



ADAMAS UNIVERSITY

School of Basic and Applied Sciences

Department of Chemistry

**B.Sc. in Environmental Science and
Sustainability**

Programme Code: CHM3405

Course Structure

And

Detailed Syllabus

Academic Year: 2026-27

SCHOOL OF BASIC AND APPLIED SCIENCES								
UNDERGRADUATE COURSE STRUCTURE								
B.Sc. ENVIRONMENTAL SCIENCE and SUSTAINABILITY								
BATCH 2026-27								
SEMESTER I								
S.No.	Type of Course	Code	Title of the Course	Contact Hours Per Week				Total Credits
				L	T	P	H	
1.	Major CC-1	EVS131	Principles of Ecology and Biodiversity	3	0	1	5	4
2.	Major CC-2	EVS132	Environmental Ethics and Sustainable Development Goals (SDGs)	4	0	0	4	4
3.	Minor	IKS101	Introduction to IKS	4	0	0	4	4
4.	MDC		MDC-I (To be chosen from bucket provided)					3
5.	AEC	AEC101	Communicative English-I	2	0	0	2	2
6.	AEC		Foreign Language-I	2	0	0	2	2
7.	VAC	VAC101	Environmental Education-I	2	0	0	2	2
8.	SEC	GEN103	AI for Science	2	0	0	2	2
Semester Credits								23
SEMESTER II								
1.	Major CC-3	EVS133	Introduction to Atmospheric Science	3	0	1	5	4
2.	Major CC-4	EVS134	Physics and Chemistry of the Environment	3	0	1	5	4
3.	Major CC-5	EVS135	Ecology Field Study	-	-	-		2
4.	Minor	GEN104	Basic Cyber Security and Internet of Things	4	0	0	4	4
5.	MDC		MDC-II (To be chosen from bucket provided)					3
6.	VAC	VAC105	Community Engagement	2	0	0	2	2
7.	AEC	AEC102	Communicative English-II	2	0	0	2	2
8.	AEC		Foreign Language-II	2	0	0	2	2
9.	SEC		SEC I (To be chosen from bucket provided)					2
10.	SEC		Soft Skills and Aptitude Course	1	0	0	1	1
Semester Credits								26
SEMESTER III								
1.	Major CC-6	EVS231	Water Resources Management	3	0	1	5	4
2.	Major CC-7	EVS232	Earth and Earth Surface Processes	3	0	1	5	4
3.	Major CC-8	EVS233	Introduction to Life Processes	3	0	1	5	4
4.	Minor		Minor I (To be chosen from bucket provided)					4
5.	MDC		MDC-III (To be chosen from bucket provided)					3

6.	VAC		To be chosen from bucket provided					2
7.	SEC		SEC II (To be chosen from bucket provided)					2
8.	SEC		Soft Skills and Aptitude Course	1	0	0	1	1
Semester Credits								24
SEMESTER IV								
1.	Major CC-9	EVS234	Natural Resource Management and Sustainable Ecosystems	3	0	1	5	4
2.	Major CC-10	EVS235	Pollution and Control Technologies	3	0	1	5	4
3.	Major CC-11	EVS236	Energy Transitions and Sustainability	3	0	1	5	4
4.	Minor		Minor II (To be chosen from bucket provided)					4
5.	VAC		To be chosen from bucket provided					2
6.	SEC		SEC III (To be chosen from bucket provided)					2
7.	SEC		Soft Skills and Aptitude Course	1	0	0	1	1
Semester Credits								21
SEMESTER V								
1.	Major CC-12	EVS321	Land Use and Soil Conservation	3	0	1	5	4
2.	Major CC-13	EVS322	Waste Management and Circular Economy	3	0	1	5	4
3.	Major CC-14	EVS323	Environmental Legislation and Environmental Impact Assessment	3	0	1	5	4
4.	Minor		Minor III (To be chosen from bucket provided)					4
5.	SEC		SEC IV (To be chosen from bucket provided)					2
6.	SEC		Soft Skills and Aptitude Course	1	0	0	1	1
7.	INT	EVS324	Internship	-	-	-	-	2
Semester Credits								21
SEMESTER VI								
1.	Major CC-15	EVS325	Data Science, Statistics and AI in Environmental Science	3	0	1	5	4
2.	Major CC-16	EVS326	Instruments and Analytical methods	3	0	1	5	4
3.	Major CC-17	EVS327	EHS and Sustainable Lifestyle	4	0	0	4	4
4.	Minor		Minor IV (To be chosen from bucket provided)					4
5.	SEC		SEC V (To be chosen from bucket provided)					2

6.	Major CC18	EVS328	Project	0	0	4	8	4
7.	SEC		Soft Skills and Aptitude Course	1	0	0	1	1
Semester Credits								23
Total Credits of the Program after 3rd Year								138
SEMESTER VII								
1.	Major CC-19	EVS421	Climate Change Adaptation and Mitigation Strategies	4	0	0	4	4
2.	Major CC-20	EVS422	Environmental, Social and Governance	2	1	1	4	4
3.	Major CC-21	EVS423	Applications of RS-GIS in Environmental Science and Sustainability	2	1	1	4	4
4.	Major CC-22 (With Research)	EVS424	Research Methodology	2	1	1	4	4
4A.	Major CC-23 (Without Research)	EVS425	Sustainable Designs and Supply Chain Management	3	1	0	4	4
5	Minor		Minor V (To be chosen from bucket provided)					4
6	SEC		Soft Skills and Aptitude Course	1	0	0	1	1
Total Semester Credit								21
SEMESTER VIII								
1.	Major CC-24	EVS426	Green Technologies and Environmental Innovations	3	0	1	5	4
2.	Minor		Minor VI (To be chosen from bucket provided)				4	4
3A.	Major CC-25 (Without Research)	EVS427	Environmental Modelling and Risk Assessment	2	1	1	4	4
3B.	Major CC-26 (Without Research)	EVS428	Eco-restoration Strategies	3	1	0	4	4
3C.	Minor (For Without Research)		Minor VII (To be chosen from bucket provided)				4	4
3.	Dissertation CC-Disrt-27 (For With research)	EVS429	Dissertation	-	-	12	24	12
Total Semester Credit								20
Total Credits of the Program after 4th Year								179

Total Core Course Credit for With Research: 98

Total Core Course Credit for Without Research: 94

ADAMAS UNIVERSITY
School of Basic and Applied Sciences
Department of Chemistry
B.Sc. in Environmental Science and Sustainability
Programme Code: CHM3405
Course Structure
Academic Year: 2026-27

Semester: I

Course Title: Principles of Ecology and Biodiversity
Programme: B.Sc. Environmental Science and Sustainability
Semester: I
Course Code: EVS131
Course Type: Major core Course
L-T-P-C: 3-0-1-4

Course Objectives

- To introduce students to the foundational concepts and principles of ecology.
- To explore the interrelationships between organisms and their physical and biological environment.
- To provide a scientific basis for understanding species interactions, ecosystem dynamics, and biogeochemical cycles.
- To examine the patterns, importance, and threats to biodiversity at genetic, species, and ecosystem levels.
- To promote an understanding of ecological balance, conservation needs, and sustainable management of natural resources.

Course Outcomes (COs)

Upon successful completion of this course, students will be able to:

CO1: Explain the basic ecological concepts including ecosystem structure, function, and energy flow.

CO2: Analyse population dynamics, community interactions, and ecological succession.

CO3: Describe global patterns of biodiversity and the factors influencing them.

CO4: Evaluate the ecological significance of biodiversity at different levels and its role in ecosystem services.

CO5: Identify key drivers of biodiversity loss and assess the need for conservation strategies.

CO6: Apply ecological principles to real-world environmental issues, sustainability, and natural resource management.

Module I: Fundamentals of Ecology

- Definition, scope and relevance of ecology in sustainability
- Levels of organisation: individual, population, community, ecosystem
- Laws of thermodynamics and ecological implications

- Autecology and Synecology
- Limiting factors: Liebig's Law, Shelford's Law
- Ecological niche, ecotypes, and ecological amplitude

Module II: Ecosystem Structure and Function

- Components of ecosystems: abiotic and biotic
- Food chains, food webs and trophic levels
- Energy flow models: linear and Y-shaped, ecological efficiencies
- Biogeochemical cycles: Carbon, Nitrogen, Phosphorus, and Sulphur
- Ecosystem productivity: GPP, NPP, NEP, and respiration
- Case studies: Terrestrial and Aquatic ecosystems

Module III: Population and Community Ecology

- Population attributes: growth models (exponential, logistic), carrying capacity
- r- and K-selection strategies
- Community structure: stratification, dominance, ecotone, edge effect
- Species interactions: mutualism, commensalism, parasitism, competition, predation
- Ecological succession: types, models, climax concept

Module IV: Biodiversity Concepts and Patterns

- Definition and levels: genetic, species, ecosystem diversity
- Biodiversity hotspots (Indian context: Western Ghats, Indo-Burma, Himalayas)
- Biodiversity gradients: latitudinal and altitudinal
- Ecosystem services and functional values of biodiversity
- Threats to biodiversity: habitat loss, invasive species, pollution, climate change
- Convention on Biological Diversity (CBD), Aichi Targets, Post-2020 Global Biodiversity Framework

Module V: Biodiversity Conservation and Sustainable Use

- In-situ and Ex-situ conservation strategies
- Protected area network: Biosphere Reserves, National Parks, Wildlife Sanctuaries
- Community participation and traditional knowledge systems
- Role of NBA, SBB, BMC
- Sustainable use of biodiversity: bioresources, bioprospecting, benefit sharing
- Ecological restoration and rewilding approaches

Practical (Lab + Field Work):

- Quadrat and transect methods for vegetation study
- Species richness and diversity indices (Shannon-Wiener, Simpson's)
- Tree and herb layer sampling in campus or nearby natural sites
- Biodiversity mapping and inventory using field guides
- Visit to a local protected area / biodiversity-rich site for ecosystem assessment
- Report preparation and group presentations on field findings

Textbooks and Reference Books/ Other Resources:

1. Alcock, J. (2013). *Animal behavior: An evolutionary approach* (10th ed.). Sinauer Associates.
2. Gaston, K. J., & Spicer, J. I. (2004). *Biodiversity: An introduction* (2nd ed.). Blackwell Publishing.

3. Groom, M. J., Meffe, G. K., & Carroll, C. R. (2006). *Principles of conservation biology* (3rd ed.). Sinauer Associates.
4. Krebs, C. J. (2009). *Ecology: The experimental analysis of distribution and abundance* (6th ed.). Benjamin Cummings.
5. Miller, G. T., & Spoolman, S. E. (2019). *Living in the environment* (20th ed.). Cengage Learning.
6. Odum, E. P., & Barrett, G. W. (2005). *Fundamentals of ecology* (5th ed.). Brooks/Cole.
7. Singh, J. S., Singh, S. P., & Gupta, S. R. (2014). *Ecology, environmental science and conservation*. S. Chand Publishing.
8. Stiling, P. (2014). *Ecology: Global insights and investigations*. McGraw-Hill Education.
9. Shukla, R. S., & Chandel, P. S. (2009). *Plant ecology and soil science* (4th ed.). S. Chand Publishing.
10. Ambasht, R. S., & Ambasht, N. K. (2008). *A textbook of ecology* (2nd ed.). CBS Publishers & Distributors.

Course Title: Environmental Ethics and Sustainable Development Goals (SDGs)

Programme: B.Sc. Environmental Science and Sustainability

Semester: I

Course Code: EVS132

Course Type: Major core Course

L-T-P-C: 4-0-0-4

Course Objectives

- To introduce the philosophical foundations and key principles of environmental ethics.
- To explore the ethical relationship between humans and the natural environment.
- To analyse global environmental challenges through an ethical lens.
- To examine the United Nations Sustainable Development Goals (SDGs) and their relevance to environmental stewardship.
- To develop awareness and critical thinking for ethical decision-making in sustainability practices.

Course Outcomes

Upon successful completion of this course, students will be able to:

CO1: Understand and articulate the fundamental concepts and theories of environmental ethics.

CO2: Evaluate human responsibilities towards nature from various ethical perspectives.

CO3: Analyse key environmental issues and dilemmas using ethical frameworks.

CO4: Explain the scope, targets, and significance of the UN Sustainable Development Goals (SDGs).

CO5: Connect ethical principles with the implementation of SDGs in local and global contexts.

CO6: Propose sustainable and ethically informed solutions to environmental problems.

Module I: Introduction to Environmental Ethics

- Definition, scope, and importance
- Anthropocentrism, ecocentrism, biocentrism

- Major ethical theories: utilitarianism, deontology, virtue ethics, deep ecology

Module II: Ethical Perspectives on Human-Nature Relationship

- Intrinsic and instrumental value of nature
- Rights of animals, plants, and ecosystems
- Indigenous and traditional ecological knowledge in ethics

Module III: Environmental Issues and Ethical Dilemmas

- Climate change ethics
- Biodiversity loss and species extinction
- Pollution and environmental justice
- Intergenerational equity and sustainability

Module IV: United Nations Sustainable Development Goals (SDGs)

- History and evolution of SDGs
- Overview of 17 SDGs
- Linkages between SDGs and environmental ethics

Module V: Ethics, Policy, and Sustainable Development

- Ethical decision-making in environmental policy
- Corporate social responsibility and sustainability reporting
- Case studies on ethical challenges in implementing SDGs
- Role of individuals, communities, and governments in achieving SDGs

Textbooks and Reference Books/ Other Resources

1. DesJardins, J. R. (2013). *Environmental ethics: An introduction to environmental philosophy* (5th ed.). Wadsworth Publishing.
2. Light, A., & Rolston, H. (Eds.). (2003). *Environmental ethics: An anthology*. Blackwell Publishing.
3. Norton, B. G. (1991). *Toward unity among environmentalists*. Oxford University Press.
4. United Nations. (2015). *Transforming our world: The 2030 agenda for sustainable development*. <https://sdgs.un.org/2030agenda>
5. Singer, P. (2015). *Animal liberation* (40th anniversary ed.). Harper Perennial Modern Classics.
6. Weiss, E. B., & Jacobson, H. K. (1998). *Engaging countries: Strengthening compliance with international environmental accords*. MIT Press.

Semester: II

Course Title: Introduction to Atmospheric Science

Programme: B.Sc. Environmental Science and Sustainability

Semester: II

Course Code: EVS133

Course Type: Major core Course

L-T-P-C: 3-0-1-4

Course Objectives

- To provide foundational knowledge of the Earth's atmosphere, its composition, and vertical structure.
- To familiarise students with basic meteorological parameters and atmospheric processes.
- To explain the principles of weather systems, climate, and atmospheric circulation.
- To introduce observational tools and techniques used in atmospheric science.
- To build a scientific understanding of atmospheric dynamics relevant to environmental and climate studies.

Course Outcomes

Upon successful completion of this course, students will be able to:

CO1: Understand the composition, structure, and evolution of the Earth's atmosphere.

CO2: Explain fundamental atmospheric processes including radiation, pressure, and temperature dynamics.

CO3: Interpret weather phenomena and patterns based on meteorological parameters.

CO4: Describe general circulation systems and their influence on global and regional climates.

CO5: Demonstrate familiarity with basic meteorological instruments and atmospheric observations.

CO6: Relate atmospheric science concepts to environmental and climate change issues.

Module I: Fundamentals of the Atmosphere

- Definition and importance of atmospheric science
- Origin and evolution of the atmosphere
- Composition of dry air; variable components (water vapour, ozone, aerosols)
- Vertical structure: troposphere to exosphere
- Lapse rates, tropopause and stratopause; concept of atmospheric pressure
- Atmospheric stability: inversion and convection

Module II: Solar Radiation and Energy Balance

- Solar constant and Earth's receipt of solar radiation
- Diurnal and seasonal variations in insolation
- Radiation laws: Stefan-Boltzmann, Wien's displacement
- Earth's energy budget and heat balance
- Albedo, emissivity and atmospheric window
- Greenhouse effect and radiative forcing

Module III: Atmospheric Pressure, Temperature and Humidity

- Gas laws and hydrostatic equilibrium
- Concepts of temperature, pressure, density and humidity
- Adiabatic processes: DALR, SALR, lifting condensation level
- Winds: pressure gradient force, Coriolis effect, geostrophic wind
- General circulation of the atmosphere: Hadley, Ferrel, and Polar cells
- Jet streams and monsoon systems (with reference to Indian subcontinent)

Module IV: Atmospheric Dynamics and Circulation

- Wind systems and forces (Coriolis, pressure gradient, frictional)
- Geostrophic and gradient winds
- General circulation: Hadley, Ferrel and Polar cells

- Air masses and fronts: warm, cold, occluded, stationary
- Cyclones and anticyclones: tropical and extratropical
- Local winds: land and sea breeze, mountain-valley winds
- Clouds: formation, classification and types
- Precipitation processes: collision-coalescence, Bergeron-Findeisen
- Thunderstorms and extreme weather events

Module V: Weather Systems and Observation

- Weather and climate
- Classification of climate: Köppen, Trewartha and Thornthwaite
- ENSO, La Niña and their environmental implications
- Introduction to Climate change
- Role of atmosphere in air pollution dispersion and transport
- Contemporary atmospheric issues: ozone depletion, acid rain, urban heat island

Practical (Lab + Field Work):

- Measurement of temperature, humidity, wind speed/direction using weather instruments
- Plotting of weather data: isotherms, isobars, wind roses
- Satellite images and synoptic weather chart interpretation
- Observation of cloud types and estimation of cloud cover
- Report on a local weather event or climate anomaly using IMD/NOAA data

Textbooks and Reference Books/ Other Resources:

1. Aguado, E., & Burt, J. E. (2018). *Understanding weather and climate* (7th ed.). Pearson.
2. Lutgens, F. K., Tarbuck, E. J., & Tasa, D. (2016). *The atmosphere: An introduction to meteorology* (13th ed.). Pearson.
3. Wallace, J. M., & Hobbs, P. V. (2006). *Atmospheric science: An introductory survey* (2nd ed.). Academic Press.
4. Ahrens, C. D. (2012). *Meteorology today: An introduction to weather, climate and the environment* (10th ed.). Cengage Learning.
5. Barry, R. G., & Chorley, R. J. (2009). *Atmosphere, weather and climate* (9th ed.). Routledge.
6. Lal, D. S. (2013). *Climatology* (4th ed.). Sharda Pustak Bhawan.

Course Title: Physics and Chemistry of the Environment

Programme: B.Sc. Environmental Science and Sustainability

Semester: II

Course Code: EVS134

Course Type: Major core Course

L-T-P-C: 3-0-1-4

Course Objectives:

- To introduce the physical and chemical principles underlying environmental systems.
- To develop an understanding of atmospheric, aquatic, and terrestrial processes.

- To explore the role of radiation, thermodynamics, and chemical reactions in natural and anthropogenic environments.
- To enable students to conduct basic environmental chemistry and physics experiments.
- To lay the groundwork for advanced study in pollution, climate science, and environmental modelling.

Course Outcomes

Upon successful completion of this course, students will be able to:

CO1: Understand and explain the fundamental physical and chemical principles governing natural environmental processes, including thermodynamics, kinetics, radiation laws, chemical equilibrium, and redox reactions.

CO2: Apply principles of environmental physics (e.g., energy balance, heat transfer, atmospheric dynamics, light and radiation) to analyse climatic patterns, pollutant dispersion, and radiative forcing.

CO3: Demonstrate knowledge of environmental chemistry, including acid-base chemistry, solubility, complexation, and speciation in air, water, and soil systems.

CO4: Analyse the sources, reactions, transport, and fate of major environmental pollutants, such as particulate matter, greenhouse gases, persistent organic pollutants, and heavy metals.

CO5: Conduct basic laboratory experiments and numerical modelling to measure environmental parameters and interpret chemical and physical data using standard methods.

CO6: Evaluate the environmental and health implications of physicochemical interactions in natural and anthropogenic systems, and suggest mitigation strategies based on scientific reasoning.

Module I: Fundamentals of Environmental Physics

- Nature of matter and energy: kinetic and potential energy
- Solar radiation: spectrum, solar constant, Earth's energy balance
- Albedo, heat budget, greenhouse effect, and global warming
- Laws of thermodynamics and their environmental relevance
- Energy transfer in the environment: conduction, convection, radiation

Module II: Fundamentals of Environmental Chemistry

- Atomic structure, chemical bonding, and oxidation-reduction reactions
- Acids, bases, and buffers - environmental relevance (rainwater, soil, lakes)
- Chemical kinetics and equilibrium in natural systems
- Concepts of pH, pKa, solubility product, and their significance
- Colloids and surfactants in the environment

Module III: Atmospheric Physics and Chemistry

- Composition and structure of the atmosphere
- Temperature lapse rates and atmospheric stability
- Photochemical reactions and smog formation
- Ozone chemistry: formation, depletion, and recovery
- Major air pollutants and their chemical transformations (NO_x, SO_x, CO, VOCs)

Module IV: Water Chemistry and Soil Chemistry

- Water chemistry: physical and chemical properties of water
- DO, BOD, COD - significance and determination

- Oil and Grease, Conductivity, Solids in water
- Redox potential and electrochemical reactions in water bodies
- Soil chemistry: components of soil, ion exchange, cation exchange capacity
- Nutrient cycles (N, P, S) and eutrophication

Module V: Environmental Interactions and Processes

- Partitioning of pollutants: air-water, soil-water, octanol-water coefficients
- Chemical speciation and bioavailability
- Sorption, desorption, leaching, and volatilisation
- Radiological aspects: natural and anthropogenic radioisotopes, half-life
- Case studies: acid rain, heavy metal contamination, pesticide degradation

Practical (Lab + Field Work):

- Determination of pH, conductivity, and TDS of water samples
- Analysis of DO, BOD, and COD in water
- Estimation of soil pH, moisture content, and organic matter
- Determination of chloride, nitrate, phosphate in water samples
- Simple experiments demonstrating thermodynamics and radiation balance
- Spectrophotometric analysis and calibration curve preparation

Textbooks and Reference Books/ Other Resources:

1. Rao, C. N. R. (1999). *Understanding chemistry*. Universities Press.
2. Manahan, S. E. (2017). *Environmental chemistry* (10th ed.). CRC Press.
3. De, A. K. (2006). *Environmental chemistry* (6th ed.). New Age International Publishers.
4. Desai, P. V. (2005). *Environmental studies*. Jaico Publishing House.
5. Hewitt, P. G. (2016). *Conceptual physics* (12th ed.). Pearson Education.
6. Sawyer, C. N., McCarty, P. L., & Parkin, G. F. (2003). *Chemistry for environmental engineering and science* (5th ed.). McGraw-Hill Education.

Course Title: Ecology Field Study

Programme: B.Sc. Environmental Science and Sustainability

Semester: II

Course Code: EVS135

Course Type: Major core Course

L-T-P-C: 0-0-0-2

Course Objectives

- To impart hands-on understanding of ecological concepts through field-based observations and data collection.
- To familiarise students with standard field methods for studying ecosystems, species, and environmental parameters.
- To develop skills in ecological sampling, biodiversity estimation, and habitat assessment.
- To inculcate scientific temper and team-based research skills through field surveys and documentation.
- To encourage critical thinking on human-nature interactions and ecological sustainability through real-world contexts.

Course Outcomes

Upon successful completion of this course, students will be able to:

- CO1:** Apply ecological field techniques for flora, fauna, and habitat assessment.
- CO2:** Record and analyse ecological data using quantitative and qualitative tools.
- CO3:** Identify common plant and animal species and interpret their ecological roles.
- CO4:** Conduct biodiversity estimation and understand its significance in conservation.
- CO5:** Understand landscape-level ecological processes through field immersion.
- CO6:** Communicate ecological findings effectively through field reports and presentations.

Curriculum Overview (Indicative Topics & Activities)

Note: The course is entirely field-based. Activities may vary based on terrain, ecosystem type, and semester logistics.

1. Field Orientation and Techniques

- Introduction to fieldwork ethics, safety, and protocols
- Use of GPS, compass, field notebook, transects, quadrats

2. Vegetation and Forest Survey

- Tree, shrub, herb identification
- Phytosociology: frequency, density, abundance
- Biomass estimation and canopy cover

3. Aquatic and Wetland Ecology

- Sampling aquatic fauna and flora
- Water quality parameters (pH, DO, turbidity, temperature)
- Study of planktons, nekton, neuston, periphyton and benthos

4. Faunal Diversity Observation

- Bird watching and identification techniques
- Observation on common insects and fishes
- Camera trapping or pugmark tracking
- Studies on animal behaviour

5. Biodiversity Estimation and Landscape Mapping

- Common Diversity Indices related to diversity dominance and evenness.
- Ecotone studies and edge effects
- Mapping ecosystem services in field sites

6. Field Report Writing and Data Analysis

- Species checklists and ecological insights
- Group presentations and discussions
- Report preparation and submission with illustrations/maps

Textbooks and Reference Books/ Other Resources

1. Krebs, C. J. (2016). *Ecology: The experimental analysis of distribution and abundance* (6th ed.). Pearson.
2. Sutherland, W. J. (2006). *Ecological census techniques: A handbook* (2nd ed.). Cambridge University Press.

Semester: III

Course Title: Water Resources Management

Programme: B.Sc. Environmental Science and Sustainability

Semester: III

Course Code: EVS231

Course Type: Major core Course

L-T-P-C: 3-0-1-4

Course Objectives

- To understand the hydrological cycle and the classification and availability of global and national water resources.
- To study the principles of water resource planning, assessment, and management.
- To analyse the causes and impacts of water-related challenges including scarcity, pollution, and overuse.
- To explore sustainable water management techniques such as rainwater harvesting, watershed management, and IWRM.
- To build practical skills in water quality assessment, water budgeting, and field-based water management techniques.

Course Outcomes

Upon successful completion of this course, students will be able to:

CO1: Explain the global and Indian distribution of water resources and their significance.

CO2: Describe key concepts of the hydrological cycle and water budgeting.

CO3: Assess different sources of water (surface, ground, atmospheric) and their utilisation patterns.

CO4: Analyse problems associated with water pollution, scarcity, and intersectoral conflicts.

CO5: Apply principles of integrated water resource management (IWRM), watershed planning, and participatory approaches.

CO6: Demonstrate practical skills in water sampling, quality analysis, and field-based techniques like rainwater harvesting design.

Module I: Introduction to Water Resources

- Global water budget and distribution
- Water resources of India: surface water, groundwater, glacial and atmospheric water
- Freshwater ecosystems: rivers, lakes, wetlands, springs
- Importance of water in environment, health, agriculture, and economy
- Water resource classification: static and dynamic, blue/green/grey water

Module II: Hydrological Cycle and Water Balance

- Precipitation, evapotranspiration, infiltration, percolation, runoff
- Surface runoff and stream flow - factors affecting
- Groundwater hydrology: types of aquifers, Groundwater Flow, water level fluctuations
- Hydrological data collection methods
- Watershed concept and delineation
- Basics of water balance studies and water budgeting

Module III: Water Use, Overuse, and Conflicts

- Sectoral water demand: agriculture, industry, domestic, power
- Causes of water stress: over-extraction, contamination, poor recharge
- Groundwater depletion: causes, impacts, examples (e.g., Punjab, Bundelkhand)
- Inter-state and international water disputes (Cauvery, Teesta, Indus)
- Climate change impacts on water resources
- Gender, caste, and water access inequality

Module IV: Water Quality and Monitoring

- Physical, chemical, and biological parameters
- Drinking water standards: BIS and WHO
- Eutrophication, salinisation, acidification
- Point and non-point sources of water pollution
- Water quality index (WQI) and pollution load estimation
- Tools for monitoring: sensors, remote sensing, and GIS basics

Module V: Sustainable Water Management

- Rainwater harvesting: techniques and case studies
- Artificial recharge methods: recharge pits, trenches, injection wells
- Participatory irrigation management (PIM) and water user associations
- Wetland restoration and catchment area treatment
- Integrated Water Resources Management (IWRM): principles and implementation, drip irrigation
- National Water Policy and Jal Shakti Abhiyan

Practical / Fieldwork Components

- Water sampling techniques (surface and groundwater)
- Analysis of pH, TDS, hardness, turbidity, nitrate, chloride, etc.
- Field visit to a local water treatment plant or watershed site
- Preparation of local water resource inventory
- Preparation of rainwater harvesting plan for an institution or village
- Group project: water budgeting for a household/community/institution

Textbooks and Reference Books/ Other Resources:

1. Todd, D. K., & Mays, L. W. (2005). *Groundwater hydrology* (3rd ed.). Wiley.
2. Agarwal, A., Narain, S., & Khurana, I. (2005). *Water harvesting manual*. Centre for Science and Environment.
3. Shiklomanov, I. A. (1999). *World water resources: A new appraisal and assessment for the 21st century*. UNESCO.
4. Ministry of Jal Shakti. (2020). *National water policy*. Government of India. <https://jalshakti-dowr.gov.in>
5. United Nations Environment Programme (UNEP). (2012). *Integrated water resources management planning approach*. UNEP-DHI Centre. <https://www.unep.org/>
6. Agarwal, A., Narain, S., & Khurana, I. (2005). *Water harvesting manual*. Centre for Science and Environment.
7. Reddy, V. R. (2005). *Water security and management: Ecological imperatives and policy options*. Indian School of Political Economy.

Course Title: Earth and Earth Surface Processes

Programme: B.Sc. Environmental Science and Sustainability

Semester: III

Course Code: EVS232

Course Type: Major core Course

L-T-P-C: 3-0-1-4

Course Objectives

- To provide a foundational understanding of the structure, composition, and evolution of the Earth system.
- To explain dynamic processes shaping the Earth's surface, including plate tectonics, weathering, erosion, and sedimentation.
- To explore the role of geophysical and geomorphic processes in landscape evolution and natural hazards.
- To develop a systems-based perspective on Earth surface interactions with the atmosphere, hydrosphere, and biosphere.
- To train students in identification, mapping, and interpretation of landforms and earth materials using practical tools.

Course Outcomes

Upon successful completion of this course, students will be able to:

CO1: Describe the origin, internal structure, and major components of the Earth system.

CO2: Explain plate tectonics, continental drift, and mountain-building processes.

CO3: Classify and interpret physical and chemical weathering, erosion, and sediment transport mechanisms.

CO4: Analyse fluvial, coastal, aeolian, and glacial processes in shaping landforms.

CO5: Evaluate geohazards such as earthquakes, volcanoes, and landslides through a process-based understanding.

CO6: Demonstrate practical skills in rock/mineral identification, landform analysis, and topographic map interpretation.

Module I: Structure and Evolution of Earth

- Origin and age of the Earth
- Earth's internal structure: crust, mantle, core
- Composition of the lithosphere and asthenosphere
- Earth's magnetic field and paleomagnetism
- Geological time scale and Earth's evolutionary milestones

Module II: Plate Tectonics and Earth Dynamics

- Continental Drift: Supercontinent Pangaea, Drift over geological time, Evidence for Drift
- Sea-floor spreading, subduction zones, and rift valleys
- Theory of plate tectonics and supporting evidence
- Types of plate boundaries: convergent, divergent, transform

- Orogeny and mountain-building processes
- Volcanism and seismicity: causes and effects

Module III: Weathering, Erosion, and Sedimentation

- Physical, chemical, and biological weathering
- Soil formation and factors influencing weathering
- Erosion agents: water, wind, ice, gravity
- Sediment transport and deposition processes
- Soil erosion and degradation in India

Module IV: Earth Surface Processes and Landforms

- Fluvial processes: river dynamics, meanders, deltas
- Coastal processes: wave action, beaches, estuaries
- Glacial and periglacial processes: moraines, fjords
- Aeolian processes: dunes, loess, desertification
- Karst topography and cave formation

Module V: Geohazards and Human Interactions with Earth Processes

- Earthquakes: causes, measurement (Richter, Moment Magnitude), prediction
- Volcanoes: types, eruption mechanisms, distribution
- Landslides and slope instability
- Tsunamis and their triggers
- Anthropogenic impacts on Earth processes (mining, deforestation, dams, urbanisation)
- Risk mitigation and early warning systems

Practical / Field and Applied Components

- Identification of common rocks and minerals using hand specimens
- Study and interpretation of topographic maps and contour patterns
- Mapping of fluvial and coastal features from satellite images
- Construction and analysis of longitudinal and cross-profiles of rivers
- Visit to a geomorphologically active site (riverbank, coastal zone, quarry, hill slope)
- Case study presentations on recent geohazards (e.g., Himalayan landslides, Turkey-Syria earthquakes, etc.)

Textbooks and Reference Books/ Other Resources:

1. Holmes, A. (1965). *Principles of physical geology* (2nd ed.). Thomas Nelson and Sons.
2. Strahler, A. N., & Strahler, A. H. (2005). *Modern physical geography* (4th ed.). Wiley.
3. Summerfield, M. A. (1991). *Global geomorphology: An introduction to the study of landforms*. Longman Scientific & Technical.
4. Keller, E. A. (2011). *Introduction to environmental geology* (5th ed.). Pearson.
5. Dasgupta, A. (2015). *Fundamentals of geomorphology*. Rawat Publications.
6. Valdiya, K. S. (2001). *Environmental geology: Indian context*. Tata McGraw-Hill.
7. BIS/ISRO topographical maps and Geological Survey of India (GSI) publications.

Course Title: Introduction to Life Processes

Programme: B.Sc. Environmental Science and Sustainability

Semester: III

Course Code: EVS233

Course Type: Major core Course

L-T-P-C: 3-0-1-4

Course Objectives:

- To introduce fundamental biological systems relevant to environmental functions.
- To understand how biological structures and physiological processes influence environmental adaptation.
- To explore the role of microbiology, plant and animal physiology in environmental sustainability.
- To impart laboratory skills in environmental biology and biomonitoring techniques.
- To foster appreciation for environmental biotechnology and nature-based solutions.

Course Outcomes

Upon successful completion of this course, students will be able to:

CO1: Explain the fundamental biological principles governing life processes such as metabolism, cellular respiration, photosynthesis, and homeostasis in living organisms.

CO2: Differentiate between the structure and function of prokaryotic and eukaryotic cells, including the roles of cell organelles in maintaining life functions.

CO3: Describe the biochemical composition of living organisms—proteins, carbohydrates, lipids, and nucleic acids—and their roles in sustaining cellular functions.

CO4: Understand the mechanisms of growth, reproduction, and energy transformation in plants and animals, with relevance to ecosystem productivity and nutrient cycles.

CO5: Analyse how physiological processes such as osmoregulation, enzymatic activity, and transport systems contribute to organismal adaptation and survival in different environments.

CO6: Relate life processes to broader ecological and environmental systems, including implications for biodiversity, ecosystem health, and sustainability.

Module I: Cell Biology and Structural Organisation

- Prokaryotic vs. eukaryotic cells
- Structure and function of cellular organelles
- Cell cycle and environmental regulation of cell division
- Tissue types in plants and animals - their environmental functions
- Introduction to genetic material and environmental mutagens

Module II: Microbiology and Its Environmental Relevance

- Types of environmental microbes: bacteria, cyanobacteria, fungi, protozoa
- Roles in nutrient cycling, biofertilisers, biodegradation
- Symbiotic interactions (e.g. Rhizobium-legume, mycorrhizae)
- Extremophiles and microbes in extreme habitats (acid mine, hot springs)
- Microbes in environmental biotechnology: wastewater treatment, oil spill remediation

Module III: Environmental Physiology of Plants and Animals

- Stomatal regulation, transpiration, and water-use efficiency
- Light capture and photosynthetic adaptations (C3, C4, CAM plants)

- Thermoregulation and osmoregulation in animals
- Stress physiology: drought, salinity, heavy metals, and temperature effects
- Behavioural and physiological adaptations in harsh environments

Module IV: Reproduction, Development, and Life History Strategies

- Plant reproduction strategies: sexual vs asexual (environmental importance)
- Seed dispersal mechanisms and germination ecology
- Invertebrate and vertebrate reproductive strategies
- Metamorphosis and development in insects and amphibians
- Environmental triggers for dormancy, hibernation, and migration

Module V: Applied Environmental Biology

- Bioindicators and biosensors for environmental monitoring
- Biological pest control and biopesticides
- Bioremediation: phytoextraction, rhizofiltration, microbial remediation
- Bioenergy: algae and microbial fuel cells
- Introduction to conservation genetics and molecular tools in biodiversity studies

Practical (Lab + Field Work):

- Microscopic examination of microbial cultures from soil/water
- Identification of plant tissues and specialised environmental adaptations
- Observation of stomatal opening under different conditions
- Culturing environmental microbes (nutrient agar, Winogradsky column)
- Visit to vermicomposting or microbial treatment plant
- Case study-based group project: e.g., use of microbes in cleaning oil spills

Textbooks and Reference Books/ Other Resources:

1. Madigan, M. T., Bender, K. S., Buckley, D. H., Sattley, W. M., & Stahl, D. A. (2017). *Brock biology of microorganisms* (15th ed.). Pearson.
2. Taiz, L., Zeiger, E., Møller, I. M., & Murphy, A. (2015). *Plant physiology and development* (6th ed.). Sinauer Associates.
3. Tortora, G. J., Funke, B. R., & Case, C. L. (2018). *Microbiology: An introduction* (13th ed.). Pearson.
4. Raven, P. H., Johnson, G. B., Mason, K. A., Losos, J. B., & Singer, S. R. (2020). *Biology* (12th ed.). McGraw-Hill Education.
5. Das, H. K. (2010). *Textbook of biotechnology* (4th ed.). Wiley India.
6. Campbell, N. A., Urry, L. A., Cain, M. L., Wasserman, S. A., Minorsky, P. V., & Reece, J. B. (2020). *Biology* (12th ed.). Pearson.
7. Odum, E. P., & Barrett, G. W. (2005). *Fundamentals of ecology* (5th ed.). Thomson Brooks/Cole.
8. Dash, M. C. (2001). *Fundamentals of ecology* (2nd ed.). Tata McGraw-Hill.

Semester: IV

Course Title: Natural Resource Management and Sustainable Ecosystems

Programme: B.Sc. Environmental Science and Sustainability

Semester: IV

Course Code: EVS234

Course Type: Major core Course

L-T-P-C: 3-0-1-4

Course Objectives

- To introduce the classification, status, and significance of natural resources in ecological and socio-economic contexts.
- To examine the principles and practices of sustainable resource management, including participatory approaches.
- To explore the role of ecosystem services and biodiversity in sustaining human well-being.
- To analyse the interlinkages between resource exploitation, ecosystem degradation, and climate change.
- To familiarise students with national and global policies, tools, and case studies related to sustainable resource and ecosystem management.

Course Outcomes

Upon successful completion of this course, students will be able to:

CO1: Identify and categorise various types of natural resources and their ecological roles.

CO2: Explain the concepts and frameworks of sustainability in resource use and ecosystem stewardship.

CO3: Analyse the causes and consequences of resource depletion and ecosystem degradation.

CO4: Evaluate strategies and tools for sustainable management of land, water, forests, and biodiversity.

CO5: Interpret global conventions, national policies, and community-based approaches in natural resource governance.

CO6: Apply ecosystem-based management principles in the context of climate resilience and sustainable development.

Module I: Introduction to Natural Resources and Sustainability

- Definition and classification of natural resources: renewable, non-renewable, flow, biotic, abiotic
- Resource use patterns: historical trends and present status (India and global)
- Concept of sustainability: weak and strong sustainability, sustainable yield
- Tragedy of the commons and resource conflicts
- Ecological footprints, planetary boundaries, and carrying capacity

Module II: Water, Forest, and Land Resources

- Surface water and groundwater resources: availability, over-extraction, pollution
- Forests: types, importance, deforestation, forest transition
- Community forestry, Joint Forest Management (JFM), REDD+
- Land degradation, desertification, and sustainable land use planning

Module III: Ecosystem Services and Biodiversity

- Structure and function of ecosystems
- Provisioning, regulating, cultural, and supporting services

- Biodiversity as a natural resource: hotspots, species richness, genetic diversity
- Drivers of ecosystem degradation and biodiversity loss
- Economic valuation of ecosystem services (TEEB, cost-benefit frameworks)

Module IV: Tools and Approaches for Resource and Ecosystem Management

- Ecosystem-based management (EBM) and adaptive management
- Environmental Impact Assessment (EIA) and Strategic Environmental Assessment (SEA)
- Geographic Information Systems (GIS) and remote sensing in resource mapping
- Payment for Ecosystem Services (PES), ecological restoration, and nature-based solutions
- Traditional ecological knowledge (TEK) and participatory rural appraisal (PRA)

Module V: Policies, Institutions, and Case Studies

- National Forest Policy, National Water Policy, National Biodiversity Action Plan
- CAMPA Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006 to Law Course
- Global frameworks: SDGs, CBD, UNCCD, UNFF, UN-REDD
- Community-based resource management: examples from India (Chilika, Arvari River, Mendha Lekha)
- Climate change and resilience in ecosystem and resource management

Practical / Field Component

- Preparation of local natural resource inventory: water, soil, vegetation and land use.
- Mapping of ecosystem services in a selected campus/community landscape.
- Field-based assessment of resource-use conflicts and community dependence.
- Basic GIS/Google Earth-based natural resource mapping.
- Case-study report on community-based natural resource management.

Textbooks and Reference Books/ Other Resources:

1. Gadgil, M., & Guha, R. (1995). *The use and abuse of nature*. Oxford University Press.
2. Singh, J. S., & Singh, S. P. (2020). *Ecology, environmental science and conservation* (2nd ed.). S. Chand Publishing.
3. Food and Agriculture Organization of the United Nations (FAO). (2022). *The state of the world's forests 2022: Forest pathways for green recovery and building inclusive, resilient and sustainable economies*. FAO. <https://www.fao.org/state-of-forests>
4. Millennium Ecosystem Assessment. (2005). *Ecosystems and human well-being: Synthesis*. Island Press. <https://www.millenniumassessment.org>
5. Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES). (2019). *Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services*. IPBES Secretariat. <https://ipbes.net/global-assessment>
6. Forest Survey of India. (2021). *India state of forest report 2021*. Ministry of Environment, Forest and Climate Change, Government of India. <https://fsi.nic.in>
7. India Biodiversity Portal. (n.d.). *Biodiversity information for India*. <https://indiabiodiversity.org>
8. World Resources Institute India (WRI India). (n.d.). *Resources and publications*. <https://wri-india.org/publications>

Course Title: Pollution and Control Technologies

Programme: B.Sc. Environmental Science and Sustainability

Semester: IV

Course Code: EVS235

Course Type: Major core Course

L-T-P-C: 3-0-1-4

Course Objectives

- To introduce the major types, sources, and effects of environmental pollution on ecosystems and human health.
- To build understanding of physical, chemical, and biological techniques for pollution monitoring and analysis.
- To familiarise students with control technologies for air, water, soil, and noise pollution.
- To expose students to pollution prevention and cleaner production strategies for sustainable development.
- To impart hands-on experience in sampling, treatment methods, and designing basic control systems.

Course Outcomes

Upon successful completion of this course, students will be able to:

CO1: Identify various sources, pathways, and impacts of environmental pollutants.

CO2: Analyse pollution trends using appropriate sampling, monitoring, and analytical techniques.

CO3: Describe and evaluate control technologies for air, water, soil, and noise pollution.

CO4: Apply treatment processes such as filtration, adsorption, sedimentation, and biological degradation.

CO5: Interpret environmental quality standards and recommend suitable control or remediation measures.

CO6: Demonstrate skills in handling pollution control devices and suggesting mitigation strategies through practical exercises.

Module I: Fundamentals of Environmental Pollution

- Definition and classification of pollutants
- Sources and types of pollution: air, water, soil, noise, radiation
- Fate and transport of pollutants in the environment
- Effects on biota, human health, and climate
- National Ambient Air Quality Standards (NAAQS), Water Quality Standards, and Noise standards

Module II: Air Pollution and Control Technologies

- Common air pollutants: CO, NO_x, SO₂, SPM, VOCs
- Air Quality Index
- Sources: vehicular, industrial, domestic, natural
- Control technologies:
 - Gravity settlers

- Cyclone separators
- Bag filters
- Electrostatic precipitators (ESP)
- Wet scrubbers
- Emission inventories and stack monitoring

Module III: Water Pollution and Control Technologies

- Major water pollutants: organic, inorganic, pathogens, heavy metals
- Water Quality Index
- Wastewater treatment:
 - Primary (screening, sedimentation)
 - Secondary (activated sludge, trickling filters)
 - Tertiary (chlorination, membrane processes)
- Sludge handling and disposal
- Effluent discharge standards: STP and ETP design basics
- Zero Liquid Discharge (ZLD)

Module IV: Soil and Noise Pollution Management

- Sources and effects of soil pollution: agrochemicals, industrial effluents, solid waste leachate
- Soil remediation techniques: phytoremediation, bioremediation, chemical stabilisation
- Noise pollution: sources, decibel scale, effects on humans
- Control methods: sound barriers, acoustic insulation
- Noise monitoring and standards

Module V: Cleaner Production and Pollution Prevention

- Introduction to cleaner production (CP) and pollution prevention (P2)
- Life cycle analysis (LCA) and environmental risk assessment
- Green chemistry and low-waste technologies
- Resource efficiency and process optimisation
- Case studies: CETPs, green manufacturing, Zero Liquid Discharge (ZLD) industries

Practical / Field and Applied Components

- Sampling and analysis of air, water, and soil quality parameters
- Visit to STP/ETP or air monitoring station
- Demonstration of filtration, sedimentation, and aeration processes
- Experiment: determining COD/BOD and TDS in water samples, EC and pH.
- Noise level mapping and decibel analysis in campus/locality
- Group project: designing a simple control device or model (e.g., wet scrubber, biofilter)

Textbooks and Reference Books/ Other Resources:

1. Rao, C. S. (2006). *Environmental pollution control engineering* (2nd ed.). New Age International Publishers.
2. Peavy, H. S., Rowe, D. R., & Tchobanoglous, G. (1985). *Environmental engineering*. McGraw-Hill Education.
3. Manahan, S. E. (2011). *Environmental chemistry* (9th ed.). CRC Press.
4. Central Pollution Control Board (CPCB). (n.d.). *Guidelines and manuals*. Ministry of Environment, Forest and Climate Change, Government of India. <https://cpcb.nic.in/>

5. United Nations Environment Programme (UNEP). (2004). *Cleaner production and eco-efficiency: Complementary approaches to sustainable development*. UNEP.
<https://www.unep.org/>
6. National Green Tribunal (NGT), State Pollution Control Boards (SPCBs), & Ministry of Environment, Forest and Climate Change (MoEFCC). (n.d.). *Reports and notifications*. Government of India. <https://moef.gov.in/>
7. American Public Health Association (APHA). (2017). *Standard methods for the examination of water and wastewater* (23rd ed.). American Public Health Association, American Water Works Association, & Water Environment Federation.

Course Title: Energy Transitions and Sustainability

Programme: B.Sc. Environmental Science and Sustainability

Semester: IV

Course Code: EVS236

Course Type: Major core Course

L-T-P-C: 3-0-1-4

Course Objectives

- To provide a foundational understanding of energy systems, their sources, and consumption patterns.
- To explore the environmental, economic, and social challenges posed by current energy systems.
- To introduce students to sustainability science and the principles of energy transition.
- To evaluate global and regional pathways for transitioning to renewable and low-carbon energy systems.
- To develop analytical skills for assessing sustainable energy solutions, energy policies, and their climate linkages.

Course Outcomes

Upon successful completion of this course, students will be able to:

CO1: Understand different types of energy sources and their environmental implications.

CO2: Explain the concept of sustainability and its relation to energy systems.

CO3: Analyse the role of renewable energy in sustainable development and climate action.

CO4: Evaluate energy transition strategies and policies at local, national, and global levels.

CO5: Demonstrate basic technical understanding of renewable energy technologies through practical exercises.

CO6: Critically reflect on energy justice, social equity, and participatory models in sustainability transitions.

Module I: Fundamentals of Energy and Sustainability

- Types of energy: renewable and non-renewable
- Energy units, efficiency, and consumption trends
- The energy-environment-economy nexus

- Introduction to sustainability concepts and SDG 7

Module II: Renewable Energy Technologies

- Solar energy: PV systems, thermal systems
- Wind energy: onshore and offshore
- Bioenergy, hydro-power energy, geothermal energy, tidal energy
- Storage, grid integration, and intermittency

Module III: Climate Change and Energy Transition

- Fossil fuel dependence and GHG emissions
- Climate mitigation through clean energy
- IPCC scenarios and carbon budgets
- National and global energy transition pathways (India, EU, China)

Module IV: Socio-political Dimensions of Energy Transitions

- Energy access, energy poverty, and energy justice
- Gender and energy
- Community-based renewable energy initiatives
- Just transitions: definitions, challenges, case studies

Module V: Policies, Markets, and Future of Energy

- Energy governance and regulatory frameworks
- Feed-in tariffs, carbon tax, renewable purchase obligations, carbon credit
- Green hydrogen, smart grids, decentralised energy systems
- Role of innovation, startups, and public-private partnerships

Practical/Field Component

- Solar PV performance analysis using simulation tools
- Wind turbine site assessment and data interpretation
- Household energy audit and LCA (Life Cycle Assessment) basics
- Case study presentation: community solar, wind farms, etc.

Textbooks and Reference Books/ Other Resources:

1. Boyle, G. (Ed.). (2012). *Renewable energy: Power for a sustainable future* (3rd ed.). Oxford University Press.
2. Sovacool, B. K. (2017). *Energy and ethics: Justice and the global energy challenge*. Palgrave Macmillan.
3. Goldthau, A., Keating, M., & Kuzemko, C. (Eds.). (2018). *Handbook of the international political economy of energy and natural resources*. Edward Elgar Publishing.
4. Pachauri, R. K., & Yamin, F. (Eds.). (2012). *Climate change and sustainable development*. TERI Press.
5. IPCC. (2022). *Climate change 2022: Mitigation of climate change. Contribution of Working Group III to the Sixth Assessment Report*. Cambridge University Press.
6. International Energy Agency (IEA). (2021). *World energy outlook 2021*. OECD Publishing.

Semester: V

Course Title: Land Use and Soil Conservation

Programme: B.Sc. Environmental Science and Sustainability

Semester: V

Course Code: EVS321

Course Type: Major core Course

L-T-P-C: 3-0-1-4

Course Objectives

- To understand the principles and patterns of land use and their socio-environmental implications.
- To examine the properties and functions of soil in terrestrial ecosystems and agriculture.
- To study causes and consequences of land degradation and soil erosion.
- To explore strategies and technologies for sustainable land management and soil conservation.
- To assess land use policies, planning frameworks, and participatory approaches to land restoration.

Course Outcomes

Upon successful completion of this course, students will be able to:

CO1: Describe different land use categories, drivers of land use change, and land capability classification.

CO2: Explain soil formation processes, properties, and roles in ecological and agricultural systems.

CO3: Identify causes of soil erosion, salinisation, acidification, and other forms of degradation.

CO4: Evaluate traditional and modern soil conservation measures for diverse landscapes.

CO5: Analyse land use and soil conservation policies and institutional frameworks.

CO6: Apply knowledge to interpret land use maps, assess land degradation, and recommend sustainable land use strategies.

Module I: Fundamentals of Land Use and Land Cover

- Classification of land use and land cover (LULC)
- Land use patterns in India and globally
- Land capability and suitability classification
- Urbanisation, deforestation, agricultural expansion, mining impacts
- Remote sensing and GIS in LULC mapping

Module II: Soil Formation, Properties, and Functions

- Factors and processes of soil formation
- Physical, chemical, and biological properties of soil
- Soil profiles and classification (FAO, USDA, NBSS&LUP)
- Soil fertility, nutrient cycles, and microbial functions
- Role of soil in ecosystem services and food security

Module III: Land Degradation and Soil Erosion

- Types and causes of land degradation: water and wind erosion, salinity, waterlogging
- Soil erosion processes and factors (RUSLE model basics)
- Desertification and its drivers (UNCCD context)
- Impacts of land degradation on biodiversity, productivity, and climate
- Case studies from India (Bundelkhand, Chambal, Rajasthan, Sundarbans)

Module IV: Soil and Water Conservation Techniques

- Mechanical measures: contour bunding, terracing, check dams, gully plugging
- Vegetative measures: cover cropping, agroforestry, shelterbelts, strip cropping
- Soil fertility management: composting, mulching, organic farming
- Participatory land restoration
- Traditional indigenous practices of land and soil conservation

Module V: Policy, Planning and Sustainable Land Management

- National Land Use Policy, Wasteland Atlas, and land use planning tools
- Role of institutions: NBSS&LUP, ICAR, NRSC, State Land Use Boards
- Land tenure, property rights, and common lands
- Global programmes: UNCCD, LDN (Land Degradation Neutrality), SDG 15
- Participatory planning and success stories in sustainable land and soil management

Practical / Field Component

- Identification of land-use/land-cover types using satellite imagery or Google Earth.
- Soil sampling and analysis of pH, texture, moisture and organic matter.
- Field observation of soil erosion features and conservation structures.
- Preparation of a simple land degradation map for a selected area.
- Design of a soil and water conservation plan for a small site.

Textbooks and Reference Books/ Other Resources:

1. Brady, N. C., & Weil, R. R. (2016). *The nature and properties of soils* (15th ed.). Pearson Education.
2. Sehgal, J. (2005). *Pedology: Concepts and applications*. Kalyani Publishers.
3. Lal, R. (2000). *Soil conservation and management*. CRC Press.
4. Indian Council of Agricultural Research (ICAR). (2010). *Handbook of soil and water conservation practices*. ICAR Publications.
5. United Nations Convention to Combat Desertification (UNCCD). (n.d.). *Land degradation and sustainable land management reports*. <https://www.unccd.int/>
6. National Bureau of Soil Survey and Land Use Planning (NBSS&LUP). (n.d.). *Soil maps and land resource inventories*. Indian Council of Agricultural Research. <https://www.nbsslup.in/>

Course Title: Waste Management and Circular Economy

Programme: B.Sc. Environmental Science and Sustainability

Semester: V

Course Code: EVS322

Course Type: Major core Course

L-T-P-C: 3-0-1-4

Course Objectives

- To provide foundational understanding of solid and hazardous waste types, sources, and management strategies.
- To introduce policies, regulatory frameworks, and institutional mechanisms related to waste management in India.

- To explore the concepts, models, and applications of the circular economy for sustainable resource use.
- To develop practical skills in waste characterisation, auditing, and segregation techniques.
- To sensitise students to innovative business models, recycling, and upcycling practices for zero-waste solutions.

Course Outcomes

Upon successful completion of this course, students will be able to:

CO1: Classify different types of wastes and describe their sources, properties, and environmental impacts.

CO2: Interpret regulatory frameworks and institutional responsibilities related to waste management in India.

CO3: Evaluate methods of waste collection, segregation, treatment, recycling, and final disposal.

CO4: Apply circular economy principles to resource management and waste reduction strategies.

CO5: Design waste audits and zero-waste models for institutions and urban systems.

CO6: Demonstrate hands-on skills in waste categorisation, composting, recycling, and upcycling through practical exercises.

Module I: Fundamentals of Waste and Classification

- Definition and types of waste: solid, liquid, biomedical, e-waste, hazardous, radioactive
- Waste sources: municipal, industrial, agricultural, household, and institutional
- Physical, chemical, and biological characteristics of waste
- Health and environmental impacts of improper waste disposal
- Waste hierarchy: reduce, reuse, recycle, recover, dispose

Module II: Waste Management Rules in India

- Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016
- E-Waste (Management) Rules, 2016
- Plastic Waste Management Rules, 2016 (amended 2022)
- Solid Waste Management Rules, 2016
- Construction and Demolition Waste Management Rules, 2016
- Bio-Medical Waste Management Rules, 2016
- Extended Producer Responsibility (EPR) and institutional mechanisms

Module III: Collection, Treatment, and Disposal Technologies

- Waste collection systems and segregation at source
- Composting: aerobic, vermicomposting, in-vessel methods
- Anaerobic digestion and biogas generation
- Recycling technologies (paper, plastic, glass, e-waste)
- Incineration and landfill: design, types, leachate and gas management
- Integrated Waste Management (IWM) models

Module IV: Circular Economy: Principles and Practices

- Definition, need, and benefits of circular economy
- Linear and circular models of resource flow
- LCA: Design for circularity, cradle-to-cradle, closed-loop systems
- Circular business models: product-service systems, take-back schemes

- Industrial symbiosis and resource recovery innovations
- National and international strategies (EU Circular Economy Action Plan, India's Resource Efficiency Strategy)

Module V: Tools, Innovations, and Community Engagement

- Waste audit: methodology, indicators, and data recording
- Behavioural change communication (BCC) for waste reduction
- Role of start-ups and social enterprises (e.g., Swachh Bharat, Kabadiwala Connect)
- Informal sector and waste pickers: integration into formal systems
- Education and awareness campaigns: design and delivery
- Best practices: zero-waste campuses, cities, and eco-industrial parks

Practical / Field and Applied Components

- Field visit to composting units, landfills, or MRF (Material Recovery Facilities)
- Hands-on waste audit of a classroom or department
- Segregation, weighing, and categorisation of dry/wet waste
- Preparation of compost using local biodegradable waste
- Waste-to-wealth project: plastic bricks, recycled paper products, etc.
- Group assignment: Circular redesign proposal for a product or service

Textbooks and Reference Books/ Other Resources:

1. Tchobanoglous, G., Theisen, H., & Vigil, S. (1993). *Integrated solid waste management: Engineering principles and management issues*. McGraw-Hill.
2. Sharma, S. (2016). *Waste management and resource efficiency*. Springer.
3. United Nations Environment Programme (UNEP). (2018). *Circular economy: An introduction*. UNEP. <https://www.unep.org/>
4. Central Pollution Control Board (CPCB). (2016). *Waste management rules 2016: Guidelines and notifications*. Ministry of Environment, Forest and Climate Change, Government of India. <https://cpcb.nic.in/>
5. Ellen MacArthur Foundation. (n.d.). *Circular economy reports and case studies*. <https://ellenmacarthurfoundation.org/>
6. Ministry of Housing and Urban Affairs (MoHUA). (n.d.). *Swachh Bharat Mission portal and MoEFCC publications*. <https://swachhbharatmission.gov.in/>
7. Chakrabarti, S. (2019). *Treatment of urban solid waste: Engineering and integrated management*. The Energy and Resources Institute (TERI).

Course Title: Environmental Legislation and Environmental Impact Assessment

Programme: B.Sc. Environmental Science and Sustainability

Semester: V

Course Code: EVS323

Course Type: Major core Course

L-T-P-C: 3-0-1-4

Course Objectives

- To provide an understanding of national and international environmental laws, policies, and institutional frameworks.

- To familiarise students with the legal tools and enforcement mechanisms used in environmental governance.
- To introduce the principles, process, and significance of Environmental Impact Assessment (EIA).
- To develop students' capacity to evaluate environmental clearance reports, impact studies, and mitigation plans.
- To build practical skills in conducting screening, scoping, and environmental audits through hands-on exercises and case studies.

Course Outcomes

Upon successful completion of this course, students will be able to:

CO1: Describe the evolution and framework of environmental legislation in India and globally.

CO2: Interpret key environmental acts, rules, and regulations relevant to air, water, forests, and biodiversity.

CO3: Explain the process and importance of EIA in sustainable development and project clearance.

CO4: Apply steps such as screening, scoping, baseline data collection, and impact prediction in EIA.

CO5: Analyse EIA reports and understand public consultation and stakeholder involvement.

CO6: Evaluate environmental management plans (EMP), audits, and post-clearance monitoring mechanisms.

Module I: Environmental Governance and Legal Framework

- Constitutional provisions for environmental protection (Articles 48A, 51A(g))
- Role of judiciary and the National Green Tribunal (NGT)
- Principles of environmental law: precautionary, polluter-pays, intergenerational equity
- Institutional setup: MoEFCC, CPCB, SPCBs
- Introduction to international environmental law: Stockholm (1972), Rio (1992), History of COPs, Important COPs.

Module II: Major Environmental Laws in India

- The Environment (Protection) Act, 1986
- The Water (Prevention and Control of Pollution) Act, 1974
- The Air (Prevention and Control of Pollution) Act, 1981
- Forest Conservation Act, 1980 and Wildlife Protection Act, 1972
- CRZ (Notification), 2018; Island Protection Zone Notification, 2011
- Regulation of Persistent Organic Pollutants Rules, 2018 under the provisions of Environment (Protection) Act, 1986
- Other important environmental acts and rules.

Module III: Introduction to Environmental Impact Assessment (EIA)

- Definition, objectives, and scope of EIA
- Legal basis for EIA: EIA Notification 2006 and amendments
- Types of EIA: Rapid, Comprehensive, Strategic EIA
- Screening, Scoping, Terms of Reference (ToR)
- Stakeholder roles and inter-agency coordination

Module IV: EIA Methodology and Tools

- Baseline data collection (air, water, soil, noise, ecology, socio-economic)
- Impact prediction techniques (checklists, matrices, overlays, models)
- Risk assessment and mitigation strategies
- Public consultation and disclosure
- Cost-benefit analysis and sustainability appraisal

Module V: EMP, Environmental Auditing and Case Studies

- Environmental Management Plans (EMPs): structure and examples
- Corporate Environment Responsibility (CER)
- Environmental auditing: types, objectives, ISO 14001 basics
- Post-clearance monitoring and compliance
- Case studies: mining projects, infrastructure (roads, dams), industries (thermal power plants, cement)
- Role of NGOs and civil society in environmental justice

Practical / Field and Applied Components

- Analysis of a sample EIA report (real project)
- Drafting a mock EIA for a small-scale infrastructure project
- Public hearing simulation or debate
- Field visit to an industry for compliance audit exposure
- Comparison of Indian and international EIA systems
- Group project: Developing an EMP for a hypothetical development activity

Textbooks and Reference Books/ Other Resources:

1. Divan, S., & Rosencranz, A. (2001). *Environmental law and policy in India: Cases, materials and statutes* (2nd ed.). Oxford University Press.
2. Kulkarni, V., & Ramachandra, T. V. (2006). *Environmental management*. Capital Publishing Company.
3. Ministry of Environment, Forest and Climate Change (MoEFCC). (2006). *Environmental Impact Assessment Notification, 2006* (and subsequent amendments). Government of India. Retrieved from <https://moef.gov.in>
4. Canter, L. W. (1996). *Environmental impact assessment* (2nd ed.). McGraw-Hill Education.
5. United Nations Environment Programme (UNEP). (2002). *EIA training resource manual: For environmental impact assessment and environmental auditing*. UNEP. Retrieved from <https://www.unep.org>
6. Ministry of Environment, Forest and Climate Change (MoEFCC). (n.d.). *National Green Tribunal (NGT) judgments archive*. Retrieved from <https://moef.gov.in>

Course Title: Internship

Programme: B.Sc. Environmental Science and Sustainability

Semester: V

Course Type: Internship

Course Code: EVS324

L–T–P–C: 0–0–0–2

Course Objectives:

- To provide hands-on exposure to environmental work in professional or community settings.
- To help students understand institutional, technical, and policy dimensions of environmental practice.
- To encourage the development of workplace skills including teamwork, communication, and problem-solving.
- To apply classroom knowledge in real-world environmental and sustainability initiatives.
- To prepare students for career pathways by building industry or field-based experience.

Course Outcomes (COs):

CO1: Gain practical understanding of environmental systems through field or institutional engagement.

CO2: Apply theoretical knowledge to address sustainability challenges encountered during the internship.

CO3: Develop professional competencies such as communication, time management, and teamwork.

CO4: Reflect critically on organisational functions, project management, and sustainability practices.

CO5: Prepare a detailed internship report, demonstrating analytical and observational skills.

CO6: Build clarity about potential career paths and strengthen employability in the environmental sector.

Course Details:

The internship offers students practical exposure to real-world environmental challenges by engaging them with organisations such as environmental consultancy firms, research institutes, NGOs, governmental departments, or industries. The experience aims to bridge academic learning with professional practice, enhance employability skills, and cultivate a deeper understanding of environmental systems and sustainability frameworks. Each student is required to complete a minimum number of working hours (Minimum 4 weeks) and submit a report detailing their observations, learnings, and reflections.

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Semester: VI

Course Title: Data Science, Statistics and AI in Environmental Science

Programme: B.Sc. Environmental Science and Sustainability

Semester: VI

Course Code: EVS325

Course Type: Major core Course

L-T-P-C: 3-0-1-4

Course Objectives

- To introduce the fundamentals of data science, statistical analysis, and AI with a focus on environmental applications.

- To develop competency in handling environmental datasets and extracting meaningful insights.
- To teach the basics of predictive modelling, machine learning, and pattern recognition in environmental contexts.
- To familiarise students with statistical and computational tools for data analysis.
- To build the capacity for data-driven decision-making in environmental monitoring, modelling, and management.

Course Outcomes

Upon successful completion of this course, students will be able to:

CO1: Understand and apply basic statistical concepts to analyse environmental data.

CO2: Manage, clean, and visualise environmental datasets using data science tools.

CO3: Apply supervised and unsupervised learning algorithms for environmental predictions.

CO4: Interpret outputs from AI and machine learning models in the context of environmental science.

CO5: Use programming and software tools for environmental data analytics and model building.

CO6: Critically evaluate the role of data science and AI in addressing environmental challenges.

Module I: Fundamentals of Data Science and Environmental Data

- Introduction to data science and its relevance in environmental studies
- Types of environmental data: structured, unstructured, time series, spatial
- Data acquisition: sensors, remote sensing, monitoring stations, surveys
- Data quality: accuracy, precision, uncertainty, missing values
- Basics of data cleaning and preparation

Module II: Statistical Methods for Environmental Analysis

- Descriptive statistics: mean, median, mode, standard deviation, skewness, kurtosis
- Probability distributions (Normal, Poisson, Binomial)
- Hypothesis testing (t-test, chi-square, ANOVA)
- Correlation and regression analysis

Module III: Introduction to Artificial Intelligence and Machine Learning

- AI, ML, and Deep Learning: Basic concepts and differences
- Supervised learning (classification and regression): decision trees, random forest, support vector machines
- Unsupervised learning: clustering (k-means, hierarchical)
- Neural networks: basic concepts
- Ethical considerations in AI and environmental data

Module IV: Applications of Data Science and AI in Environmental Science

- Air quality prediction and monitoring
- Climate change modelling and forecasting
- Biodiversity monitoring and species distribution modelling
- Water quality analysis and prediction
- Land use classification through machine learning and remote sensing

Module V: Tools, Software, and Practical Applications

- Introduction to R and Python for environmental data analysis

- Data cleaning and organisation of environmental datasets in Excel/R/Python.
- Descriptive statistics and visualisation of air/water/climate data.
- Correlation and regression analysis using environmental datasets.
- Basic machine-learning model for air quality/water quality prediction.
- Mini-project: data-based environmental interpretation and presentation data visualisation tools: matplotlib, seaborn, ggplot2
- Machine learning libraries: Scikit-learn, TensorFlow (basics)
- Hands-on mini-project: build a simple predictive model using real-world environmental data
- Future trends: Big data, IoT, and AI integration in environmental sustainability

Textbooks and Reference Books/ Other Resources:

1. Montgomery, D. C., & Runger, G. C. (2014). *Applied statistics and probability for engineers* (6th ed.). Wiley.
2. Géron, A. (2022). *Hands-on machine learning with Scikit-Learn, Keras, and TensorFlow: Concepts, tools, and techniques to build intelligent systems* (3rd ed.). O'Reilly Media.
3. Witten, I. H., Frank, E., Hall, M. A., & Pal, C. J. (2016). *Data mining: Practical machine learning tools and techniques* (4th ed.). Morgan Kaufmann.
4. Brunsdon, C., & Comber, L. (2019). *An introduction to R for spatial analysis and mapping* (2nd ed.). SAGE Publications Ltd.
5. Berthouex, P. M., & Brown, L. C. (2002). *Statistics for environmental engineers* (2nd ed.). CRC Press.
6. Friedman, D., Pisani, R., & Purves, R. (2004). *Statistics* (4th ed.). W. W. Norton & Company.
7. Various authors. (n.d.). *Research papers and case studies on AI applications in environmental science*.

Course Title: Instruments and Analytical Methods

Programme: B.Sc. Environmental Science and Sustainability

Semester: VI

Course Code: EVS326

Course Type: Major core Course

L-T-P-C: 3-0-1-4

Course Objectives

- To familiarise students with the principles and working of key analytical instruments used in environmental studies.
- To introduce quantitative and qualitative analytical methods relevant to environmental samples.
- To build competency in sample collection, preservation, and preparation for instrumental analysis.
- To impart hands-on skills in laboratory instrumentation, calibration, and data interpretation.

- To train students in maintaining quality assurance, standard operating procedures (SOPs), and data integrity in environmental labs.

Course Outcomes

Upon successful completion of this course, students will be able to:

CO1: Understand the basic principles of instrumental and analytical techniques used in environmental monitoring.

CO2: Identify appropriate instruments for the analysis of air, water, and soil pollutants.

CO3: Perform standard procedures for sample collection, preservation, and preparation.

CO4: Operate common instruments like spectrophotometers, pH meters, and conductometers.

CO5: Interpret data generated from instrumental analysis with attention to accuracy and precision.

CO6: Apply concepts of calibration, quality control, and error minimisation in environmental laboratories.

Module I: Basics of Analytical Chemistry

- Definitions: accuracy, precision, detection limit, sensitivity, selectivity
- Types of analysis: qualitative vs. quantitative
- Errors in analysis: systematic and random errors
- Units, conversions, and concentration terms (ppm, ppb, molarity, normality)
- Sample handling: collection, preservation, storage
- Overview of wet chemical methods vs. instrumental techniques

Module II: Spectroscopic Techniques

- Principles of light absorption and transmittance
- Emission Spectroscopy: Flame Photometry, ICP
- UV-Vis Spectrophotometry: components, working principle, calibration curve
- Atomic Absorption Spectroscopy (AAS): flame and graphite furnace AAS
- Fluorometry and its environmental applications
- Applications: heavy metals, nitrates, phosphates, organics in water

Module III: Electrochemical and Chromatographic Methods

- pH meter: principle, calibration, applications
- Conductivity and TDS meter: significance in water and soil analysis
- Ion-selective electrodes and ORP meters
- Chromatography: principles of paper, thin-layer (TLC), gas (GC), and liquid chromatography (HPLC)
- Applications: pesticide, PAHs, VOCs, and nutrient analysis

Module IV: Gravimetric, Titrimetric and Thermal Methods

- Principle of gravimetric estimation (e.g., sulphates, solids in water)
- Types of titrations: acid-base, redox, complexometric, precipitation
- Indicators and end point detection
- Thermogravimetric analysis (TGA): principle and environmental use

Module V: Data Handling, Calibration, and QA/QC

- Calibration standards and blank corrections
- Preparation of calibration curves and linearity checks
- Reproducibility, repeatability, control charts

- QA/QC protocols and SOPs in environmental labs
- Introduction to GLP (Good Laboratory Practices) and NABL accreditation
- Data reporting and error minimisation

Practical / Laboratory Components

- Operation of pH meter, conductivity meter, and spectrophotometer
- Preparation of standard solutions and calibration curves
- Estimation of nitrate/phosphate using UV-Vis spectrophotometry
- Determination of water hardness and alkalinity by titrimetry
- Demonstration/visit: AAS, GC/HPLC (in collaboration with advanced lab/industry)
- Lab record-keeping and preparation of technical reports

Textbooks and Reference Books/ Other Resources:

1. Skoog, D. A., West, D. M., Holler, F. J., & Crouch, S. R. (2013). *Fundamentals of analytical chemistry* (9th ed.). Cengage Learning.
2. Willard, H. H., Merritt, L. L., Dean, J. A., & Settle, F. A. (1988). *Instrumental methods of analysis* (7th ed.). CBS Publishers & Distributors.
3. Khopkar, S. M. (2007). *Environmental pollution analysis*. New Age International Publishers.
4. Patnaik, P. (2004). *Handbook of environmental analysis: Chemical pollutants in air, water, soil, and solid wastes* (2nd ed.). CRC Press.
5. American Public Health Association (APHA). (2017). *Standard methods for the examination of water and wastewater* (23rd ed.). APHA, AWWA, WEF.
6. Christian, G. D. (2004). *Analytical chemistry* (6th ed.). Wiley India.

Course Title: EHS and Sustainable Lifestyle

Programme: B.Sc. Environmental Science and Sustainability

Semester: VI

Course Code: EVS327

Course Type: Major core Course

L-T-P-C: 4-0-0-4

Course Objectives

- To introduce the principles of Environment, Health, and Safety (EHS) in the context of individual and institutional sustainability.
- To impart awareness on occupational safety, public health, and environmental risk management.
- To familiarise students with national and international EHS regulations, standards, and audit mechanisms.
- To promote the concept of a sustainable lifestyle through mindful consumption, well-being, and environmental stewardship.
- To encourage students to adopt responsible behaviour and ethical practices aligned with sustainability goals.

Course Outcomes

Upon successful completion of this course, students will be able to:

CO1: Define and explain the principles of Environment, Health, and Safety (EHS) in daily and organisational contexts.

CO2: Identify workplace and lifestyle-related environmental and health hazards and recommend safety measures.

CO3: Interpret EHS laws, ISO standards, and audit practices applicable to environmental safety and compliance.

CO4: Develop personal and community-based strategies for sustainable living, resource conservation, and waste reduction.

CO5: Assess the impact of lifestyle choices on personal well-being and environmental health.

CO6: Practise critical thinking and behavioural change toward ethical, minimalistic, and responsible consumption.

Module I: Introduction to EHS - Concepts and Scope

- Definition and components of EHS: environment, occupational health, and safety
- Scope of EHS in industry, academia, and households
- Workplace hazards: physical, chemical, ergonomic, biological
- Risk assessment, accident causation theories, and control measures
- Basic principles of hazard communication and signage systems

Module II: EHS Compliance

- International conventions and frameworks: ILO, OSHA, REACH, GHS
- Environmental audits, health surveillance, and workplace inspections
- Emergency response, first aid, and fire safety protocols
- ISO 14001 (EMS), ISO 45001 (OHSMS), and EHS management systems

Module III: Health, Hygiene, and Environmental Well-being

- Public health, occupational diseases, and preventive strategies
- Water, air, and sanitation-related health concerns
- Personal hygiene, mental health, and stress management
- Noise and indoor pollution: sources and mitigation
- Urban health and vulnerable populations (children, elderly, informal workers)

Module IV: Principles of Sustainable Lifestyle

- Concept of sustainability in everyday life: needs and wants, Indian Traditional Knowledge Systems.
- Ecological footprint and carbon footprint analysis
- Consumption patterns, fast fashion, food choices, e-waste
- Minimalism, ethical consumerism, and sustainable living models
- Time, energy, and resource management in daily life

Module V: Behavioural Change and Sustainable Practices

- Psychology of behaviour change: nudging, social norms, incentives
- Campus sustainability initiatives: green hostels, waste segregation, energy audit
- Role of youth and communities in driving sustainability
- Lifestyle for Environment (LiFE) movement - policy and practice
- Case studies: Zero Waste Homes, Eco-clubs, sustainable campuses, green hostels

Textbooks and Reference Books/ Other Resources:

1. Goel, S. (2017). *Environment, health and safety*. Deep & Deep Publications.
2. Basu, R. (2001). *Environmental management*. Universities Press.
3. World Health Organization. (n.d.). *Reports on public health and environment*.
<https://www.who.int>
4. International Organization for Standardization. (2015). *ISO 14001:2015 – Environmental management systems – Requirements with guidance for use*. ISO.
5. International Organization for Standardization. (2018). *ISO 45001:2018 – Occupational health and safety management systems – Requirements with guidance for use*. ISO.
6. United Nations Environment Programme. (n.d.). *Sustainable lifestyles and education programme*. <https://www.unep.org>
7. Ministry of Environment, Forest and Climate Change (MoEFCC). (n.d.). *Mission LiFE resource materials*. <https://moef.gov.in>

Course Title: Project

Programme: B.Sc. Environmental Science and Sustainability

Semester: VI

Course Code: EVS328

Course Type: Major core Course

L-T-P-C: 0-0-4-4

Course Objectives

- To provide hands-on experience in identifying and addressing real-world environmental or sustainability issues through independent or group research.
- To cultivate scientific inquiry and problem-solving skills through the formulation of research questions, hypotheses, and data collection strategies.
- To enhance students' competencies in scientific writing, referencing, data interpretation, and report preparation aligned with professional and academic standards.
- To encourage interdisciplinary and field-based learning that integrates ecological, social, economic, and technological perspectives.
- To develop teamwork, project management, and communication skills essential for careers in research, consultancy, development sectors, or higher education.

Course Outcomes (COs)

CO1: Identify and define a relevant environmental or sustainability problem and formulate research objectives or questions to address it.

CO2: Design a project plan, select appropriate methods for data collection and analysis, and demonstrate ethical and safety considerations.

CO3: Collect, manage, and analyse qualitative and/or quantitative data using suitable analytical tools and technologies.

CO4: Interpret results in relation to existing literature and theoretical frameworks in environmental science and sustainability.

CO5: Prepare and present a well-structured project report or dissertation that communicates findings with clarity and academic integrity.

CO6: Demonstrate collaborative and independent working abilities, professional behaviour, and critical reflection on the learning process and outcomes.

Course Description:

This capstone course provides students with the opportunity to engage in independent, original, and application-oriented research in the domain of environmental science and sustainability. Students will conceptualise, design, and execute a project under faculty supervision, either individually or in small groups. The project may be field-based, laboratory-based, analytical, or review-oriented, focusing on pressing environmental challenges, sustainable solutions, or ecosystem studies.

The course aims to foster interdisciplinary thinking, scientific inquiry, and solution-oriented learning. It encourages students to connect theoretical knowledge with practical application, develop analytical and critical thinking skills, and communicate scientific findings effectively. Students will also learn project documentation, ethical research practices, and teamwork.

Evaluation is based on project planning, execution, final report submission, presentation, and viva voce.

Semester: VII

Course Title: Climate Change Adaptation and Mitigation Strategies

Programme: B.Sc. Environmental Science and Sustainability

Semester: VII

Course Code: EVS421

Course Type: Major core Course

L-T-P-C: 4-0-0-4

Course Objectives

- To introduce students to the scientific basis and global implications of climate change.
- To distinguish between adaptation and mitigation approaches and their applications in various sectors.
- To analyse sector-specific climate impacts and appropriate response strategies.
- To familiarise students with international frameworks, national policies, and community-based initiatives for climate resilience.
- To develop critical thinking skills for evaluating and designing adaptive and mitigative responses.

Course Outcomes

Upon successful completion of this course, students will be able to:

CO1: Understand the key drivers and effects of climate change on natural and human systems.

CO2: Differentiate between climate change adaptation and mitigation and explain their interconnections.

CO3: Identify and assess adaptation strategies across agriculture, water, health, and urban sectors.

CO4: Evaluate major mitigation strategies including carbon markets, renewables, afforestation, and energy efficiency.

CO5: Interpret national and international climate policies, including NDCs, IPCC frameworks, and the Paris Agreement.

CO6: Formulate integrated approaches for sustainable climate risk management using local and global case studies.

Module I: Introduction to Climate Change and Vulnerability

- Scientific evidence and projections
- Vulnerability, exposure, and risk concepts
- Global hotspots and at-risk populations
- IPCC reports and risk frameworks

Module II: Adaptation Strategies

- Types of adaptation: anticipatory, reactive, autonomous, planned
- Sector-specific adaptation (agriculture, water, health, infrastructure)
- Community-based adaptation and traditional knowledge
- Resilience thinking and nature-based solutions

Module III: Mitigation Strategies

- Energy efficiency and renewable energy
- Carbon sequestration: afforestation, soil carbon
- Low-carbon transportation and green buildings
- Circular economy and climate-smart agriculture

Module IV: Climate Policy and Governance

- Overview of climate finance flows and access
- Risk management in financial institutions
- Green bonds, sustainability-linked loans, ESG investing
- Blended finance, just transition finance
- Climate risk integration into investment decisions
- Role of MDBs (Multilateral Development Banks), GCF, Adaptation Fund
- UNFCCC, Kyoto Protocol, Paris Agreement
- Nationally Determined Contributions (NDCs)
- Climate finance: Green Climate Fund, adaptation funds
- India's National Action Plan on Climate Change (NAPCC) and SAPCCs

Module V: Integrated and Cross-cutting Approaches

- Synergies and trade-offs between adaptation and mitigation
- Technology transfer and innovation
- Monitoring, Evaluation, and Learning (MEL) frameworks
- Role of NGOs, private sector, and citizen participation

Textbooks and Reference Books/ Other Resources:

1. Field, C. B., Barros, V. R., Dokken, D. J., Mach, K. J., & Mastrandrea, M. D. (Eds.). (2014). *Climate change 2014: Impacts, adaptation, and vulnerability*. Cambridge University Press.

2. Klein, R. J. T., Huq, S., Denton, F., Downing, T., Richels, R., Robinson, J. B., & Toth, F. L. (2007). *Inter-relationships between adaptation and mitigation*. In *Climate Change 2007: Impacts, Adaptation and Vulnerability*. Cambridge University Press.
3. Parry, M. L., Canziani, O. F., Palutikof, J. P., van der Linden, P. J., & Hanson, C. E. (Eds.). (2007). *Climate change 2007: Impacts, adaptation and vulnerability*. IPCC Working Group II. Cambridge University Press.
4. Ministry of Environment, Forest and Climate Change (MoEFCC). (2021). *India's updated NDC and Long-Term Low Emission Development Strategy*. Government of India.
5. UNFCCC. (2015). *The Paris Agreement*. United Nations Framework Convention on Climate Change.
6. Burton, I., Diringer, E., & Smith, J. (2006). *Adaptation to climate change: International policy options*. Pew Center on Global Climate Change.
7. IPCC. (2023). *AR6 Synthesis Report: Climate Change 2023*. Intergovernmental Panel on Climate Change.
8. United Nations Framework Convention on Climate Change (UNFCCC). (2015). *The Paris Agreement*. United Nations.
9. Task Force on Climate-Related Financial Disclosures (TCFD). (2017). *Recommendations of the TCFD*. Financial Stability Board.
10. Khan, M. R., & Roy, P. (2022). *Climate Change and Risk: Implications for Financial Markets and Institutions*. Springer.
11. Elkington, J. (2020). *Green Swans: The Coming Boom in Regenerative Capitalism*. Fast Company Press.
12. UNEP Finance Initiative. (2021). *Guidelines for Climate Target Setting for Banks*.
13. OECD. (2022). *Climate Finance and the USD 100 Billion Goal: A Summary of Progress*.

Course Title: Environmental, Social and Governance

Programme: B.Sc. Environmental Science and Sustainability

Semester: VII

Course Code: EVS422

Course Type: Major core Course

L-T-P-C: 2-1-1-4

Course Objectives

- To introduce the fundamental principles and components of ESG and its relevance in sustainability.
- To understand global and national frameworks, standards, and reporting mechanisms in ESG.
- To equip students with tools to evaluate ESG risks, metrics, and disclosures across sectors.
- To explore the interlinkages between corporate responsibility, stakeholder engagement, and ethical governance.
- To build foundational analytical and reporting skills for ESG performance assessment.

Course Outcomes

Upon successful completion of this course, students will be able to:

CO1: Explain the concepts, significance, and evolution of ESG in environmental and economic contexts.

CO2: Identify and interpret key ESG frameworks, standards, and regulatory requirements.

CO3: Assess environmental, social, and governance risks in different industries.

CO4: Analyse ESG metrics and sustainability disclosures of public and private organisations.

CO5: Apply ESG principles in real-world scenarios using case studies and practical examples.

CO6: Demonstrate skills in ESG reporting, stakeholder mapping, and sustainable investment analysis.

Module I: Introduction to ESG Concepts and Evolution

- ESG: Origins and evolution
- Relation with CSR, Sustainability and SDGs.
- Importance of ESG for business, government, and society
- ESG drivers: climate change, stakeholder activism, ethical investing
- Global ESG trends and industry adoption

Module II: ESG Frameworks, Standards, and Guidelines

- Global frameworks:
 - Global Reporting Initiative (GRI)
 - Sustainability Accounting Standards Board (SASB)
 - Task Force on Climate-Related Financial Disclosures (TCFD)
 - UN PRI
- Indian context: BRSR (Business Responsibility and Sustainability Report), SEBI guidelines
- ESG ratings agencies: MSCI, Sustainalytics, S&P Global and others

Module III: Environmental, Social, and Governance Pillars

- **Environmental Pillar:** climate impact, carbon accounting, pollution control, natural resource usage
- **Social Pillar:** employee relations, DEI, community impact, occupational health and safety
- **Governance Pillar:** board structure, anti-corruption, transparency, executive compensation
- Materiality assessment and double materiality

Module IV: ESG Risk Assessment and Management

- ESG risk identification, classification, and evaluation
- Sectoral ESG risks and opportunities (energy, agriculture, finance, FMCG, manufacturing)
- Climate risk disclosure and adaptation strategies
- ESG integration in business strategy and risk management
- Role of ESG in corporate resilience and compliance

Module V: ESG Analytics, Reporting, and Case Studies

- ESG metrics and Key Performance Indicators (KPIs)
- ESG data collection and assurance
- ESG reporting tools and software
- Case studies of ESG practices from India and abroad
- Group activity: Prepare an ESG Snapshot Report for a sample company

Practical / Tutorial Component

- Interpretation of ESG reports of companies listed on NSE/BSE
- Stakeholder mapping exercises
- ESG risk matrix preparation
- Mock sustainability reporting task
- Simple GHG inventory or SDG mapping project

Textbooks and Reference Books/ Other Resources

1. CFA Institute - *Introduction to ESG Investing*
2. UN PRI & UNEP FI publications
3. SEBI BRSR Handbook
4. “Sustainable Investing” - BlackRock, Morningstar reports
5. ESG reports from TCS, ITC, HUL, Reliance, etc.
6. GRI, SASB, and TCFD documentation

Course Title: Applications of RS-GIS in Environmental Science and Sustainability

Programme: B.Sc. Environmental Science and Sustainability

Semester: VII

Course Code: EVS423

Course Type: Major core Course

L-T-P-C: 2-1-1-4

Course Objectives

- To provide foundational understanding of the principles of remote sensing and GIS technologies.
- To introduce various satellite sensors, data types, and image processing techniques used in environmental applications.
- To equip students with the skills to use GIS software for mapping and spatial analysis of environmental parameters.
- To explore the use of RS-GIS tools in resource management, pollution monitoring, disaster mitigation, and urban planning.
- To develop students' ability to design and interpret RS-GIS-based environmental studies.

Course Outcomes

Upon successful completion of this course, students will be able to:

CO1: Understand the principles, terminology, and historical evolution of remote sensing and GIS.

CO2: Describe various platforms, sensors, data types, and preprocessing techniques in RS and GIS.

CO3: Analyse and interpret satellite imagery for environmental monitoring and assessment.

CO4: Apply GIS tools to perform spatial analysis and create thematic maps for environmental data.

CO5: Demonstrate the application of RS-GIS techniques in real-world problems such as deforestation, land use change, and disaster management.

CO6: Conduct an independent mini-project using RS-GIS tools for solving a selected environmental problem.

Module I: Fundamentals of Remote Sensing and GIS

- Definition and scope of Remote Sensing (RS) and GIS
- Electromagnetic spectrum and energy interaction with atmosphere and earth surface
- Types of remote sensing: active vs passive, optical vs microwave
- Components and functioning of GIS
- Coordinate systems, projections, and data models (raster and vector)

Module II: Sensors, Platforms, and Data Acquisition

- Aerial photography vs satellite remote sensing
- Satellite platforms: IRS, Landsat, MODIS, Sentinel, Cartosat, etc.
- Sensors: Panchromatic, multispectral, hyperspectral, thermal, and radar sensors
- Types of data: spatial, spectral, temporal, and radiometric resolution
- Data formats and sources (Bhuvan, USGS Earth Explorer, NASA Earthdata)

Module III: Image Processing and Analysis

- Image preprocessing: radiometric and geometric correction
- Image enhancement: contrast stretching, filtering
- Image classification: supervised and unsupervised methods
- Accuracy assessment and ground truthing
- Change detection techniques

Module IV: GIS Tools and Environmental Applications

- GIS operations: buffering, overlay, query, and spatial statistics
- Thematic mapping and spatial interpolation
- Environmental applications:
 - Land use/land cover change detection
 - Forest and biodiversity mapping
 - Water resource mapping and watershed analysis
 - Pollution tracking and urban sprawl
 - Disaster risk zoning (flood, landslide, drought)

Module V: Case Studies and Project-Based Applications

- National and global case studies using RS-GIS in environmental planning
- Introduction to open-source and proprietary software
- Mini-project on mapping and analysis of an environmental issue using satellite data
- Map interpretation, reporting, and visualisation techniques
- Ethics and limitations of RS-GIS in environmental research

Practical Component

- Familiarisation with GIS software interface
- Georeferencing and digitising topographic maps
- Downloading and processing satellite data
- Classification of land cover from satellite images
- Spatial analysis using real-world environmental datasets
- Mini-project presentation and reporting

Textbooks and Reference Books/ Other Resources

1. Jensen, J.R. - *Remote Sensing of the Environment*
2. Lillesand, T. & Kiefer, R.W. - *Remote Sensing and Image Interpretation*
3. Lo, C.P. & Yeung, A.K.W. - *Concepts and Techniques of GIS*
4. Bhatta, B. - *Remote Sensing and GIS*
5. ISRO-Bhuvan Portal, USGS Earth Explorer, QGIS and ArcGIS tutorials

Course Title: Research Methodology

Programme: B.Sc. Environmental Science and Sustainability

Semester: VII

Course Code: EVS424

Course Type: Major core Course (with research)

L-T-P-C: 2-1-1-4

Course Objectives

- To introduce the foundational principles and practices of scientific research in environmental science and sustainability.
- To develop the ability to formulate research questions, hypotheses, and objectives.
- To equip students with knowledge of research design, sampling techniques, data collection, and data analysis tools.
- To familiarise students with ethical issues, plagiarism, referencing styles, and scientific writing.
- To build capacity for preparing research proposals, reports, and publications in academic or applied formats.

Course Outcomes (COs)

CO1: Understand and explain the fundamentals of research methodology and its relevance to environmental and sustainability studies.

CO2: Formulate clear research objectives, questions, and hypotheses based on literature review and problem identification.

CO3: Design research frameworks, including selection of appropriate sampling techniques and data collection methods.

CO4: Apply basic statistical and analytical tools for interpretation and presentation of environmental data.

CO5: Demonstrate knowledge of research ethics, plagiarism issues, and correct citation practices using standard referencing systems.

CO6: Prepare structured research proposals and reports with clarity, precision, and academic integrity.

Module 1: Foundations of Research

- Nature, objectives and significance of research
- Types of research: Fundamental, applied, qualitative, quantitative, interdisciplinary
- Research in environmental and sustainability sciences

Module 2: Research Design and Planning

- Steps in research process
- Formulation of research problem, hypothesis and objectives
- Literature review: Sources, databases, search strategies, citation management

Module 3: Data Collection and Sampling

- Sampling techniques: Probability and non-probability sampling
- Primary and secondary data: Tools and techniques (questionnaires, interviews, observation, sensors, etc.)
- Designing surveys and field studies

Module 4: Data Analysis and Interpretation

- Types of data and variables
- Descriptive statistics, basic inferential statistics, and graphical representation
- Introduction to software tools: Excel, SPSS, R

Module 5: Research Ethics, Communication, and Proposal Writing

- Ethical issues in research: Plagiarism, consent, authorship, and data integrity
- Importance of referencing and avoiding academic misconduct, Common referencing styles: APA, MLA, Chicago, Harvard, Use of citation management tools (e.g., Zotero, Mendeley)
- Scientific writing: Reports, articles, proposals, and presentations, Visualising data: Tables, figures, graphs, and maps.

Practical / Tutorial Component

- Literature search using Google Scholar, Scopus, Web of Science and other databases.
- Preparation of research problem, objectives and hypothesis.
- Designing sampling strategy, questionnaire or field/lab data sheet.
- Referencing practice using APA style and citation-management tools.
- Preparation and presentation of a short research proposal.

Textbooks and Reference Books/ Other Resources

1. Kothari, C. R., & Garg, G. (2019). *Research methodology: Methods and techniques* (4th ed.). New Age International.
2. Kumar, R. (2021). *Research methodology: A step-by-step guide for beginners* (6th ed.). SAGE Publications.
3. Creswell, J. W., & Creswell, J. D. (2018). *Research design: Qualitative, quantitative, and mixed methods approaches* (5th ed.). SAGE Publications.
4. Dawson, C. (2019). *Introduction to research methods: A practical guide for anyone undertaking a research project* (5th ed.). Robinson.
5. Walliman, N. (2017). *Your undergraduate dissertation: The essential guide for success* (2nd ed.). SAGE Publications.
6. UNEP. (2013). *TUNZA research guide: A step-by-step guide to environmental research for young people*. United Nations Environment Programme.
7. MoEFCC & UGC. (2019). *Guidelines for Academic Integrity and Research Ethics*.

Course Title: Sustainable Designs and Supply Chain Management

Programme: B.Sc. Environmental Science and Sustainability

Semester: VII

Course Code: EVS425

Course Type: Major core Course (without research)

L-T-P-C: 3-1-0-4

Course Objectives

- To introduce the principles of sustainable product and system design with a lifecycle perspective.
- To familiarise students with sustainable supply chain frameworks and green procurement practices.
- To evaluate environmental, social, and economic impacts across the product lifecycle.
- To promote understanding of circular economy, eco-labelling, and resource-efficient supply chains.
- To equip students with tools to critically assess sustainability strategies in industrial and consumer supply chains.

Course Outcomes

CO1: Understand the concepts and principles of sustainable design and their environmental relevance.

CO2: Analyse the stages of a supply chain and identify opportunities for sustainability integration.

CO3: Apply life cycle thinking and eco-design principles in product development and system innovation.

CO4: Evaluate case studies in sustainable manufacturing, logistics, and product stewardship.

CO5: Demonstrate familiarity with global frameworks like ISO 14001, GRI, and circular economy models.

CO6: Critically assess and recommend sustainable alternatives in supply chain and design practices.

Module 1: Foundations of Sustainable Design

- Definitions and principles of sustainability and sustainable development
- Product lifecycle thinking: cradle-to-cradle, cradle-to-grave, cradle to gate etc.
- Environmental impacts of design choices
- Design for the environment (DfE) and eco-efficiency

Module 2: Life Cycle Assessment (LCA) and Circular Economy

- Introduction to Life Cycle Assessment: goal, scope, inventory, impact assessment
- Tools and software for LCA
- Circular economy and closed-loop systems
- Resource efficiency, waste minimisation, and industrial symbiosis

Module 3: Sustainable Supply Chain Management (SSCM)

- Traditional vs sustainable supply chains
- Supply chain structure: upstream, downstream, logistics, distribution
- Sustainable procurement and ethical sourcing
- Supplier selection and risk management

Module 4: Sustainable Product and Packaging Design

- Material selection and substitution
- Green materials and biodegradable alternatives
- Sustainable packaging: minimisation, reuse, recycling
- Eco-labels and certifications (e.g., EPEAT, FSC, ENERGY STAR)

Module 5: Global Standards, Case Studies, and Policy Integration

- ISO 14001 and Environmental Management Systems (EMS)
- Extended Producer Responsibility (EPR) and Waste Management Rules
- Case studies: automotive, electronics, textile, FMCG sectors
- Indian and international policies promoting sustainable supply chains

Textbooks and Reference Books/ Other Resources

- Choudhary, A. K. (2015). *Sustainable supply chains: A research-based textbook on operations and strategy*. Springer.
- Sarkis, J. (2012). *Green supply chain management: Product life cycle approach*. IGI Global.
- McDonough, W., & Braungart, M. (2002). *Cradle to cradle: Remaking the way we make things*. North Point Press.
- UNEP. (2017). *Sustainable public procurement guidelines*. United Nations Environment Programme.
- ISO. (2015). *ISO 14001: Environmental management systems—Requirements with guidance for use*.
- Manzini, E., & Vezzoli, C. (2003). *A strategic design approach to develop sustainable product service systems: Examples taken from the 'environmentally friendly innovation' Italian prize*. Journal of Cleaner Production, 11(8), 851–857.
- Indian Ministry of Environment, Forest and Climate Change (MoEFCC). (2016). *E-Waste and Plastic Waste Management Rules*.
- Ellen MacArthur Foundation. (2020). *Circular economy case studies and reports*. <https://ellenmacarthurfoundation.org>

Semester: VIII

Course Title: Green Technologies and Environmental Innovations

Programme: B.Sc. Environmental Science and Sustainability

Semester: VIII

Course Code: EVS426

Course Type: Major core Course

L-T-P-C: 3-0-1-4

Course Objectives

- To introduce the concept and principles of green technology and sustainable innovation.
- To explore technological interventions that reduce environmental impacts and promote resource efficiency.
- To understand the role of green technologies in various sectors such as energy, transport, construction, agriculture, and industry.
- To examine policies, standards, and certifications promoting the development and adoption of green technologies.

- To equip students with case-based knowledge and tools for evaluating and applying green solutions.

Course Outcomes

Upon successful completion of this course, students will be able to:

CO1: Define green technologies and explain their significance in environmental sustainability.

CO2: Identify and assess various green technologies in sectors such as energy, water, and materials.

CO3: Analyse the environmental, economic, and social benefits of adopting green innovations.

CO4: Apply principles of life cycle thinking and eco-design in evaluating technologies.

CO5: Interpret environmental certifications, green building codes, and sustainability indices.

CO6: Critically examine real-world case studies of green technology implementation across sectors.

Module I: Introduction to Green Technologies

- Definition and evolution of green technology
- Principles: reduce, reuse, recycle, recovery, redesign
- Cleaner production and industrial ecology
- Sustainability science and green innovation
- Barriers and enablers for green technology adoption

Module II: Resource Efficiency Technologies

- Energy efficiency in buildings, appliances, lighting, and motors
- Green transportation: EVs, hybrid vehicles, hydrogen fuels
- Smart grids and energy storage systems
- Water-saving technologies: dual plumbing, greywater recycling

Module III: Green Materials and Processes

- Green chemistry principles and applications
- Eco-friendly construction materials: fly ash bricks, bamboo, recycled aggregates
- Biodegradable and compostable alternatives to plastic
- Waste-to-energy, bio-refineries, and bioplastics

Module IV: Green Buildings, Infrastructure, and Urban Technologies

- Green building design: passive architecture, thermal insulation, daylighting
- Green roofs and urban forestry
- Building energy simulation and rating tools (e.g., ECBC, IGBC, LEED, GRIHA)
- Sustainable mobility: non-motorised transport, carpooling, public transit
- Smart cities and green infrastructure planning

Module V: Governance, Standards, and Case Studies

- Policy instruments: subsidies, taxes, feed-in tariffs, green procurement
- International agreements: Kigali Amendment, Paris Agreement (tech focus)
- National policies: National Electric Mobility Mission, UJALA, FAME, PAT scheme
- Green technology case studies: Amul bio-methanation, SELCO solar, urban composting in Pune
- Role of start-ups, incubators, and industry in scaling green innovations

Practical/Field Component

- Demonstration or case study of solar, biogas, composting or green building technologies.

- Calculation of energy saving, material saving or emission reduction potential.
- Comparative analysis of conventional versus green technology alternatives.
- Visit to a green building, renewable energy unit, STP, composting unit or innovation centre.
- Group project: design of a small green technology solution for campus/community use.

Textbooks and Reference Books/ Other Resources

1. Anastas, P. T., & Warner, J. C. (1998). Green chemistry: Theory and practice. Oxford University Press.
2. Mulvihill, M. J. (Ed.). (2011). Green technology: An A-to-Z guide. SAGE Publications.
3. Organisation for Economic Co-operation and Development (OECD). (2011). Fostering green growth through innovation. OECD Publishing.
4. United Nations Environment Programme (UNEP). (2011–2023). Green economy and green growth reports. UNEP. <https://www.unep.org>
5. GRIHA Council. (2023). GRIHA manual: Green Rating for Integrated Habitat Assessment. <https://www.grihaindia.org>
6. Indian Green Building Council (IGBC). (2023). IGBC rating systems and guidelines. Confederation of Indian Industry. <https://igbc.in>
7. The Energy and Resources Institute (TERI). (2020–2024). Renewables and sustainability updates. TERI Publications. <https://www.teriin.org>

Course Title: Environmental Modelling and Risk Assessment

Programme: B.Sc. Environmental Science and Sustainability

Semester: VIII

Course Code: EVS427

Course Type: Major core Course (without research)

L-T-P-C: 2-1-1-4

Course Objectives

- To introduce students to basic concepts, tools, and applications of environmental modelling.
- To develop an understanding of the role of models in assessing environmental processes and predicting changes.
- To familiarise students with qualitative and quantitative risk assessment frameworks.
- To provide practical experience with simple modelling techniques related to air, water, and soil pollution.
- To explore the integration of modelling and risk assessment in environmental decision-making and policy.

Course Outcomes (COs)

After completing this course, students will be able to:

CO1: Explain the fundamental principles and types of environmental models.

CO2: Interpret and apply basic models related to air, water, and soil contamination.

CO3: Understand and use tools of environmental risk assessment for different ecosystems.

- CO4:** Critically assess uncertainty and sensitivity in environmental model outputs.
- CO5:** Demonstrate practical skills in model application using spreadsheet tools or software.
- CO6:** Evaluate the role of model-based approaches in environmental management and decision-making.

Module I: Introduction to Environmental Modelling

- Definition, purpose, and types of models (deterministic vs stochastic, static vs dynamic)
- Steps in model development: conceptualisation, calibration, validation
- Sources of data for environmental modelling
- Model performance indicators (Nash-Sutcliffe efficiency, RMSE - conceptual only)

Module II: Air Pollution Modelling

- Conceptual introduction to air dispersion models
- **Gaussian Plume Model:** assumptions, key factors influencing dispersion (no derivation)
- Applications: industrial pollution, traffic emissions
- Case studies from urban environments

Module III: Water Quality and Aquatic Modelling

- Hydrological and water quality models
- **Streeter-Phelps DO sag curve:** conceptual understanding of oxygen deficit in polluted rivers
- Applications in eutrophication control, wastewater management
- River basin modelling tools

Module IV: Soil and Groundwater Contamination Modelling

- Contaminant transport in soils and aquifers (advection, dispersion - conceptual overview)
- Overview of groundwater flow models
- Practical examples: pesticide runoff, landfill leachate migration
- Uncertainty and sensitivity analysis in contamination models

Module V: Environmental Risk Assessment and Decision-Making

- Framework of risk assessment (hazard identification, dose-response, exposure assessment, risk characterisation)
- Use of models in risk estimation and mitigation planning
- Applications in **pollution control, resource management, and public health**
- Multi-criteria decision analysis (MCDA) for environmental planning
- Case studies: contaminated sites, industrial emissions, flood risk

Practical Component

- Preparation of conceptual models for air, water or soil pollution problems.
- Use of Excel-based simple dispersion/dilution/risk calculation exercises.
- Exposure assessment and hazard identification using case-study data.
- Risk matrix preparation for environmental and occupational scenarios.
- Mini-project on model-based interpretation of an environmental risk problem.

Textbooks and Reference Books/ Other Resources

1. Bedient, P. B., Rifai, H. S., & Newell, C. J. (2020). *Groundwater contamination: Transport and remediation* (3rd ed.). Waveland Press.
2. Canter, L. W. (2022). *Environmental impact assessment* (3rd ed.). McGraw-Hill.

3. Chapra, S. C. (2008). *Surface water-quality modeling*. Waveland Press.
4. Gilbert, R. O. (1987). *Statistical methods for environmental pollution monitoring*. Van Nostrand Reinhold.
5. Kumar, S., & Gopal, K. (2019). *Environmental modelling and simulation*. Capital Publishing Company.
6. Ott, W. R. (2006). *Environmental indices: Theory and practice*. Ann Arbor Press.
7. US EPA. (2004). *Risk assessment guidance for superfund (RAGS), Volume I: Human Health Evaluation Manual*. Environmental Protection Agency.

Course Title: Eco-restoration Strategies

Programme: B.Sc. Environmental Science and Sustainability

Semester: VIII

Course Code: EVS428

Course Type: Major core Course (without research)

L-T-P-C: 3-1-0-4

Course Objectives

- To introduce students to the science and practice of ecological restoration across diverse ecosystems.
- To explore the causes of ecosystem degradation and the need for restoration interventions.
- To familiarise students with contemporary eco-restoration techniques and tools.
- To develop critical understanding of biodiversity, soil, and hydrological restoration processes.
- To enable students to design basic restoration plans and assess ecological outcomes.

Course Outcomes (COs)

Upon completion of this course, students will be able to:

CO1: Explain the ecological principles underpinning restoration efforts.

CO2: Identify key drivers of ecosystem degradation and prioritise restoration needs.

CO3: Apply appropriate methods for soil, vegetation, and waterbody restoration.

CO4: Evaluate the effectiveness of restoration projects using ecological indicators.

CO5: Develop community-based and climate-resilient restoration plans.

CO6: Integrate policy, socio-economic, and traditional knowledge dimensions into eco-restoration projects.

Module I: Foundations of Ecological Restoration

- Definitions and scope of eco-restoration
- Natural vs assisted recovery
- Principles: resilience, reference ecosystems, succession
- Global and Indian perspectives (UN Decade of Ecosystem Restoration, NGRBA, CAMPA)

Module II: Drivers of Ecosystem Degradation

- Land-use change, deforestation, mining, urbanisation

- Pollution, invasive species, climate change impacts
- Socio-economic drivers and anthropogenic pressures
- Landscape fragmentation and habitat loss

Module III: Restoration Techniques and Approaches

- Soil amelioration and erosion control
- Revegetation techniques: natural regeneration, afforestation, native species use
- Wetland, riparian and river restoration
- Forest and grassland restoration strategies
- Use of bioengineering and green infrastructure

Module IV: Monitoring and Assessment in Restoration

- Indicators of ecosystem recovery: vegetation, soil health, faunal return
- Tools and techniques: remote sensing, GIS, biodiversity indices
- Participatory monitoring and citizen science
- Case studies from India: degraded forest land, mining sites, riverbanks

Module V: Social, Economic, and Policy Dimensions

- Community participation and local knowledge
- Eco-restoration and ecosystem services
- Integrating eco-restoration into climate change mitigation and adaptation
- Restoration economics and financing (e.g., carbon credits, PES)

Textbooks and Reference Books/ Other Resources

1. Clewell, A. F., & Aronson, J. (2013). *Ecological restoration: Principles, values, and structure of an emerging profession* (2nd ed.). Island Press.
2. Society for Ecological Restoration International Science & Policy Working Group. (2004). *The SER international primer on ecological restoration*. Society for Ecological Restoration.
3. Shackelford, N., Paterno, G. B., Winkler, D. E., Erickson, T. E., & Perring, M. P. (2021). *Ecological restoration*. Oxford University Press.
4. Suding, K. N. (2011). *Toward an era of restoration in ecology: Successes, failures, and opportunities ahead*. Annual Review of Ecology, Evolution, and Systematics, 42, 465-487.
5. Jørgensen, S. E., & Fath, B. D. (2011). *Fundamentals of ecological modelling: Applications in environmental management and research* (4th ed.). Elsevier.
6. Aronson, J., Milton, S. J., & Blignaut, J. N. (2007). *Restoring natural capital: Science, business, and practice*. Island Press.
7. Government of India. (2020). *National Action Plan on Forest Landscape Restoration in India*. Ministry of Environment, Forest and Climate Change (MoEFCC).

Course Title: Dissertation

Programme: B.Sc. Environmental Science and Sustainability

Semester: VIII

Course Code: EVS429

Course Type: Major core Course (with research)

L-T-P-C: 0-0-12-12

Course Objectives:

- To develop research aptitude and independent scientific thinking in undergraduate students.
- To foster the application of interdisciplinary knowledge to address environmental challenges.
- To familiarise students with data collection, analysis, and scientific writing.
- To promote ethical and responsible conduct of environmental research.
- To enhance communication and presentation skills for disseminating research findings.

Course Outcomes (COs):

CO1: Identify relevant environmental issues and frame appropriate research questions or project objectives.

CO2: Design and execute a research/project plan using scientific methods and field/lab techniques.

CO3: Collect, process, and interpret data using quantitative and/or qualitative methods.

CO4: Apply environmental theories and sustainability principles to develop practical solutions.

CO5: Write a structured research report/dissertation adhering to scientific standards and ethical norms.

CO6: Present and defend the project/dissertation findings effectively before an academic panel.

Course Details:

This course provides students with the opportunity to engage in independent, supervised research or applied project work in the domain of environmental science and sustainability. Students will integrate theoretical knowledge, analytical tools, and practical skills to investigate real-world problems, leading to the development of a project report or dissertation.