understand the concept of urban environmental systems and the components of urban ecosystems.
	2. Analyze interactions between natural and human-made elements in urban settings.
Content Outline	• Definition and scope of urban environmental system, Cities as integrated environmental systems, Components of urban systems: air, water, soil biota and human activities. Energy flow and material cycles in urban environments. Impacts of urbanization on natural ecosystems, Urban heat island effect, Interaction between built environment and natural system.
Module 2 (Credit 1)- Urban Pollution and Environmental Management	
Learning Outcomes	After learning the module, learners will be able to,
	1. Understand the sources, causes, and chemical/physical characteristics of urban pollutants.

	2. Apply monitoring and assessment techniques to measure urban pollution level.
Content Outline	• Sources and Characteristics of urban air pollution, Urban water pollution: domestics sewage and environmental impacts, Heavy metals and toxic substances in urban areas, Environmental monitoring in cities, Urban environmental management strategies, Sustainable urban development concepts.

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

Module 1 – Urban Environmental Systems-Concepts and Structure

Project 1: Study of Urban Environmental Systems

Description: Students will explore the structure and functioning of an urban environmental system in their town or city by: Identifying key components of the urban system such as air, water, soil, green spaces, built environment, and population. Mapping interactions between natural and human-made components (e.g., water supply–wastewater, green spaces–air quality). Observing energy and material flows including resource use, waste generation, and transportation. Analyzing impacts of urbanization on environmental quality and ecosystem services. This activity helps students understand the concepts, structure, and interconnections within urban environmental systems and apply systems thinking to real urban settings.

Module 2 – Urban Pollution and Environmental Management

Project 1: Urban Pollution Assessment and Management Study

Description: Students will conduct a field-based survey or case study in an urban area to: Identify major types of urban pollution such as air, water, noise, solid waste, and soil pollution. Observe and record pollution sources including traffic, industries, sewage discharge, and waste dumping. Assess impacts of urban pollution on human health, environment, and quality of life. Study existing environmental management practices like waste segregation, sewage treatment, green spaces, and traffic control. Suggest practical measures for pollution control and sustainable urban environmental management. This activity helps students link urban pollution issues with management strategies and develop skills in environmental assessment and sustainable planning.

Reference Book:

1. Urban Ecology: Patterns, Processes, and Applications" – Edited by J. Marzluff et al.
2. Urban Ecology: An International Perspective on the Interaction Between Humans and Nature" – Edited by John M. Marzluff, Eric Shulenberger, et al.
3. Urban Ecosystems: Environmental, Social, and Economic Aspects" – Edited by W. F. E. Precht
4. Principles of Environmental Science" – by William P. Cunningham & Mary Ann Cunningham
5. Environmental Chemistry" – by A. K. De Strong foundation in chemistry of pollutants.
6. Urban Air Pollution: Its Origin and Control" – by W. T. Davis & S. J. Calderbank

7. Solid Waste Management: Principles and Practice" – by R. C. Tolaymat / P. L. Bishop
8. Environmental Pollution Control Engineering" – by C. S. Rao
9. Environmental Impact Assessment: Theory and Practice" – by Peter Wathern
10. Cunningham, W. P. & Cunningham, M. A. Principles of Environmental Science – McGraw-Hill.
11. A.K. De. Environmental Chemistry – New Age International
12. Marzluff, J. M. et al. (Eds.) Urban Ecology: An International Perspective – Springer
13. Peavy, H. S., Row, R. N., & Tchobanoglous, G. Environmental Engineering – McGraw-Hill
14. C. S. Rao Environmental Pollution Control Engineering – Wiley Eastern

Course Syllabus

Semester - IV

.4.1 Major (Core)

Course Title	**Solid and Hazardous Waste Management (Th)**
Course Credits	4
Course Outcomes	After going through the course, learners will be able to
	• Explain the types, sources, and characteristics of solid and hazardous wastes.
	• Understand and apply waste segregation, collection, storage, and transportation practices.
	• Evaluate the environmental and health impacts of improper waste management.
	• Explain hazardous waste management techniques, including handling, treatment, storage, and disposal (TSDF).
Module 1 (Credit 1) – Introduction of Solid Waste	
Learning Outcomes	After learning the module, learners will be able to,
	1. Understand the sources and characteristics of solid waste, including physical, chemical, and biological properties.
	2. Explain methods for collection, segregation, storage, and transportation of solid waste.
Content Outline	• Definition. Characteristic and perspectives. Sources and generation of solid waste. Classification. Characteristic of solid waste: physical, chemical and biological. Solid waste generation. Factors affecting solid waste generation. Handling and separation of solid waste at source. Method of collection. Transfer station. Location of transfer station.
Module 2 (Credit 1) - Methods of Treatment and Disposal of solid waste	
Learning Outcomes	After learning the module, learners will be able to,
	1. Identify and describe various methods of waste treatment, including physical, chemical, and biological techniques.

	2. Analyze environmental and health impacts of different waste disposal methods.
Content Outline	• Composting. Sanitary land filling. Thermal process: incineration, pyrolysis and gasification. Waste reduction techniques: recycling- paper and paper board, plastics and glass.
Module 3 (Credit 1) – Hazardous Waste and its management	
Learning Outcomes	After learning the module, learners will be able to,
	1. Define and classify hazardous wastes based on origin, composition, and characteristics.
	2. Identify common sources of hazardous waste, including industrial, biomedical, and e-waste.
Content Outline	• Definition. Classification. Hazardous waste generation. Nuclear waste. Biomedical waste. Chemical waste. Identification of hazardous waste. Electronic waste (E-waste).
Module 4 (Credit 1) – Hazardous waste treatment technology	
Learning Outcomes	After learning the module, learners will be able to,
	1. Understand the principles of hazardous waste treatment technologies, including physical, chemical, and biological methods.
	2. Describe safe disposal methods such as secure landfills, deep-well injection, and engineered containment.
Content Outline	• On site disposal: physical, chemical and biological. Off-site disposal: Co-disposal and sanitary land filling. E-waste management. Biomedical waste management: autoclave, hydroclave, microwave and disinfection by solar radiation.

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

Module 1 – Introduction of Solid Waste

Project 1: Solid Waste Characterization and Segregation Study

Description: Students will collect solid waste samples from a selected location (household, hostel, market, or campus). They will: Classify waste into biodegradable, non-biodegradable, and recyclable categories. Estimate the percentage composition of each waste type. Study current segregation practices and identify gaps. Suggest improved

segregation and reduction measures. This activity helps students understand waste composition, source segregation, and sustainable solid waste management practices.

Module 2 – Methods of Treatment and Disposal of solid waste

Project 1: Study of Solid Waste Treatment Methods

Description: Students will survey a local solid waste treatment facility (municipal composting unit, biogas plant, recycling center, or incinerator) or study it through case reports. They will: Identify treatment methods used (composting, recycling, incineration, waste-to-energy). Analyze the advantages and limitations of each method. Assess environmental impacts and efficiency of the treatment process. This activity helps students understand practical treatment technologies used in solid waste management.

Module 3 – Hazardous Waste and its management

Project 1: Hazardous Waste Identification and Classification Study

Description: Students will survey a selected industry, laboratory, hospital, or workshop (or use a documented case study) to: Identify different types of hazardous wastes generated. Classify them based on toxicity, flammability, corrosivity, and reactivity. Study labeling, storage, and safety symbols used. Assess risks to human health and the environment. This activity helps students understand real-world sources and characteristics of hazardous waste.

Module 4 – Hazardous waste treatment technology

Project 1: Study of Hazardous Waste Treatment Technologies

Description: Students will study different hazardous waste treatment technologies through case studies, virtual resources, or a visit to a treatment facility (TSDF). They will: Identify physical, chemical, and biological treatment methods (e.g., neutralization, stabilization/solidification, incineration, bioremediation). Understand the principle and process of each technology. Analyze the advantages, limitations, and environmental safety aspects. This activity helps students gain insight into technological approaches for reducing hazardous waste toxicity and volume.

Reference Book:

1. Solid waste pollution: Dr. Aradhana Salpekar, Jnanada Prakashan, New Delhi, 2008.
2. Textbook of solid wastes management by Khan Iqbal and Ahsan Naved,CBS Publishers and distributors, New Delhi.
3. Environmental Problems and Solution: D.K. Asthana, S.Chand Publication, New Delhi.
4. Environmental Chemistry: S.S.Dara, S.Chand Publication,New Delhi.
5. Environmental Chemistry: B.K. Sharma, Goel Publication, Meerut.
6. Municipal solid Waste Management Manual (Part II), CPHEEO, Ministry of Urban
7. Development, Swachh Bharat Mission, Govt. Of India.
8. Handbook of Solid Waste Management, George Tchobanoglous, McGraw Hills.
9. Sustainable Solid Waste Management- A systems engineering approach, IEEE Press, Wiley
10. Environmental Sanitation by Baljeet Kappor, S.Chand & Co. 2001.
11. Environmental Biology and Toxicology- P.D. Sharma, Rastogi Publication, 2004.
12. Environmental Science- W. Cunningham and Saigo, McGraw Hill, New York.
13. A Textbook of Environment- Agrawal, Mcmillion publication, Mumbai

14. Environmental Chemistry- B.K. Sharma, Goel Publication, Meerut.
15. Environmental Science- S. C. Santra, New Central Book Agency private Limited, 2006.
16. Solid Waste Management In Developing Countries (1983) by A.D.Bhide & B.B. Sundaresan, INSDOC, New Delhi.

Semester - IV

.4.2 Major (Core)

Course Title	**Water Resources and Treatment (Th)**
Course Credits	4
Course Outcomes	After going through the course, learners will be able to
	1. Describe the types, distribution, and importance of water resources, including surface water, groundwater, and rainwater.
	2. Identify sources and causes of water pollution affecting natural water resources.
	3. Analyze physical, chemical, and biological characteristics of water relevant to water quality assessment.
	4. Apply knowledge of water conservation, management, and reuse strategies for sustainable development.
Module 1 (Credit 1) – General Introduction of water	
Learning Outcomes	After learning the module, learners will be able to,
	1. Understand the concept and importance of water resources for life, ecosystems, and sustainable development.
	2. Identify different types of water resources, including surface water, groundwater, and rainwater.
Content Outline	• Sources and types of water; hydrological cycle, Classification, Global water crisis • Properties of water: Physical Properties (temperature, colour, odour, total dissolved solids) • Chemical Properties (DO, COD, BOD, acidity and alkalinity, electrical conductivity)
Module 2 (Credit 1)- Water Resources	
Learning Outcomes	After learning the module, learners will be able to,
	1. Recognize factors affecting water availability, such as climate change, population growth, and land-use change.
	2. Analyze issues related to water scarcity and stress.

Content Outline	• Water resources (oceans, rivers, lakes and wetlands) and types of water; Overexploitation of surface and ground water resources; Demand for water (agriculture, industrial, domestic); hot spots of surface water, water quality standards in India; role of state in water resources management.
Module 3 (Credit 1) – Physical Treatment of water	
Learning Outcomes	After learning the module, learners will be able to,
	1. Explain the need and objectives of water treatment for safe drinking and domestic use.
	2. Understand conventional water treatment processes, including screening, aeration, sedimentation.
Content Outline	• Physical treatment: Important unit operations, gas transfer, ion transfer, solute stabilization, solid transfer, schematic layout of water treatment plant. • Preliminary treatment of water: screens, purpose, types, aeration-theory, types of aerators, factors governing aeration, design consideration of aerators. • Sedimentation: Theory, sedimentation tank-horizontal, circular, hopper bottom.
Module 4 (Credit 1) – Chemical Treatment of water	
Learning Outcomes	After learning the module, learners will be able to,
	1. Define chemical treatment and explain its role in water treatment.
	2. Evaluate the effectiveness of chemical treatment methods for removing suspended solids, pathogens, and dissolved impurities.
Content Outline	• Coagulation: Theory, common coagulants, dosage of coagulants, optimum coagulant dose by Jar test apparatus. Flocculation- theory, operations. • Filtration: Theory, types of filters (Slow sand filter, rapid sand filter and pressure filter). • Disinfection: Basic theory, chlorination forms, ozonisation, ultra purification, UV radiation.

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

Module 1 – General Introduction of water

Project 1: Water Uses and Conservation Awareness Study

Description: Students will survey households, campus facilities, or nearby communities to document major uses of water and identify areas of water wastage. Based on their findings, students will suggest simple water conservation measures and present them as a poster or brief write-up. Learning Focus: Uses of water, Water scarcity issues & Need for water conservation.

Module 2 – Water Resources

Project 1: Identification and Classification of Water Resources

Description: Students will identify various water resources in their locality or region, such as rivers, lakes, reservoirs, groundwater, rainwater, and oceans. They will classify them into surface water and groundwater, and prepare a brief report or chart describing their sources, uses, and importance. Learning Focus: Types of water resources, Surface water vs groundwater, Role of water resources in human activities.

Module 3 – Physical Treatment of water

Project 1: Demonstration of Sedimentation and Filtration Processes

Description: Students will collect a turbid water sample and allow it to undergo sedimentation in a container. After settling, the clear water will be passed through a simple sand–gravel–charcoal filter. Students will observe changes in turbidity, color, and clarity, and record their findings. Learning Focus: Principle of sedimentation, Filtration as a physical treatment method, Removal of suspended impurities.

Module 4 – Chemical Treatment of water

Project 1: Study of Coagulation and Flocculation Using Alum

Description: Students will treat a turbid water sample with alum (potash alum) in varying doses. They will observe the formation of flocs, settling of suspended particles, and improvement in water clarity. Results will be recorded and analyzed to determine the optimum alum dose. Learning Focus: Principle of coagulation and flocculation, Role of alum as a chemical coagulant, Reduction of turbidity in water.

Reference Book:

1. Bansil, P.C. 2004. Water Management in India. Concept Publishing Company, India.
2. Brebbia, C.A. 2013. Water Resources Management VII. WIT Press.
3. CEA. 2011. Water Resources and Power Maps of India. Central Board of Irrigation & Power.
4. Grumbine, R.E. & Pandit, M.K. 2013. Threats from India's Himalaya dams. Science 339: 36-37.
5. Loucks, D.P., Stedinger, J.R. & Haith, D. A. 1981. Water Resource Systems Planning and Analysis. Englewood Cliffs, NJ, Prentice Hall.
6. Mays, L.W. 2006. Water Resources Sustainability. The McGraw-Hill Publications.

7. Schward& Zhang, 2003. Fundamentals of Groundwater. John Willey and Sons.
8. Souvorov, A.V. 1999. Marine Ecologonomics: The Ecology and Economics of Marine Natural Resource Management. Elsevier Publications.
9. Vickers, A. 2001. Handbook of Water Use and Conservation. Water Plow Press.

Semester - IV

.4.3 Minor Stream

Course Title	**Geosphere and Geochemistry (Th)**
Course Credits	4
Course Outcomes	After going through the course, learners will be able to
	1. Describe the structure, composition, and dynamics of the geosphere, including the crust, mantle, and core.
	2. Explain the origin, classification, and properties of rocks and minerals and their role in Earth systems.
	3. Understand the principles of geochemistry, including elemental abundance and distribution in the Earth.
	4. Apply basic geochemical concepts to environmental issues, including contamination, resource depletion, and sustainability.
Module 1 (Credit 1) - Introduction to the Geosphere	
Learning Outcomes	After learning the module, learners will be able to,
	1. Describe the structure of the Earth, including the crust, mantle, and core, with their physical and chemical characteristics.
	2. Explain the rock cycle and classify rocks into igneous, sedimentary, and metamorphic types.
Content Outline	• Definition, scope, and components of the geosphere, Structure of Earth: crust, mantle, core, Nature of solid in the geosphere, Definition and classification of minerals, Physical and chemical properties of minerals, Rock cycle, Earthquakes and volcanism
Module 2 (Credit 1) - Geochemical Principles	
Learning Outcomes	After learning the module, learners will be able to,
	1. Explain the basic principles of geochemistry, including the chemical composition of the Earth and elemental distribution.
	2. Describe geochemical cycles of important elements such as carbon, nitrogen, sulfur, and phosphorus.

Content Outline	• Introduction to geochemistry, Chemical composition of Earth, Geochemical cycles: carbon, nitrogen, sulfur, phosphorus, Weathering and soil formation processes, Elemental distribution in lithosphere, hydrosphere and atmosphere.
Module 3 (Credit 1) – Geochemical Processes	
Learning Outcomes	After learning the module, learners will be able to,
	1. Explain major geochemical processes such as weathering, erosion, transportation, and sedimentation.
	2. Explain sedimentary and diagenetic processes influencing mineral formation and stability.
Content Outline	• Mineral stability and solubility, Redox reactions in geochemical systems Adsorption, ion exchange, and transport mechanisms, Geochemical fractionation and isotope geochemistry (introductory). Soil formation and geomorphological processes, land degradation and erosion.
Module 4 (Credit 1) – Applied Geochemistry	
Learning Outcomes	After learning the module, learners will be able to,
	1. Understand geochemical techniques used in mineral exploration and resource assessment.
	2. Evaluate geochemical controls on groundwater quality and surface water chemistry.
Content Outline	• Definition, Environmental geochemistry and pollution, Groundwater chemistry and aquifer geochemistry. Heavy metal cycling and contamination, Geochemical methods in resource exploration, Geochemical modelling basics.

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

Module 1 – Introduction to the Geosphere

Project 1: Rock and Mineral Identification Survey

Description: Students will explore: Basic rock and mineral types that constitute the geosphere. Activity Description: Students collect or observe common rock/mineral samples (or images if samples are unavailable), classify them into igneous, sedimentary, and metamorphic rocks, and note their physical properties such as color, hardness, and texture. Learning Focus: Rock cycle, mineral properties, observation skills, classification.

Module 2 – Geochemical Principles

Project 1: Elemental Abundance and Distribution Analysis

Description: Students will explore: The abundance and distribution of major, minor, and trace elements in the Earth's crust. Activity Description: Students prepare a comparative chart or table showing elemental abundance in the crust, mantle, and core. They classify elements into major, minor, and trace categories and explain their geochemical significance. Learning Focus: Element classification, Earth chemistry, data interpretation.

Module 3 – Geochemical Processes

Project 1: Chemical Weathering and Soil Formation Study

Description: Students will explore: Major geochemical processes involved in chemical weathering and their role in soil formation. Activity Description: Students study different types of chemical weathering (hydrolysis, oxidation, carbonation) using diagrams, case studies, or local examples. They prepare a short report explaining how these processes influence soil composition and nutrient availability. Learning Focus: Weathering reactions, soil chemistry, environmental relevance.

Module 4 – Applied Geochemistry

Project 1: Soil and Water Contamination Assessment Using Geochemical Indicators

Description: Students will explore: Application of geochemical principles to assess soil and water quality. Activity Description: Students analyze provided data or case studies on soil or groundwater contamination (e.g., heavy metals, salinity, nutrients). They interpret geochemical parameters such as pH, EC, and elemental concentrations and suggest possible sources of contamination. Learning Focus: Environmental geochemistry, data interpretation, pollution assessment.

Reference Book:

1. Earth structure and geosphere, Earth: An Introduction to Physical Geology – Tarbuck & Lutgens
2. Minerals & rocks, Manual of Mineralogy – Klein & Dutrow
3. Geochemistry basics, Principles of Geochemistry – Faure & Mensing
4. Environmental geochemistry, Environmental Geochemistry – Shaw & Holland
5. Chemical cycles & weathering, Igneous and Metamorphic Petrology – Winter (for rock/chemical processes)
6. Geochemical methods, Introduction to Geochemistry – Mason & Moore
7. Geochemistry & resources, Geochemistry: Pathways & Processes – White & Brown
8. Groundwater chemistry, Groundwater Chemistry and Geochemistry – Appelo & Postma

Semester - IV

.4.4 Open Electives Course (OEC)

Course Title	**Hazard and Disaster Management**
Course Credits	4
Course Outcomes	After going through the course, learners will be able to
	1. Understands the concepts, types, and impacts of natural and man-made hazards and disasters.
	2. Apply principles of disaster preparedness, response, mitigation, and recovery.
	3. Explain the role of institutions, policies, and legal frameworks in disaster management.
	4. Evaluate disaster case studies to suggest improved disaster risk reduction strategies.
Module 1 (Credit 1) – Fundamentals of Hazards and Disasters	
Learning Outcomes	After learning the module, learners will be able to,
	1. Define hazards and disasters and classify them into natural and man-made categories.
	2. Describe causes, impacts, and vulnerability associated with different disasters.
Content Outline	• Definition and classification of hazards and disasters, Natural hazards: earthquakes, floods, cyclones, droughts, landslides, tsunamis, Man-made hazards: industrial accidents, chemical spills, nuclear hazards, fires, Causes, impacts, and vulnerability to disasters, Disaster management cycle: prevention, mitigation, preparedness, response, and recovery.
Module 2 (Credit 1)- Risk Assessment and Disaster Preparedness	
Learning Outcomes	After learning the module, learners will be able to,
	1. Explain concepts of disaster risk, hazard, vulnerability, and capacity.
	2. Describe disaster preparedness planning and community-based approaches.

Content Outline	• Disaster risk, hazard, vulnerability, and capacity assessment, Hazard mapping and zoning, Early warning systems and communication, Disaster preparedness planning and community participation, Role of local bodies and NGOs in disaster preparedness.
Module 3 (Credit 1) – Disaster Response, Mitigation and Recovery	
Learning Outcomes	After learning the module, learners will be able to,
	1. Explain disaster response mechanisms including rescue and relief operations.
	2. Understand post-disaster recovery, rehabilitation, and reconstruction processes.
Content Outline	• Disaster response mechanisms and emergency management, Search, rescue, and relief operations, Structural and non-structural mitigation measures, post-disaster recovery, rehabilitation, and reconstruction, Psychological and social impacts of disasters.
Module 4 (Credit 1)–Disaster Management Policies, Institutions and Case Studies	
Learning Outcomes	After learning the module, learners will be able to,
	1. Identify the roles of national and international disaster management institutions.
	2. Analyze disaster case studies to assess lessons learned and best practices.
Content Outline	• Disaster management policies and legal frameworks, Disaster Management Act, 2005 (India), Institutional framework: NDMA, SDMA, NDRF, UNDRR, Role of science, technology, and GIS in disaster management, Case studies of major disasters in India and the world.

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

Module 1 – Fundamentals of Hazards and Disasters

Project 1: Identification of Occupational and Environmental Hazards

Description: Students identify common occupational hazards (physical, chemical, biological, ergonomic, psychosocial) and environmental hazards (air, water, soil, noise pollution) in a selected workplace or community setting and prepare a brief report. Learning Outcome: Recognizes different types of occupational and environmental hazards and their potential impacts on health and safety. Evaluation Criteria: Accuracy of hazard identification, relevance to setting, and clarity of description.

Module 2 – Risk Assessment and Disaster Preparedness

Project 1: Hazard and Vulnerability Mapping

Description: Students prepare a hazard and vulnerability map of their local area or region, identifying natural and man-made hazards, vulnerable populations, and high-risk zones. Learning Outcome: Understands the concepts of hazard, vulnerability, and risk assessment and applies them to a real-world scenario. Evaluation Criteria: Accuracy of hazard identification, clarity of mapping, and completeness of analysis.

Module 3 – Disaster Response, Mitigation and Recovery

Project 1: Disaster Response Simulation

Description: Students prepare a brief report or plan simulating a response to a specific disaster (e.g., flood, earthquake, cyclone) covering: Immediate response actions, Search and rescue operations, Relief distribution and coordination with authorities. Learning Outcome: Applies knowledge of disaster response mechanisms and develops practical understanding of emergency operations. Evaluation Criteria: Clarity of response steps, feasibility of actions, and understanding of coordination mechanisms.

Module 4 – Disaster Management Policies, Institutions and Case Studies

Project 1: Case Study Analysis of a Major Disaster

Description: Students select a major disaster in India or globally (e.g., 2004 Tsunami, 2013 Uttarakhand Floods, Cyclone Amphan) and prepare a brief case study report including: Causes and impact of the disaster, Response measures and role of institutions, Lessons learned for future disaster management Learning Outcome: Analyzes real-life disaster events and evaluates the effectiveness of institutional response and policy implementation. Evaluation Criteria: Relevance and accuracy of case study, clarity of analysis, and understanding of institutional roles and lessons learned.

Reference Books:

1. Coppola, D. P. *Introduction to International Disaster Management*. Elsevier.
2. Goel, S. L. *Disaster Management*. Deep & Deep Publications.
3. Gupta, H. K. *Disaster Management*. Universities Press.
4. Sharma, V. K. *Disaster Management*. National Centre for Disaster Management.
5. UNDRR. *Disaster Risk Reduction Reports and Guidelines*.
6. NDMA (India). *National Disaster Management Guidelines*.

Semester - IV

.4.5 Skill Enhancement Course (SEC)

Course Title	**Bamboo Innovation and Applications (Th)**
Course Credits	2
Course Outcomes	After going through the course, learners will be able to,
	1. Apply innovative bamboo technologies in construction, furniture, handicrafts, and bio-composite products.
	2. Explain the importance of bamboo in sustainable development, climate change mitigation, and carbon sequestration.
	3. Understand bamboo processing techniques, including harvesting, treatment, preservation, and seasoning.
	4. Develop basic entrepreneurial and skill-based competencies related to bamboo innovation and green livelihoods.
Module 1 (Credit 1) – Bamboo Science, Properties, and Processing	
Learning Outcomes	After learning the module, learners will be able to,
	1. Identify major bamboo species and explain their distribution and ecological requirements.
	2. Explain bamboo processing techniques, including curing, seasoning, treatment, and preservation.
Content Outline	• Introduction to bamboo: definition, classification, and global distribution • Growth characteristics, life cycle, and regeneration capacity • Physical, mechanical, and chemical properties of bamboo • Harvesting methods, curing, seasoning, and preservation techniques, Environmental, ecological, and economic importance of bamboo.
Module 2 (Credit 1)-Bamboo Innovations and Sustainable Applications	
Learning Outcomes	After learning the module, learners will be able to,
	1. Analyze the environmental benefits of bamboo, including carbon sequestration, soil conservation, and biodiversity support.
	2. Understand bamboo's role in rural livelihoods and green entrepreneurship.

Content Outline	• Bamboo as a sustainable material in construction and green architecture • Bamboo-based products: furniture, handicrafts, boards, and composites • Bamboo applications in agriculture, paper, energy, and packaging industries • Role of bamboo in carbon sequestration, soil conservation, and climate resilience • Bamboo-based entrepreneurship, rural livelihoods, and innovation potential

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

Module 1 – Bamboo Science, Properties, and Processing

Project 1: Study of Bamboo Species and Structural Properties

Description: Students will explore: Scientific characteristics and physical properties of bamboo. Activity Description: Students identify commonly used bamboo species (using samples, images, or field observations) and study their physical and mechanical properties such as density, strength, flexibility, and durability. Findings are compiled in a comparative table with suitable applications. Learning Focus: Bamboo biology, material properties, application suitability.

Module 2 – Bamboo Innovations and Sustainable Applications

Project 1: Bamboo-Based Sustainable Product Innovation Study

Description: Students will explore: Innovative and eco-friendly applications of bamboo as a sustainable material. Description: Students identify one bamboo-based product (e.g., furniture, construction material, packaging, textiles, or handicrafts). They study its raw material source, processing method, environmental benefits, and potential market value, and present their findings as a short report or poster. Learning Focus: Sustainable materials, product innovation, environmental benefits.

Reference Book:

1. Liese, W. – *Bamboo: The Plant and its Uses*
2. INBAR Publications – *Bamboo for Sustainable Development*
3. Mathur, P.N. – *Bamboo Science and Technology*
4. FAO – *Bamboo Based Technologies and Utilization*
5. National Bamboo Mission (India) – Training Manuals and Reports
6. Bamboo: The Plant and its Uses" – Walter Liese
7. Bamboo for Sustainable Development" – INBAR Publications
8. Bamboo Science and Technology" – P.N. Mathur
9. Bamboo Based Technologies" – FAO / INBAR Manuals

Semester - IV

.4.7 Minor Stream

Course Title	**Environmental Biochemistry (Th)**
Course Credits	2
Course Outcomes	After going through the course, learners will be able to,
	1. Understand the fundamentals of environmental biochemistry and its role in ecosystem processes.
	2. Analyze the biochemical effects of environmental pollutants, including heavy metals, pesticides, and xenobiotics, on living organisms and ecosystems.
	3. Analyze the biochemical effects of environmental pollutants, including heavy metals, pesticides, and xenobiotics, on living organisms and ecosystems.
	4. Apply the principles of microbial biotransformation and enzymatic degradation in pollution control and bioremediation.
Module 1 (Credit 1) –Fundamentals of Environmental Biochemistry	
Learning Outcomes	After learning the module, learners will be able to,
	1. Define environmental biochemistry and explain its importance in understanding ecosystem processes.
	2. Identify major biomolecules (carbohydrates, proteins, lipids, nucleic acids) and their roles in environmental systems.
Content Outline	• Introduction to Environmental Biochemistry: Definition, scope, and importance • Biomolecules in the environment: Carbohydrates, proteins, lipids, nucleic acids • Enzymes and their role in environmental processes • Biochemical transformations in soil, water, and air
Module 2 (Credit 1)- Biochemical Aspects of Environmental Pollution	
Learning Outcomes	After learning the module, learners will be able to,
	1. Explain the biochemical effects of environmental pollutants, including heavy metals, pesticides, and xenobiotics.
	2. Understand bioaccumulation and biomagnification of chemical pollutants in food chains.

Content Outline	• Biochemical effects of environmental pollutants (heavy metals, pesticides, and xenobiotics) • Biochemical markers of environmental stress in organisms • Enzymatic degradation and biotransformation of pollutants • Bioaccumulation and biomagnification of chemical pollutants • Role of microbes in bioremediation: Enzymatic and metabolic pathways

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

Module 1 – Fundamentals of Environmental Biochemistry

Project 1: Analysis of Biomolecules in Soil and Water

Description: Students will explore: The presence and role of biomolecules (proteins, carbohydrates, lipids) in environmental samples. Activity Description: Students collect soil or water samples from a local area and perform basic qualitative tests (e.g., Biuret test for proteins, Benedict's test for sugars, Sudan III test for lipids) to detect biomolecules. They prepare a report describing the types and significance of biomolecules in environmental contexts. Learning Focus: Identification of biomolecules in environmental matrices Understanding biochemical roles in ecosystems Observation and reporting skills

Module 2 – Biochemical Aspects of Environmental Pollution

Project 1: Detection of Heavy Metals and Their Biochemical Impact

Description: Students will explore: The presence and effects of heavy metals (like lead, mercury, or cadmium) on biochemical processes in aquatic systems. Activity Description: Students collect water samples from local sources (river, pond, or tap) and analyze them for heavy metal content using qualitative kits or secondary data. They then prepare a report explaining how these metals affect enzymes, proteins, and overall ecosystem health. Learning Focus: Biochemical effects of heavy metals, Environmental monitoring, Data analysis and interpretation.

Reference Book:

1. Lehninger Principles of Biochemistry – Nelson & Cox
2. Environmental Biochemistry – Satyanarayana & Chakrapani
3. Biochemistry – Voet & Voet
4. Environmental Biochemistry – Satyanarayana & Chakrapani
5. Biochemistry and Molecular Biology of Plants – Buchanan et al.
6. Principles of Environmental Biochemistry – Malhotra & Kumar
7. Environmental Chemistry- Balram Pani
8. Environmental Chemistry- A.K. De

Course Syllabus

Semester - V

.5.1 Major (Core)

Course Title	**Waste Water Management**
Course Credits	4
Course Outcomes	After going through the course, learners will be able to
	1. Understand the sources, characteristics, and impacts of wastewater on human health and the environment.
	2. Explain the principles and processes of wastewater treatment, including primary, secondary, and tertiary treatments.
	3. Evaluate wastewater reuse and recycling options for sustainable water management.
	4. Understand environmental regulations and best practices related to wastewater management.
Module 1 (Credit 1) - Introduction to Wastewater Management	
Learning Outcomes	After learning the module, learners will be able to,
	1. Define wastewater management and explain its importance in environmental protection.
	2. Describe the physical, chemical, and biological characteristics of wastewater.
Content Outline	• Definition and importance of wastewater management • Sources and classification of wastewater: domestic, industrial, agricultural • Characteristics of wastewater: physical, chemical, and biological • Environmental and health impacts of untreated wastewater • Wastewater generation trends and need for treatment and reuse

Module 2 (Credit 1) – Preliminary & Primary Treatment	
Learning Outcomes	After learning the module, learners will be able to,
	1. Explain the purpose of preliminary and primary treatment in wastewater treatment plants.
	2. Understand the removal of suspended solids and organic matter in primary treatment.
Content Outline	• Wastewater Treatment: Sources of Wastewater, Objectives of Treatment. • Preliminary Treatment: Selection and Applications of Screens, Grit Chambers, Primary Treatment- Sedimentation. • Primary Treatment: Plane Sedimentation with Coagulation, Filtration & Disinfection Methods.
Module 3 (Credit 1) –Secondary & Tertiary Treatment	
Learning Outcomes	After learning the module, learners will be able to,
	1. Explain the principles of biological wastewater treatment.
	2. Describe secondary treatment methods such as activated sludge process, trickling filters, and oxidation ponds.
Content Outline	• Secondary Treatment (Biological Methods): Activated Sludge Process, Oxidation Pond & Trickling Filter and Up-flow Anaerobic Sludge Blanket Reactor. • Tertiary Treatment: Adsorption, Ion Exchange, Electrolysis, Reverse Osmosis & Treatment with Activated Carbon. • Sludge Handling Treatment and Disposal: Composition & Characteristics of Sludge, Need for Disposal, Operation & Maintenance of Wastewater Treatment Plant.
Module 4 (Credit 1) – Wastewater Reuse, Regulations, and Sustainable Practices	
Learning Outcomes	After learning the module, learners will be able to,
	1. Explain the concept and importance of wastewater reuse and recycling.
	2. Understand wastewater quality standards and discharge regulations.

Content Outline	• Wastewater recycling and reuse in agriculture, industry, and urban areas • Treated wastewater standards and guidelines • Environmental laws and regulations related to wastewater management • Decentralized wastewater treatment systems • Sustainable and eco-friendly wastewater management practices

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

Module 1 – Introduction to Wastewater Management

Project 1: Identification and Classification of Wastewater Sources

Description: Students will explore: Different sources and types of wastewaters in their local area. Activity Description: Students conduct a field or neighbourhood survey to identify sources of wastewater such as domestic sewage, commercial effluents, and small-scale industrial discharge. They classify wastewater based on origin and prepare a short report or chart showing sources, characteristics, and possible environmental impacts. Learning Focus: Wastewater sources, classification, observation skills, environmental awareness.

Module 2 – Preliminary & Primary Treatment

Project 1: Study of Screening and Grit Removal Processes

Description: Students will explore: The purpose and functioning of preliminary treatment units in wastewater treatment. Activity Description: Students visit a wastewater treatment plant (WWTP) or use videos/diagrams to screens, grit chambers, and skimming tanks. They prepare a labeled flow diagram and a short report explaining how each unit removes large solids, grit, and floating matter. Learning Focus: Preliminary treatment processes, process understanding, diagrammatic representation.

Module 3 – Secondary & Tertiary Treatment

Project 1: Comparative Study of Aerobic and Anaerobic Secondary Treatment

Description: Students will explore: Biological processes used to remove organic matter in secondary treatment. Activity Description: Students study activated sludge process, trickling filters, oxidation ponds, and anaerobic digesters using diag rams, videos, or plant visit reports. They prepare a comparison chart highlighting working principle, microorganisms involved, efficiency, energy requirement, and applications. Learning Focus: Secondary treatment principles, microbial role, comparative analysis.

Module 4 – Wastewater Reuse, Regulations, and Sustainable Practices

Project 1: Assessment of Treated Wastewater Reuse Practices

Description: Students will explore: Real-world applications of wastewater reuse and recycling. Activity Description: Students study a local or documented case of treated wastewater reuse (agriculture, landscaping, industrial cooling, or urban reuse). They analyze treatment level, reuse purpose, benefits, and challenges, and present findings as a short report or presentation. Learning Focus: Wastewater reuse, sustainability concepts, analytical and presentation skills.

Reference Book:

1. A Text book of Sanitary Engineering: Vinayak Gharpure, Engineering Book Publishing Company, Pune
2. Water Pollution : V. P. Kudesia, Pragati Prakashan, Meerut
3. Environmental Chemistry : B. K. Sharma, Goel Publishing House, Meerut
4. Environmental Chemistry : A. K. De,Wiley eastern limited, New Delhi
5. Water Supply & Sanitary Engineering: G.S. Birdie
6. Textbook of Water Supply & Sanitary Engineering: S.K. Husain
7. Water supply and sanitary engineering : R. C. rangwala and S. C. rangwala, Charotal publishing house, Anand
8. Water and Wastewater Technology by Mark J. Hammer, Prentice Hall of India Pvt. Ltd., New Delhi, 1998
9. Water Treatment Technologies and Environment by S.N. Kaul, Lidia Szpyrkowicz & Arvind Kumar, Dyaya Publishing House Delhi, 2004.
10. Introduction to Environmental Engineering: Mackenzie L. Davis & David A. Cornwell, McGraw Hill Publishing Company, New Delhi.
11. Basic Water Treatment: George Smethurst, Scientific Publishers, Jodhpur.
12. Chemical And Biological Methods For Water Pollution Studies: R. K. Trivedy, P. K. Goel, Environmental Publication, Karad.
13. Water Pollution and disposal of Waste water on Land : U. N. Mahida (Tata Mc-Grew Hill Publishing Company, New Delhi.
14. Waste water treatment for pollution control : Soli J. Arceivala (Tata Mc-Grew Hill Publishing Company, New Delhi)
15. Waste water treatment : M. N. Rao, A. K. Datta (Oxford and IBH publishing company, New Delhi)
16. Waste water Engineering: Metcalf and Eddy, TataMc-Grew Hill Publishing Company, NewDelhi
17. Wastewater Treatment: M. N. Rao, A. K. Datta, IBH Publishing Company, New Delhi.
18. Elements of Environment Engineering: K.L. Duggal, S. Chand and Company Ltd.
19. A Technical Manual for Water and Wastewater Analysis: Sunil Pande and Leeana Deshpande,Himalaya Publishing House.
20. Environmental Engineering, Water supply, sanitary engineering and pollution A Kamala, D L Kanth Rao, Tata Mc-Grew Hill Publishing Company, New Delhi

Semester - V

.5.2 Major (Core)

Course Title	**Engineering Aspects of Pollution Control**
Course Credits	4
Course Outcomes	After going through the course, learners will be able to
	1. Understand the nature, sources, and characteristics of air, water, soil, and noise pollution from an engineering perspective.
	2. Analyze the efficiency and applicability of various pollution control devices and treatment processes for industrial and municipal wastes.
	3. Explain the principles and working mechanisms of engineering technologies used for air and water pollution control.
	4. Evaluate environmental impacts of industrial processes and select appropriate pollution control technologies based on economic and environmental feasibility.
Module 1 (Credit 1) - Atmospheric Pollution Control Technologies	
Learning Outcomes	After learning the module, learners will be able to,
	1. Identify major air pollutants and their industrial and vehicular sources.
	2. Select appropriate air pollution control equipment for specific emission sources.
Content Outline	• Methods to control air pollution in the environment, Limestone injection, Desulfurization; Catalytic converter and control of vehicular emission, Gravity settling chamber, Centrifugal collectors- cyclone collector and dynamic precipitators; Electrostatic precipitators; Fabric filters. Adsorption, absorption, condensation, combustion, Flue gas desulfurization (FGD) and NOx removal.
Module 2 (Credit 1)- Pesticide Pollution Control	
Learning Outcomes	After learning the module, learners will be able to,
	1. Analyze the environmental and health impacts of pesticide residues.

	2. Evaluate sustainable alternatives to conventional pesticides.
Content Outline	• Pesticide Pollution Control: Chemical and biological methods to degrade pesticides, Bio-pesticide: biological pest control agents. Plant products: Insecticide, neem pesticides, unique multifactor action of neem-bitters. • Pesticide Pollution Control Technologies: Conventional method: incineration and thermal desorption, soil flushing and washing, phytoremediation and bioremediation, land farming, Reclamation of degraded lands. Latest researches in soil and pesticide Pollution control.
Module 3 (Credit 1) – Water Pollution Control Methods	
Learning Outcomes	After learning the module, learners will be able to,
	1. Analyze treatment efficiency for domestic and industrial wastewater.
	2. Apply suitable water pollution control methods for different types of contaminants.
Content Outline	• Sewage and waste water treatments systems, Measurement of treatment efficiencies; Biological treatments aerobic versus anaerobic treatments; Environmental pollution control-Bioremediation, Bioaugmentation and Biostimulation; Biofilms in treatment of waste water; Bioreactors for waste water treatments; Reactors, types and design; Reactors in series; Development and optimization of membrane bioreactor process for use in sanitary and industrial sewage treatment. • Prevention of water pollution, Impurities in water, suspended and dissolved, Principle of sedimentation, coagulation, filtration and disinfection. Ballast water management.
Module 4 (Credit 1) – Noise and Radiation Pollution Control Method	
Learning Outcomes	After learning the module, learners will be able to,
	1. Differentiate between source, path, and receiver-based noise control measures.
	2. Apply noise control strategies in industrial, traffic, and residential environments.
Content Outline	• Noise control at source; receiver end and along the sound path, Noise barriers, mufflers or silencers, vibration isolation,

	damping, lagging, protection of the personal- ear plugs, ear muffs, helmets; acoustic absorptive material, Methods of reducing highway noise. • Preventive measures from radiation, Control of occupation radiation, Minimizing X-ray hazards. Disposal methods: dilution and dispersal, other recent methods for disposal of critically dangerous radioactive wastes.

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

Module 1 – Atmospheric Pollution Control Technologies

Project 1: Comparative Analysis of Particulate Air Pollution Control Devices

Description: Students will explore: Engineering principles and performance of particulate control technologies. Activity Description: Students study settling chambers, cyclone separators, fabric filters (bag filters), and electrostatic precipitators using diagrams, videos, or industrial case studies. They prepare a comparison table highlighting working principle, particle size removal efficiency, advantages, limitations, and applications. Learning Focus: Particulate pollution control, engineering design concepts, analytical comparison.

Module 2 – Pesticide Pollution Control

Project 1: Assessment of Pesticide Use and Environmental Risk

Description: Students will explore: Patterns of pesticide usage and associated pollution risks. Activity Description: Students conduct a field survey or secondary-data study on commonly used pesticides in agricultural areas. They identify types of pesticides, application methods, persistence, and environmental pathways and assess their potential impacts on soil, water, non-target organisms, and human health. Findings are presented in a report or chart. Learning Focus: Pesticide pollution sources, environmental pathways, risk assessment.

Module 3 – Water Pollution Control Methods

Project 1: Evaluation of Water Pollution Control Measures in a Local Water Body

Description: Practical implementation of water pollution control strategies. Activity Description: Students select a local river, lake, or pond and analyze sources of pollution and existing control measures (sewage treatment, effluent control, regulatory actions). They propose improvement strategies and present findings in a report or poster. Learning Focus: Applied pollution control, environmental assessment, problem-solving skills.

Module 4 – Noise and Radiation Pollution Control Method

Project 1: Monitoring and Control of Environmental Noise Levels

Description: Students will explore: Sources, intensity, and control of noise pollution. Activity Description: Students measure noise levels (dB) in different locations (traffic area, residential area, silent zone) using a sound level meter or mobile app. They compare observed values with permissible standards and suggest noise control measures such as

barriers, zoning, and green belts. Learning Focus: Noise monitoring, standards, control strategies, data interpretation.

Reference Book:

1. Environmental Management- Dr. Anand S. Bal, Himalaya Publication, 2009.
2. Non-Conventional Energy Sources- G. D. Rai, Khanna Publishers, Delhi.
3. M.H.Fulekar (2005) Environemtal Biotechnology Oxford IBH Publishing cooperation.
4. M.H.Fulekar (2010) Bioremediation technology recent advances, springer
5. Environmental Engineering- Gerard Kiely, The McGraw-Hill Company
6. Environmental Science and Engineering- J Glynn Henry and G W Heinke, PHI Learning Private Limited
7. Air Pollution- M.N. Rao, Tata McGraw Hill Publishing Company Limited, New Delhi, 2003
8. Environmental Science- S. C. Santra, New Central Book Agency Pvt. Ltd., 2006.
9. 24. Fundamental Concepts of Environmental Chemistry- G. S. Sodhi, Narosa Publishing House, New Delhi, 2002
10. 25. A Textbook of Environmental Science- R.N. Trivedi, Anmol Publications Private Limited, 1997.
11. N.P Cheremisinoff (1996) Biotechnology for Waste and Wastewater Treatment, William AndrewPublishing,New York.
12. Bru ce Rittman, Perry L. McCarty, Environmental Biotechnology: Principles and Applications,2nd edition, McGraw-Hill, 2000.
13. Raina M. Maier, Ian L. Pepper, Charles P. Gerba. Environmental Microbiology, Academic Press, 2000.
14. Gabriel Bitton, Wastewater Microbiology, 2nd Edition. Wiley-Liss; 2nd Edition, 1999.

Semester - V

.5.3 Indian Knowledge Systems (IKS)

Course Title	**Indian Knowledge Systems: Environmental Perspectives**
Course Credits	2
Course Outcomes	After going through the course, learners will be able to,
	1. Understand the concept, scope, and significance of Indian Knowledge Systems (IKS) in environmental studies.
	2. Identify indigenous environmental management practices related to water, soil, agriculture, and biodiversity.
	3. Analyze the relevance of traditional knowledge in addressing modern environmental challenges.
	4. Integrate Indian traditional wisdom with modern environmental science for sustainable development.
Module 1 (Credit 1) – Indian Traditional Knowledge and Environment	
Learning Outcomes	After learning the module, learners will be able to,
	1. Define Indian Knowledge Systems and explain their environmental relevance and describe the environmental concepts found in Vedas, Upanishads, Bhagavad Gita, and Puranas.
	2. Explain the concept of Panchamahabhutas and its ecological significance and understand environmental ethics and sustainability in Indian traditions.
Content Outline	• Concept and scope of Indian Knowledge System (IKS) Environmental ethics in ancient India • Relationship between nature, society, and culture in Indian philosophy • Environmental concepts in Vedas, Upanishads, Bhagavad Gita, and Puranas • Panchamahabhutas (Earth, Water, Fire, Air, Space) and their environmental significance • Traditional practices for biodiversity conservation (sacred groves, temple forests, community protection)

	• Indigenous knowledge related to soil, water, forests, and agriculture
Module 2 (Credit 1)- Traditional Environmental Management Practices in India	
Learning Outcomes	After learning the module, learners will be able to,
	1. Describe indigenous water conservation systems practiced in different regions of India and explain traditional soil management and sustainable agricultural practices.
	2. Identify community-based biodiversity conservation practices, such as sacred groves and evaluate the practical relevance of traditional environmental practices in achieving sustainability today.
Content Outline	• Ancient water management systems: tanks, stepwells, baolis, johads, ahars, eris • Traditional soil conservation and farming practices (crop rotation, mixed cropping, organic manures) • Indigenous methods of waste management and recycling • Use of medicinal plants and ethnobotanical knowledge • Traditional approaches to climate resilience and disaster management • Relevance of Indian traditional knowledge for sustainable development and environmental conservation

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

Module 1 – Indian Traditional Knowledge and Environment

Project 1: Documentation of Indigenous Environmental Practices

Description: Students will explore: Living examples of traditional environmental knowledge. Activity Description: Students interact with local elders, farmers, or community members to document traditional practices related to water conservation, agriculture, tree protection, or biodiversity. Findings are compiled as a report with photographs or charts, linking traditional knowledge with environmental conservation.

Learning Focus: Indigenous knowledge systems, field-based learning, community engagement.

Module 2 – Traditional Environmental Management Practices in India

Project1: Exploration of Sacred Groves and Traditional Soil Conservation Methods

Description: Students will explore: Community-led environmental conservation practices. Activity Description: Students study sacred groves, traditional farming methods, crop rotation, organic manuring, and natural pest control through local case studies or literature. They analyze how these practices contribute to biodiversity conservation, soil health, and ecological balance, and present findings in a report or poster. Learning Focus: Indigenous conservation practices, biodiversity protection, sustainable land management.

Reference Book:

1. D. P. Chattopadhyaya – *History of Science and Technology in Ancient India*
2. Kapila Vatsyayan (Ed.) – *Indian Knowledge Systems*
3. Radhakrishnan, S. – *Indian Philosophy*
4. M. Gadgil & R. Guha – *This Fissured Land: An Ecological History of India*
5. C. K. Chopra & P. K. Dasgupta – *Sustainable Development: Indian Perspectives*
6. NCERT – *Environmental Studies* (Selected Chapters)

Semester - V

.5.4 Minor Stream

Course Title	**Global Climate Change: Science and Impacts**
Course Credits	4
Course Outcomes	After going through the course, learners will be able to
	1. Explain the scientific basis of global climate change and distinguish it from natural climate variability.
	2. Interpret scientific evidence and assessment methods used to study and monitor climate change.
	3. Understand international climate governance, policies, and global responses to climate change challenges.
	4. Evaluate the environmental, social, economic, and ecological impacts of climate change at local, regional, and global levels.
Module 1 (Credit 1) - Global warming and climate change	
Learning Outcomes	After learning the module, learners will be able to,
	1. Define global warming and climate change and explain their interrelationship and identify major greenhouse gases and their sources.
	2. Explain the greenhouse effect and feedback mechanisms and distinguish between natural and anthropogenic climate drivers.
Content Outline	• Climate Change: Definition, scope and facts of climate change. Trends of global warming and climate change; drivers of global warming and Global Warming, Potential (GWP) & climate change; impact of climate change on atmosphere, weather patterns, sea level rise, agricultural productivity and biological responses - range shift of species, CO2 fertilization and agriculture; impact on economy and spread of human diseases. El-Nino, La Nina and their impacts.
Module 2 (Credit 1)- Evidence and Assessment of Climate Change	
Learning Outcomes	After learning the module, learners will be able to,
	1. Describe instrumental, historical, and proxy climate data and interpret trends in temperature, sea level rise, and cryosphere

	change.
	2. Explain climate modelling and scenario development and understand the role of IPCC and scientific assessment reports.
Content Outline	• Observed changes in global and regional climate, Temperature trends and heat waves, Melting of glaciers, ice caps, and polar ice sheets, Sea-level rise and ocean warming, Climate change indicators and monitoring techniques, Climate models and future climate projections (overview), Role of IPCC in climate assessment
Module 3 (Credit 1) –Impacts of Climate Change	
Learning Outcomes	After learning the module, learners will be able to,
	1. Assess impacts on ecosystems, biodiversity, and natural resources and explain effects on agriculture, water resources, and food security.
	2. Analyze climate-related risks to human health and livelihoods and understand regional and sector-specific climate vulnerabilities.
Content Outline	• Impacts on ecosystems and biodiversity, Effects on agriculture, food security, and fisheries, Climate change and water resources, Human health impacts, Climate extremes: floods, droughts, cyclones, and wildfires, Socio-economic impacts and climate vulnerability
Module 4 (Credit 1) – Mitigation, Adaptation, and Global Response	
Learning Outcomes	After learning the module, learners will be able to,
	1. Understand the role of sustainable practices, technology, and community participation in addressing climate change
	2. Evaluate national and international climate policies and agreements
Content Outline	• Climate change mitigation strategies, Renewable energy and low-carbon technologies, Climate change adaptation strategies, Climate policies and international agreements (UNFCCC, Kyoto Protocol, Paris Agreement, Montreal protocol), Sustainable development and climate resilience, Environmental policy debate; Convention on Climate Change; carbon credit and carbon trading; clean development mechanism, Agenda 21 United The United Nations Conference on Environment and Development, Intergovernmental Panel on Climate Change (IPCC), Ministry of Environment, Forests & Climate Change

	(MoEF&CC), National Action Plan on Climate Change (NAPCC)

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

Module 1 – Global warming and climate change

Project 1: Carbon Footprint Assessment and Reduction Plan

Description: Students will calculate their personal or household carbon footprint using standard parameters such as electricity use, transport, cooking fuel, and lifestyle habits. Based on the results, they will design a realistic carbon reduction plan. Students will explore: Sources of greenhouse gas emissions, Relationship between human activities and global warming and Practical mitigation strategies at individual and community levels. Expected Outcome: Awareness of personal contribution to climate change, Ability to suggest actionable steps for emission reduction.

Module 2 – Evidence and Assessment of Climate Change

Project 1: Analysis of Climate Change Indicators

Description: Students will explore key climate change indicators such as global temperature rise, atmospheric CO_2 concentration, melting of glaciers, sea-level rise, and changing precipitation patterns using secondary data from scientific reports. Students will explore: Instrumental and proxy evidence of climate change, Long-term climate datasets and trend analysis and reliability of different climate indicators. Expected Outcome: Ability to interpret scientific evidence, Understanding of how climate change is assessed using multiple indicators.

Module 3 – Impacts of Climate Change

Project 1: Sector-wise Impact Assessment of Climate Change

Description: Students will explore the impacts of climate change on different sectors such as agriculture, water resources, health, biodiversity, coastal systems, and livelihoods using case studies and published reports. Students will explore: Climate change impacts at global, national, and local levels, Sector-specific vulnerabilities and risks and Interlinkages between climate, environment, and society. Expected Outcome: Understanding of how climate change affects multiple sectors, Ability to assess vulnerability and potential consequences

Module 4 – Mitigation, Adaptation, and Global Response

Project 1: Climate Change Mitigation Strategies Mapping

Description: Students will explore: Different mitigation measures adopted at local, national, and global levels to reduce greenhouse gas emissions. Activity Description: Students identify and analyze mitigation strategies such as renewable energy adoption, energy efficiency, afforestation, sustainable transport, carbon sequestration, and green technologies. They prepare a concept map or comparative chart highlighting emission reduction potential and co-benefits. Learning Focus: Understanding mitigation pathways, policy linkages, and technological solutions.

Reference Book:

1. Abhishek Tiwary and Jerem Colls. (2010). Air Pollution: Measurement, Modelling and Mitigation. III Edition, Routledge Publication.
2. Agarwal K.M, Sikdar P.K. and Deb S.C. (2002). A text book of Environment – MacMiller India Ltd., Calcutta
3. Climate Change: Science and Politics. (2021). Centre Science and Environment, New Delhi.
4. Donald Ahrens.C. (2008). Essentials of Meteorology: An Invitation to the Atmosphere. Cengage Learning publication.
5. Howard J. Critchfield. (1983). General Climatology (Fourth Edition), Phi Learning Pvt Ltd.
6. IPCC. (2006). Guidelines for National Greenhouse gas Inventories. Published by the Institute for Global Environmental Strategies (IGES), Hayama, Japan on behalf of the IPCC.
7. John E. Oliver, John J. Hidore. (2002). Climatology: An Atmospheric Science, Second Edition. Prentice Hall publication.
8. John T. Hardy. (2003). Climate Change: Causes, Effects and Solution. John Wiley & Sons publications.
9. Mann, M. E. (2021). The New Climate War: the fight to take back our planet. Hachette UK.
10. Nicholas Stern. (2008). The Economics of Climate Change: The Stern Review. Cambridge University Press. Great Britain.
11. Rajit Sengupta and Kiran Pandey. (2021). State of India's Environment 2021: In Figures. Centre Science and Environment, New Delhi.
12. Roger G. Barry and Richard J. Chorley. (2007). Atmosphere, weather and Climate, 8th Edition, Routledge Publishers.
13. Romm, J. (2018). Climate Change: What Everyone Needs to Know®. Oxford University Press.
14. IPCC – *Climate Change: Synthesis Report*
15. Houghton, J. T. – *Global Warming: The Complete Briefing*
16. Trenberth, K. E. – *Climate System Modeling*
17. Lal, D. S. & Lal, A. K. – *Climate Change and Environmental Issues*
18. Daniel A. Vallero – *Fundamentals of Environmental Science*
19. NCERT – *Environmental Studies* and *Geography* (Selected Chapters)
20. Hardy, J.T. 2003. *Climate Change: Causes, Effects and Solutions*. John Wiley & Sons.
21. Harvey, D. 2000. *Climate and Global Climate Change*. Prentice Hall.
22. Barry, R. G. 2003. *Atmosphere, Weather and Climate*. Routledge Press, UK. 15
23. Gillespie, A. 2006. *Climate Change, Ozone Depletion and Air Pollution: Legal Commentaries with Policy and Science Considerations*. Martinus Nijhoff Publishers.
24. Manahan, S.E. 2010. *Environmental Chemistry*. CRC Press, Taylor and Francis Group.
25. Maslin, M. 2014. *Climate Change: A Very Short Introduction*. Oxford Publications. *Future*. Columbia University Press.
26. Mitra, A.P., Sharma, S., Bhattacharya, S., Garg, A., Devotta, S. &Sen, K. 2004. *Climate Change and India*. Universities Press, India.
27. Philander, S.G. 2012. *Encyclopaedia of Global Warming and Climate Cha*nge (2nd edition). Sage Publications.

Semester - V

.5.5 Minor Stream

Course Title	**Elements of Green Chemistry**
Course Credits	4
Course Outcomes	After going through the course, learners will be able to
	1. Explain the principles, goals, and significance of green chemistry in sustainable development.
	2. Apply green chemical processes and technologies to minimize waste, energy use, and toxicity.
	3. Promote sustainable practices in chemical research, manufacturing, and environmental management.
	4. Evaluate the role of green chemistry in pollution prevention and environmental protection.
Module 1 (Credit 1) - Introduction to Green Chemistry	
Learning Outcomes	After learning the module, learners will be able to,
	1. Define green chemistry and explain its evolution and objectives and describe the 12 principles of green chemistry
	2. Understand the role of green chemistry in sustainability and circular economy
Content Outline	• Definition, scope, and need of Green Chemistry, Tools of green chemistry, Evolution of Green Chemistry and sustainability concepts, Twelve principles of Green Chemistry, Green chemistry vs conventional, Role of Green Chemistry in pollution prevention, Relationship between Green Chemistry and sustainable development
Module 2 (Credit 1)- Green Chemical Processes and Technologies	
Learning Outcomes	After learning the module, learners will be able to,
	1. Explain clean and energy-efficient chemical processes and describe alternative solvents, catalysts, and reaction conditions.

	2. Evaluate green technologies such as microwave, photochemical, and biocatalytic processes.
Content Outline	• Atom economy and reaction efficiency, Green solvents: water, supercritical fluids, ionic liquids, Alternative reaction conditions: microwave, ultrasonic, photochemical methods, Catalysis in Green Chemistry: homogeneous, heterogeneous, and biocatalysts, Energy-efficient and low-waste chemical processes
Module 3 (Credit 1) – Green Synthesis and Industrial Applications	
Learning Outcomes	After learning the module, learners will be able to,
	1. Identify industrial applications of green chemistry in pharmaceuticals, agrochemicals.
	2. Explain green synthesis methods for organic and inorganic compounds
Content Outline	• Catalytic methods in green synthesis, Green synthesis of organic and inorganic compounds, Use of renewable feedstocks and biomass, Green polymer chemistry and biodegradable materials, Case studies of green industrial processes, Green chemistry in pharmaceutical, agrochemical, and fine chemical industries
Module 4 (Credit 1) – Green Chemistry for Environmental Protection	
Learning Outcomes	After learning the module, learners will be able to,
	1. Understand the role of green chemistry in air, water, and soil protection
	2. Appreciate green chemistry's contribution to environmental safety and regulatory compliance
Content Outline	• Green chemistry approaches to air, water, and soil pollution control, Design of safer chemicals and products, Waste minimization and recycling • Life cycle assessment (LCA) and eco-labeling, Role of Green Chemistry in climate change mitigation and circular economy, fuel cell and electric vehicles, solar energy and hydrogen production, energy from alternate sources; Biofuel production (bio-ethanol and biodiesel), concept of green building, Pollution free engineering processes.

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

Module 1 – Introduction to Green Chemistry

Project 1: Exploring the 12 Principles of Green Chemistry

Description: Students will explore: The 12 principles of Green Chemistry and their relevance to sustainable chemical practices. Activity Description: Students select any four principles of green chemistry and explain them using real-life examples from laboratories, households, or industries (e.g., safer solvents, waste prevention, energy efficiency). The findings may be presented as a chart, poster, or short write-up. Expected Learning Outcome: Understanding core concepts of green chemistry, Ability to relate theory with practical applications.

Module 2 – Green Chemical Processes and Technologies

Project 1: Case Study on Green Chemical Technologies

Description: Students will explore: Modern green chemical processes and technologies used in chemical and allied industries. Activity Description: Students select one green technology (such as biocatalysis, microwave-assisted synthesis, supercritical CO_2 extraction, or solvent-free reactions) and prepare a short case study covering: Process description, Advantages over conventional methods and Environmental and economic benefits. Expected Learning Outcome: Understanding of emerging green technologies, Ability to analyze sustainable industrial practices

Module 3 – Green Synthesis and Industrial Applications

Project 1: Case Study of Green Synthesis in Chemical Industries

Description: Students will explore: Real-world applications of green synthesis in industries. Activity Description: Students select an industrial example (pharmaceuticals, polymers, dyes, agrochemicals, or bio-based chemicals) and study: Green synthesis route used, Replacement of hazardous reagents and solvents, Role of catalysts or renewable feedstocks, Reduction in waste and energy consumption. The findings are presented as a short report or presentation. Learning Focus: Industrial applications of green synthesis, sustainability evaluation

Module 4 – Green Chemistry for Environmental Protection

Project 1: Application of Green Chemistry in Pollution Prevention

Description: Students will explore: How green chemistry principles help prevent air, water, and soil pollution. Activity Description: Students identify common pollutants from industries, agriculture, or households and explore green chemistry–based alternatives such as safer chemicals, biodegradable materials, green solvents, and catalytic processes. Findings are presented as a case study or comparative chart. Learning Focus: Pollution prevention, eco-friendly chemical alternatives, environmental protection.

Reference Books:

1. Balram Pani- Textbook of Environmental Chemistry
2. M. H. Fulekar (2010) Nanotechnology Importance and applications, I K international publishing house Pvt.Ltd.

3. Lynn Goldman, Christine Coussens, Implications of nanotechnology for environmental health research, National Academic Press, Washington, 2007
4. Matlack, A. S. Introduction to Green Chemistry. Marcel Dekker: New York, 2001
5. Anastas, P. T.; Warner, J. C. Green Chemistry: Theory and Practice. Oxford Univ. Press:Oxford,1998.
6. Lynn E. Foster: Nanotechnology: Science, Innovation, and Opportunity, December 21, 2005, Prentice Hall
7. Fei Wang & Akhlesh Lakhtakia (eds) (2006). Selected Papers on Nanotechnology—Theory & Modeling (Milestone Volume 182). SPIE Press
8. Caye Drapcho, Nhuan Phú Nghiêm, Terry Walker (2008). Biofuels Engineering Process Technology. [McGraw-Hill].
9. Akhlesh Lakhtakia (ed) (2004). The Handbook of Nanotechnology. Nanometer Structures: Theory, Modeling, and Simulation. SPIE Press, Bellingham, WA, USA
10. Anastas, P. T. & Warner, J. C. – *Green Chemistry: Theory and Practice*
11. Clark, J. & Macquarrie, D. – *Handbook of Green Chemistry and Technology*
12. Matlack, A. S. – *Introduction to Green Chemistry*
13. Lancaster, M. – *Green Chemistry: An Introductory Text*
14. Ahluwalia, V. K. & Kidwai, M. – *New Trends in Green Chemistry*
15. NCERT – *Chemistry* and *Environmental Studies* (Selected Units)

Semester - V

.5.6 Vocational Skill Courses (VSC-4)

Course Title	**Monitoring and Analysis of Environmental Component (Pr)**
Course Credits	2
Course Outcomes	After going through the course, learners will be able to,
	1. Identify and apply standard methods for monitoring air, water, soil, and noise quality.
	2. Perform sampling, measurement, and analysis of key environmental parameters using laboratory and field instruments.
	3. Interpret environmental monitoring data by comparing results with national and international standards (CPCB, WHO, IS).
	4. Develop practical skills related to environmental assessment, quality control, and pollution management.
Module 1 (Credit 1) –Air Quality Monitoring and Noise Pollution Monitoring	
Learning Outcomes	After learning the module, learners will be able to,
	1. Use air sampling devices and sound level meters effectively and monitor and assess environmental noise levels in different zones.
	2. Compare observed values with CPCB ambient air and noise standards and interpret the impact of air and noise pollution on human health and environment.
Content Outline	• Sampling and estimation of particulate matter. • Determination of Sulphation rate by Lead Peroxide method • Determination of Settlable particles using dust fall jar apparatus. • Construction and interpretation of wind roses and pollution roses. • Determination of Air Quality Index. • Determination of noise level in different areas viz: residential, commercial, industrial and silence zone and comparison with ambient standard.
Module 2 (Credit 1)-Water and Soil Quality Analysis	
Learning Outcomes	After learning the module, learners will be able to,
	1. Analyze physico-chemical parameters of water such as pH, DO, BOD, COD, hardness, and alkalinity and Perform soil

	analysis for pH, moisture content, organic carbon, and nutrients.
	2. Interpret water and soil quality data using permissible limits and indices and assess environmental quality and suggest suitable pollution control measures.
Content Outline	• Examination of water quality with respect to following physical parameter, Colour, Temperature, Turbidity, Conductivity, Density, Viscosity and TDS • Examination of water quality with respect to following chemical parameter: Acidity, Alkalinity, Hardness, Chlorides, DO, Sulphate, Nitrate • Soil Sampling in agriculture field and wasteland by quartering method. Analysis of organic forming soil for calculating following physical parameter. Moisture, Bulk Density, Water holding capacity, Conductivity • Analysis of organic forming of soil for chemical parameter. Acidity, Alkalinity, Chlorides, Hardness, Organic Carbon, Organic Matter • Analysis of Soil for nutrient such as: 1. Sulphate 2. Phosphate 3. Nitrate 4. Potassium 5. Calcium 6. Sodium

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

Project 1: Ambient Air Quality Assessment in Local Areas

Description: Students will monitor ambient air quality at selected locations (traffic area, residential area, campus). Key pollutants such as PM_{10}/$PM_{2.5}$, are recorded using air samplers, portable monitors, or secondary data. The data is analyzed and compared with CPCB ambient air quality standards to assess pollution levels. Learning Focus: Understanding air quality parameters, Application of air quality standards and data analysis and interpretation.

Project 2: Measurement of Environmental Noise Levels

Description: Students measure noise levels at different locations (silence zone, residential area, commercial area) using a sound level meter or calibrated mobile application. Measurements are taken during peak and non-peak hours and compared with CPCB noise standards. Learning Focus: Noise measurement techniques, Interpretation of noise standards and awareness of noise impacts.

Project 3: Assessment of Physico-Chemical Parameters of Water

Description: Students will collect water samples from different sources such as tap water, well water, river, or pond. Key parameters like pH, turbidity, total dissolved solids (TDS), alkalinity, hardness, chloride, and dissolved oxygen are analyzed using standard laboratory methods. The results are compared with BIS drinking water standards. Learning Focus: Water sampling techniques, Laboratory analysis of water quality parameters and interpretation using water quality standards

Project 4: Evaluation of Soil Physico-Chemical Characteristics

Description: Students collect soil samples from agricultural land, garden soil, and roadside areas. Parameters such as soil texture, pH, moisture content, organic carbon, electrical conductivity, and available nutrients (N, P, K) are determined using standard procedures. Learning Focus: Soil sampling and preparation, Laboratory analysis of soil properties and understanding soil fertility status.

Reference Books:

1. APHA (American Public Health Association, American water works Association and water pollution control federation)., Standard methods for the examination of water and waste water, Publication Health Association, washington, DC, USA.
2. Guidelines for Water Quality Monitoring,2007, CPCB, New Delhi,
3. ICMR (1975), Indian council of Medical Research Manual of standard of Quality of Drinking water supplies. 2nd Ed. Special Report series No. 44, New Delhi.
4. Sharma B.K., (2001), Water Pollution, Goal publishing house, Meerut.
5. Pandey S.K. Tiwari S., (2009), Physico- chemical analysis of ground water of selected area of Ghazipur city-A case study, Nature and science. Vol. 7(1), pp 17 – 20.
6. ICMR (1975), Indian council of Medical Research Manual of standard of Quality of Drinking water supplies. 2nd Ed. Special Report Series No. 44, New Delhi.
7. Reza. R. and Singh G., (2009), Physico- chemical Analysis of Ground water in Angul-Talcher region of Orissa, India, Journal of American Science, Vol.5(5), pp 53 - 58
8. Trivedy, R.K. & Goel, P.K. – *Chemical and Biological Methods for Water Pollution Studies*, Environmental Publications.
9. Peavy, H.S. & Rowland, D.R. – *Environmental Engineering*, McGraw-Hill.
10. Sawyer, C.N., McCarty, P.L., & Parkin, G.F. – *Chemistry for Environmental Engineering and Science*, McGraw-Hill.
11. CPCB Manuals – *Guidelines for Environmental Monitoring*, Central Pollution Control Board, India.

Semester - V

.5.7 Major (Core)

Course Title	**Watershed Management**
Course Credits	2
Course Outcomes	After going through the course, learners will be able to,
	1. Understand the concept, components, and importance of watersheds in water resource management.
	2. Explain watershed characteristics such as drainage patterns, runoff, infiltration, and land use.
	3. Analyze hydrological processes within a watershed, including rainfall–runoff relationships and groundwater recharge.
	4. Apply integrated watershed management approaches for ecological balance and community development.
Module 1 (Credit 1) – Introduction and Characteristics of Watershed	
Learning Outcomes	After learning the module, learners will be able to,
	1. Define a watershed and explain its significance in hydrology and environmental management.
	2. Describe the physical characteristics of watersheds, such as topography, slope, soil type, and drainage patterns.
Content Outline	• Concept of watershed development, objectives of watershed development, need for watershed development in India, Integrated and multi-disciplinary approach for watershed management. • Characteristics Of Watershed: Size, shape, physiography, slope, climate, drainage, land use, vegetation, geology and soils, hydrology and hydrogeology, socioeconomic characteristics, basic data on watersheds.
Module 2 (Credit 1)- Water Harvesting and Watershed Management	
Learning Outcomes	After learning the module, learners will be able to,
	1. Explain the concept of water harvesting and its importance in sustainable water resource management.
	2. Apply planning and monitoring techniques for designing water harvesting systems and watershed interventions.

Content Outline	• Rainwater Harvesting, catchment harvesting, harvesting structures, soil moisture conservation, check dams, artificial recharge, farm ponds, percolation tanks. • Planning of activities, people's participation, preparation of action plan, administrative requirements.

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

Module 1 – Introduction and Characteristics of Watershed

Project 1: Assessment of Land Use and Vegetation in a Watershed

Description: Students will explore: How land use and vegetation affect watershed characteristics and water availability. Activity Description: Students conduct a survey of land use types (agriculture, forest, built-up) and vegetation cover in a selected watershed area. They analyze how these factors influence runoff, infiltration, and soil erosion, and present their findings as a short report or chart.

Module 2 – Water Harvesting and Watershed Management

Project 1: Survey of Water Harvesting Systems

Description: Students will explore: Different water harvesting structures and their effectiveness in a local watershed or community area. Activity Description: Students visit (or use secondary data if field visit is not possible) local water harvesting structures such as check dams, percolation tanks, recharge pits, or contour bunds. They prepare a report describing structure type, design, function, and benefits, including its role in groundwater recharge and soil conservation. Learning Focus: Water harvesting techniques, groundwater recharge, soil and water conservation, practical observation.

Reference Book:

1. Watershed concepts & conservation, Watershed Management – K.L. Sharma
2. Watershed hydrology & engineering, Watershed Hydrology – Ponce & Hawkins
3. Soil conservation, Soil and Water Conservation Engineering – G. Singh & R.S. Sihag
4. Land use & GIS, Remote Sensing and GIS for Natural Resource Management – Rao
5. Watershed planning & assessment, Watershed Management: Principles, Methods and Case Studies – R. Lal & B.A. Stewart
6. Community & policy, Participatory Watershed Development – Oxford University Press

Course Syllabus

Semester - VI

.6.1 Major (Core)

Course Title	**Remote Sensing and GIS**
Course Credits	4
Course Outcomes	After going through the course, learners will be able to
	1. Explain the basic principles, concepts, and components of Remote Sensing and GIS.
	2. Apply Remote Sensing and GIS techniques to environmental studies and resource management.
	3. Interpret RS and GIS outputs for environmental monitoring, planning, and decision-making.
	4. Evaluate the role of Remote Sensing and GIS in sustainable environmental management.
Module 1 (Credit 1) – Fundamentals of Remote Sensing	
Learning Outcomes	After learning the module, learners will be able to,
	1. Describe electromagnetic radiation and its interaction with earth features.
	2. Identify different platforms and sensors used in remote sensing and explain various types of resolution in remote sensing.
Content Outline	• Introduction to Remote Sensing: definition, scope, and applications. Development of remote sensing. Emission of electromagnetic radiation (EMR) and its interaction with atmosphere and earth surface. Use of microwave for remote sensing. Principles of remote sensing. Types of remote sensing: passive and active. Platforms and sensors: ground, airborne, and satellite platforms. Resolution concepts: spatial, spectral, temporal, and radiometric
Module 2 (Credit 1)- Satellite Systems and Image Interpretation	
Learning Outcomes	After learning the module, learners will be able to,
	1. Describe Indian and international satellite systems and

	explain different types of sensors and scanners.
	2. Differentiate between visual and digital image interpretation and Interpret satellite imagery for basic environmental applications.
Content Outline	• Satellite systems: Indian (IRS) and international satellites. Types of sensors and scanners. Image interpretation elements: tone, texture, shape, size, pattern, shadow. Visual and digital image interpretation. Introduction to digital image processing. Digitisation procedure, image restoration. Spectra of environmental components: spectral characteristic of earth feature (vegetation, soils, reflectance of rocks, water). Applications of remote sensing in environmental studies.
Module 3 (Credit 1) – Fundamentals of Geographic Information Systems (GIS)	
Learning Outcomes	After learning the module, learners will be able to,
	1. Define GIS and explain its components and functions and differentiate between spatial and non-spatial data.
	2. Describe GIS data input, storage, and management techniques and perform basic GIS operations such as overlay, buffering, and querying.
Content Outline	• Introduction to GIS: definition, components, and functions, Objectives of GIS, Elements of GIS, Spatial and non-spatial data, Data models: raster and vector, GIS data input methods, Data storage, management, and database concepts, Basic GIS operations: overlay, buffering, and query GIS in environmental management.
Module 4 (Credit 1) – RS & GIS and Environmental Management	
Learning Outcomes	After learning the module, learners will be able to,
	1. Describe applications of RS and GIS in Environmental Impact Assessment and disaster management.
	2. Explain the importance of RS and GIS in climate change studies and environmental planning.
Content Outline	• GIS and Remote Sensing applications in: Land use and land cover analysis, Watershed and natural resource management, Environmental Impact Assessment (EIA), Disaster management, Urban and regional planning, Use of GIS in pollution monitoring forest cover, earthquake, landslide, nuclear, chemical and measuring wetland loss. and control,

	Role of GIS and Remote Sensing in climate change studies.

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

Module 1 – Fundamentals of Remote Sensing

Project 1: Identification of Remote Sensing Platforms and Sensors

Description: Students identify different remote sensing platforms (ground, airborne, satellite) and sensors using diagrams or images. A brief note on their functions and uses in environmental studies is prepared. Learning Outcome: Identifies remote sensing platforms and sensors and understands their roles. Evaluation Criteria: Correct identification, explanation, and neat presentation.

Module 2 – Satellite Systems and Image Interpretation

Project 1: Visual Interpretation of Satellite Images

Description: Students are provided with a satellite image and identify features using image interpretation elements such as tone, texture, shape, size, pattern, and shadow. A brief interpretation report is prepared. Learning Outcome: Applies image interpretation elements to identify environmental features. Evaluation Criteria: Correct identification of features, use of interpretation elements, and explanation.

Module 3 – Fundamentals of Geographic Information Systems (GIS)

Project 1: Basics and Components of GIS

Description: Students prepare a short-written assignment explaining the concept of GIS, its major components (hardware, software, data, people, and methods), and its importance in environmental studies. Learning Outcome: Understands basic GIS concepts and components. Evaluation Criteria: Concept clarity, correct explanation of components, and presentation.

Module 4 – RS & GIS and Environmental Management

Project 1: RS & GIS-Based Case Study Analysis

Description: Students study a simple case example (e.g., flood mapping, deforestation analysis, or urban expansion) using RS & GIS outputs (maps/images) and write a brief interpretation highlighting environmental implications. Learning Outcome: Applies RS & GIS concepts to analyze environmental management issues. Evaluation Criteria: Understanding of case study, interpretation of maps/images, and logical explanation.

Reference Books:

1. Lillesand & Keifer, (2011): Remote Sensing & Image Interpretation, John Wiley & Sons, ISBN: 9788126532230.
2. James B.Campbell, (2007): Introduction to Remote Sensing, Taylor & Francis, ISBN: 9780415416887.
3. J.R. Jensen, (2009): Remote Sensing of the Environment, Pearsons education Pub. ISBN: 9788131716809.
4. George Joseph, (2005): Fundamental of Remote Sensing, University Press, India, ISBN: 9788173715358.
5. Bruce Grubbs, (2005): Basic Essentials Using GPS, Falcon Press Publishing, ISBN: 9780762734214.
6. Jensen, J.R. (2006). ―Remote Sensing of the Environment – An Earth Resources Perspective‖, Pearson Education, Inc. (Singapore) Pvt. Ltd., Indian edition, Delhi.
7. Burroughs, Peter A. and Rachael McDonnell. Principles of Geographical Information Systems" Oxford University Press, New York.
8. Jensen, J.R. Introductory Digital Image Processing A remote sensing perspective. Prentice Hall Series in GIS, USA.
9. Lillesand, Thomas M. and Kiefer, Ralph, W. (2007). ―Remote Sensing and Image Interpretation‖, 4th Edition, John Wiley and Sons, New York
10. Chang, K.T. *Introduction to Geographic Information Systems*, McGraw-Hill
11. Campbell, J.B. & Wynne, R.H.*Introduction to Remote Sensing*, Guilford Press.

Semester - VI

.6.2 Field Project (FP)

Course Title	**Field Project**
Course Credits	**2 Credits**
Course Outcomes	After going through the course, learners will be able to
	1. Apply appropriate field survey methods and sampling techniques to collect baseline environmental data.
	2. Demonstrate teamwork, ethical field practices and community engagement skills.
	3. Analyze and interpret field data using basic analytical and graphical tools.
	4. Prepare comprehensive field project reports and communicate findings effectively through presentations.
Module 1 (Credit 1) – Field Survey, Problem Identification and Baseline Assessment	
Learning Outcomes	After learning the module, learners will be able to,
	1. Select an appropriate study area for an environmental field project and conduct reconnaissance surveys and identify key environmental issues.
	2. Collect baseline environmental data using field survey tools and simple sampling methods and record, organize and present field observations using tables, maps and photographs.
Content Outline	• Selection of field project area (village, ward, campus, lake, river stretch, forest patch, slum, industrial area). • Identification of local environmental issues: Water quality and availability, Solid and liquid waste management, Air and noise pollution, Soil degradation and biodiversity loss • Reconnaissance survey and site familiarization. • Community interaction and stakeholder consultation. • Collection of baseline environmental data: Water, soil or air quality (basic parameters), Waste generation and disposal

	practices, Land use and vegetation pattern • Use of field tools and techniques: Questionnaire and interviews, Observation and transect walk, Sampling methods (simple field sampling) • Data recording, tabulation and preliminary analysis.
Module 2 (Credit 1) - Field Project Implementation, Analysis and Reporting	
Learning Outcomes	After learning the module, learners will be able to,
	1. Design a field project methodology based on identified environmental problems and implement environmental interventions or awareness activities in the field.
	2. Analyze field data and evaluate the impact of the project and prepare structured field project reports and present results confidently.
Content Outline	• Design of field project methodology based on identified problem. • Implementation of small-scale environmental intervention: Awareness programme, Waste segregation initiative, Water conservation measures, Tree plantation or biodiversity documentation • Monitoring of project activities and community participation. • Data analysis and interpretation of field observations. • Impact assessment of field intervention (pre- and post-activity comparison). • Preparation of field project report: Introduction, methodology, results, discussion and conclusion, Maps, charts, photographs and annexures • Presentation and viva-voce based on field project.

Semester - VI

.6.3 Major (Elective)

Course Title	**Environmental Impact Assessment**
Course Credits	4
Course Outcomes	After going through the course, learners will be able to
	1. Explain the concepts, objectives, and importance of Environmental Impact Assessment.
	2. Identify and predict environmental impacts of developmental projects using standard EIA methodologies.
	3. Describe the EIA process, legal framework, and clearance procedures in India.
	4. Analyze real-world case studies to assess the effectiveness of EIA in environmental planning and sustainable development.
Module 1 (Credit 1) – Introduction to Environmental Impact Assessment	
Learning Outcomes	After learning the module, learners will be able to,
	1. Define Environmental Impact Assessment and explain its objectives and scope and describe the evolution and need of EIA.
	2. Explain the role of EIA in sustainable development and environmental protection.
Content Outline	• Introduction, salient features of EIA, Definition, objectives of Environmental Impact Assessment, Need and importance of EIA in environmental protection, EIA procedure (Initial Environmental examination IEE, Analytical Functions of EIA, (Scope of EIA, Identification of Impact, prediction, Impact evaluation & analysis). Role of EIA in sustainable development.
Module 2 (Credit 1)- EIA Methodologies and Impact Prediction	
Learning Outcomes	After learning the module, learners will be able to,
	1. Explain the concepts of screening and scoping of projects and collect and interpret baseline environmental data.

	2. Predict and evaluate potential environmental impacts of projects and understand the basic principles of environmental risk assessment.
Content Outline	• General criteria for the selection of EIA methodology (impact identification, impact measurement, impact interpretation and evaluation, impact communication), Screening and scoping of development projects, Baseline environmental data collection, EIA methodologies: Checklist method, Matrix method, Network method, Overlay method, Impact evaluation and significance analysis Introduction to risk assessment.
Module 3 (Credit 1) – Environmental Management Plan and Public Participation	
Learning Outcomes	After learning the module, learners will be able to,
	1. Explain the objectives and components of an Environmental Management Plan (EMP).
	2. Explain the role of NGOs, stakeholders, and local communities in environmental decision-making.
Content Outline	• Environmental Management Plan (EMP): objectives and components, Mitigation measures and environmental monitoring programs, Environmental audit and compliance monitoring, public participation in the EIA process, Role of NGOs, stakeholders, and local communities, Introduction to cost–benefit analysis.
Module 4 (Credit 1) – EIA Process in India and Case Studies	
Learning Outcomes	After learning the module, learners will be able to,
	1. Describe the stages of the EIA process in India and explain the environmental clearance process and EIA Notification in India.
	2. Analyze EIA case studies of industrial, mining, and infrastructure projects and evaluate the role of EIA in environmental planning and sustainable development.
Content Outline	• EIA process and procedural framework in India, EIA Notification and environmental clearance process, Post-project monitoring and follow-up, Case studies of EIA in: Industrial projects, Mining projects, Infrastructure projects (dams, highways, urban development), Role of EIA in environmental planning and management.

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

Module 1 – Introduction to Environmental Impact Assessment

Project 1: Identification of Environmental Impacts of a Development Project

Description: Students select a simple development project (road construction, dam, industrial unit, or urban development) and list possible environmental impacts on air, water, soil, biodiversity, and human health. Learning Outcome: Identifies potential environmental impacts of development activities. Evaluation Criteria: Identification of impacts, logical reasoning, and clarity of explanation.

Module 2 – EIA Methodologies and Impact Prediction

Project 1: Impact Prediction for a Proposed Project

Description: Students are given a hypothetical development project (e.g., industrial plant, highway, or mining activity) and asked to identify and predict possible environmental impacts using a simple checklist or matrix method. Learning Outcome: Applies EIA methodologies to predict environmental impacts. Evaluation Criteria: Identification of impacts, application of methodology, and logical interpretation.

Module 3 – Environmental Management Plan and Public Participation

Project 1: Components of an Environmental Management Plan (EMP)

Description: Students prepare a short assignment explaining the objectives and key components of an Environmental Management Plan (EMP), including mitigation measures, environmental monitoring, and compliance mechanisms. Learning Outcome: Understands the structure and importance of EMP in managing environmental impacts. Evaluation Criteria: Concept clarity, completeness of components, and presentation.

Module 4 – EIA Process in India and Case Studies

Project 1: Case Study Analysis of an EIA Project

Description: Students study a selected EIA case study (industrial, mining, dam, or infrastructure project) and identify the key environmental issues, mitigation measures, and outcomes of the EIA process. Learning Outcome: Analyzes real-world EIA case studies to understand practical implementation. Evaluation Criteria: Identification of issues, analysis of mitigation measures, and interpretation.

Reference Books:

1. Environmental Impact Assessment: Principles and Procedures, John Wiley and Sons, New York.
2. Environmental Impact Assessment: A.K. Shrivastav, APH Publishing Corporation, New Delhi.
3. Environmental Impact Assessment: S. A. Abbasi, D. S. Arya, Discovery Publishing House, New Delhi.
4. Environmental Pollution Control: Neelima Rajvidya and Dilipkumar Markandey, APH Publishing Corporation, New Delhi. (2005)
5. Environment Problems and Solutions: D. K. Asthana and Meera Asthana, S.Chand & Co. Ltd. New Delhi.
6. An Introduction to Environmental Management: Dr. Anand S. Bal, Himalaya Publishing House, New Delhi.

7. Environmental Impact Analysis Handbook: John G.R. and David C. Wooten, McGraw Hill Publications. (1987)
8. Environmental Impact Assessment Methodologies Anjaneyulu, Y. and Manickam W. BSP Books Pvt. Ltd., Hyderabad (2010)
9. Environmental Impact Analysis Handbook: J. G. Rau and D. C. Wooten; McGraw-Hill Book Co.
10. *Environmental Impact Assessment*, McGraw-Hill Canter, L.W.
11. *Introduction to Environmental Impact Assessment*, Routledge Glasson, J., Therivel, R. & Chadwick, A.
12. *Environmental Impact Analysis Handbook*, McGraw-Hill Rau, J.G. & Wooten, D.C.
13. *Environmental Impact Assessment: Theory and Practice*, Academic Press Kulp, J.L. & Goodman, G.T.
14. *Environmental Impact Assessment Notification and Guidelines* MoEFCC, Government of India

Semester - VI

.6.4 Major (Elective)

Course Title	**Environmental Research Methods and Data Analysis**
Course Credits	4
Course Outcomes	After going through the course, learners will be able to
	1. Understand the principles, objectives, and importance of environmental research.
	2. Apply suitable sampling methods and collect environmental data systematically.
	3. Prepare research reports, tables, charts, and present research findings effectively.
	4. Demonstrate ethical practices, research integrity, and effective communication in environmental research.
Module 1 (Credit 1) – Introduction to Environmental Research	
Learning Outcomes	After learning the module, learners will be able to,
	1. Define environmental research and explain its objectives and significance and describe the scientific method and characteristics of research.
	2. Conduct literature review and document sources and recognize the importance of ethics and integrity in environmental research.
Content Outline	• Definition, objectives, and significance of environmental research, Scientific method and characteristics of research, Types of research: basic, applied, and interdisciplinary, Research problem formulation and hypothesis development, Literature review: sources, importance, and documentation, Ethics and integrity in environmental research
Module 2 (Credit 1)- Research Design and Sampling Techniques	
Learning Outcomes	After learning the module, learners will be able to,
	1. Explain research design and distinguish between experimental and non-experimental designs.

	2. Determine sample size for basic field studies and plan and conduct field surveys for environmental data collection.
Content Outline	• Concept of research design and its importance, Experimental and non-experimental research designs, Variables and hypothesis testing (basic concepts), Sampling methods: Probability sampling (simple random, stratified, systematic), Non-probability sampling (convenience, judgment, quota), Sample size determination (introductory concepts), Field survey and environmental data collection methods
Module 3 (Credit 1) – Data Analysis and Interpretation	
Learning Outcomes	After learning the module, learners will be able to,
	1. Apply basic statistical measures: mean, median, mode, range, variance, and standard deviation.
	2. Interpret results of environmental data analysis to support decision-making.
Content Outline	• Types of data: primary and secondary, Data organization: classification, tabulation, and graphical presentation, Introduction to statistical tools: Measures of central tendency (mean, median, mode), Measures of dispersion (range, variance, standard deviation), Correlation and regression (basic concepts), Use of computers/software for data analysis (Excel, SPSS, or R – basics), Interpretation of research data in environmental studies.
Module 4 (Credit 1) – Research Reporting and Presentation	
Learning Outcomes	After learning the module, learners will be able to,
	1. Prepare a structured research report with proper sections and formatting and apply referencing styles, prepare citations, and maintain bibliographies.
	2. Present research findings through seminars, posters, or reports clearly to scientific and public audiences.
Content Outline	• Structure and components of a research report, Referencing styles, citations, and bibliography, Plagiarism and research ethics, Preparation of tables, charts, and graphs, Presentation of research findings through reports, posters, and seminars, Communication of research outcomes to scientific and public audiences.

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

Module 1 – Introduction to Environmental Research

Project 1: Formulation of Research Problem

Description: Students select a simple environmental topic (e.g., water quality in a local lake) and formulate a research problem. A brief note on how the problem can be investigated is included. Learning Outcome: Develops skills in defining research problems and creating hypotheses for environmental studies. Evaluation Criteria: Relevance and clarity of the research problem, appropriateness of hypothesis, and logical reasoning.

Module 2 – Research Design and Sampling Techniques

Project 1: Comparative Study of Research Designs

Description: Students prepare a short assignment comparing experimental and non-experimental research designs, highlighting their advantages, limitations, and suitability for different environmental studies. Learning Outcome: Understands different research designs and their application in environmental research. Evaluation Criteria: Clarity of comparison, relevance of examples, and presentation.

Module 3 – Data Analysis and Interpretation

Project 1: Statistical Analysis of Environmental Data

Description: Students are provided with a small dataset (e.g., pH, DO, BOD, or soil nutrient values) and asked to calculate measures of central tendency (mean, median, mode) and dispersion (range, standard deviation). Learning Outcome: Applies basic statistical tools to analyze environmental data. Evaluation Criteria: Accuracy of calculations, proper tabulation, and interpretation of results.

Module 4 – Research Reporting and Presentation

Project 1: Preparation of a Mini Research Report

Students prepare a short research report on a small environmental topic (e.g., water quality analysis, air pollution monitoring, or soil sampling study) following proper structure: Title, Introduction, Methods, Results, Discussion, Conclusion, and References. Learning Outcome: Develops skills in organizing and presenting research findings in a structured format. Evaluation Criteria: Clarity of report, proper formatting, completeness of sections, and correct referencing.

Reference Books:

1. Kothari, C.R. – *Research Methodology: Methods and Techniques*, New Age International
2. Panneerselvam, R. – *Research Methodology*, PHI Learning
3. Gupta, S.P. – *Research Methodology and Statistical Techniques*, Sultan Chand & Sons
4. Sinha, S.C. & Dhiman, A.K. – *Research Methodology*, Ess Ess Publications
5. Singh, Y.K. – *Research Methodology and Statistics*, New Age International
6. Bhattacharyya, D.K. – *Research Methodology*, Excel Books

Semester - VI

.6.6 Community Engagement (CE)

Course Title	**Community Engagement and Service**
Course Credits	2
Course Outcomes	After going through the course, learners will be able to
	1. Explain the concepts, principles and ethical foundations of community engagement and service.
	2. Identify community needs and social issues using participatory and inclusive approaches.
	3. Plan and implement community service activities related to environment, health, education and sanitation.
	4. Evaluate the impact of community service programmes and document field experiences effectively.
Module 1 (Credit 1) – Concepts and Foundations of Community Engagement and Service	
Learning Outcomes	After learning the module, learners will be able to,
	1. Define community, community engagement and community service and describe the principles, ethics and values guiding community engagement.
	2. Explain the role of citizenship, participation and empowerment in community development.
Content Outline	• Meaning and scope of community engagement and community service • Concept of community, society and citizenship • Principles and ethics of community engagement and service • Types of community service: voluntary service, service learning, outreach programmes • Role of individuals, educational institutions and civil society in community service • Community participation and empowerment • Social inclusion, equity and sustainable development • Case studies of community engagement and service initiatives (local and national)

Module 2 (Credit 1) - Community Service Practices and Social Development	
Learning Outcomes	After learning the module, learners will be able to,
	1. Plan and organize community service programmes addressing social and environmental needs.
	2. Monitor and evaluate community service activities and assess their social impact and prepare reports and reflective documentation on community service experiences.
Content Outline	• Planning and implementation of community service programmes • Community service in health, education, environment and sanitation • Role of youth and students in community development • Environmental service activities: cleanliness drives, plantation, water conservation, waste management • Collaboration with local bodies, NGOs and government agencies • Monitoring and evaluation of community service activities • Documentation, reporting and reflective learning • Case studies of successful community service and social development programmes

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

Assignments 1: Survey on Community Needs and Social Issues

Description: Design a simple questionnaire and conduct a survey (10–15 households) on: Environmental awareness, Sanitation and waste management practices, Water use and conservation and community participation in service activities. Prepare a short report with findings and suggestions. Learning Focus: Data collection, communication, social responsibility.

Assignments 2: Participation in a Community Service Activity

Description: Students actively participate in any ONE community service programme: Cleanliness drive, Tree plantation, Plastic-free awareness campaign and water conservation activity. Students submit a brief report with objectives, activities, outcomes and photographs. Learning Focus: Experiential learning, teamwork, civic responsibility.

Assignments 3: Awareness Material Preparation

Description: Prepare any ONE: Poster, Pamphlet, Slogan set and short street play script. Theme: *Environment, sanitation, health, or social responsibility*. Learning Focus: Communication skills, creativity, outreach methods.

Assignments 3: Reflective Journal

Students maintain a reflective journal describing: Community interactions, learning experiences, Challenges faced and personal growth and social responsibility

Reference Books:

1. Ife, J. & Tesoriero, F. – *Community Development: Community-Based Alternatives in an Age of Globalisation*, Pearson Education.
2. Bhattacharyya, B. – *Social Work: An Integrated Approach*, Deep & Deep Publications, New Delhi.
3. Desai, A. R. – *Rural Sociology in India*, Popular Prakashan.
4. UNDP – *Human Development Report* (selected editions).
5. Kotler, P. & Lee, N. – *Corporate Social Responsibility: Doing the Most Good for Your Company and Your Cause*, Wiley.
6. Government of India – *National Voluntary Action Policy*, *Swachh Bharat Mission* and *National Service Scheme (NSS) Manuals*.