Adamas University

SCHOOL OF BASIC AND APPLIED SCIENCES

Department of Chemistry

PROGRAMME COURSE STRUCTURE & DETAILED SYLLABUS FOR M.Sc. IN ENVIRONMENTAL SCIENCE AND SUSTAINABILITY

Programme Code: CHM4204
Duration: 2 Years Full Time
Academic Year: 2026-2027

Program Structure for 2-year Postgraduate Programs with Exit Option
1st Year of PG curricular structure for 2-year PG Programmes (3+2)

1st Year								
SEMESTER I								
S.No	**Type of Course**	**Code**	**Title of the Course**	**Contact Hours Per Week**				**Total Credits**
				L	**T**	**P**	**Total**	**C**
1	CC	EVS451	Principles of Ecology	3	0	1	5	4
2	CC	EVS452	Natural Resources and Management	4	0	0	4	4
3	CC	EVS453	Chemistry for Environment	3	0	1	5	4
4	DSE/MDE	EVS454	Concepts of Clean and Sustainable Energy	3	0	1	5	4
		EVS455	Climate Change Science and Policy	3	0	1		
			MDE - Civil Services – General Studies					
5	RM	EVS456	Statistics and Data Science in Environmental Systems	3	0	1	5	4
6	AEC		Foreign Language (Select One from a basket)	2	0	0	2	2
7	SEC	EVS457	Applications of Advanced Excel, R and Python in Environmental Science	1	0	1	3	2
8	SEC		Career Development Course I	1	0	0	1	1
Semester Credits							**30**	**25**
SEMESTER II								
1	CC	EVS460	Air and Noise Pollution and Control Technologies	3	0	1	5	4
2	CC	EVS461	Water Pollution and Control Technologies	3	0	1	5	4
3	CC	EVS462	Waste Management and Resource Recovery	3	0	1	5	4
4	DSE	EVS463	Environmental Economics and Green Accounting	4	0	0	4	4
			Any course aligning with the themes of specified DSE courses, subject to availability in the Swayam portal within the stipulated time frame, and as approved by the department					
5	MDE	EVS464	Environmental Impact Assessment and Legal Frameworks	4	0	0	4	4
			Any course aligning with the themes of specified MDE courses, subject to availability in the Swayam portal within the stipulated time frame, and as approved by the department/Civil					

			Service – General Studies					
6	AEC		Foreign Language (Select One from a basket)	2	0	0	2	2
6	SEC	EVS465	Industry, Ecological and Institutional Exposure Visit	-	-	-		2
7	SEC		Career Development Course II	1	0	0	1	1
Semester Credits							**26**	**25**
Exit option with Post-Graduate Diploma after the first year or two semesters with the completion of courses equivalent to 50 credits								

2nd Year of PG curricular structure for 2-year PG Programmes
PG Curricular Structure with Coursework and Research

2nd Year								
SEMESTER III								
Sr. No	**Type of Course**	**Code**	**Title of the Course**	**Contact Hours Per Week**				**Total Credits**
				L	**T**	**P**	**Total**	**C**
1	CC	EVS501	Environmental Geosciences and Hydrology	3	0	1	5	4
2	CC	EVS502	Environmental Biotechnology and Bioremediation	3	0	1	5	4
3	CC	EVS503	Land Use/Land Cover and Urbanisation	3	0	1	5	4
4	DSE	EVS504	Instruments for Environmental Applications	3	0	1	5	4
		EVS505	Disaster Management and Environmental Resilience	3	0	1		
		EVS506	Environmental Health, Biochemistry and Toxicology	3	0	1		
		EVS507	Sustainable Finance	3	0	1		
5	INT	EVS508	Internship	-	-	-	-	2
6	SEC		Career Development Course III	1	0	0	1	1
7	Research	EVS509	Dissertation - I	0	0	6	12	6
Semester Credits							**33**	**25**
SEMESTER IV								
1	CC	EVS510	ESG and Nature Based Solutions	4	0	0	4	4
2	DSE	EVS511	Industrial Pollution Prevention and Clean Technologies	4	0	0	4	4
		EVS512	Health, Safety and Environment	4	0	0		
3	ENT	EVS513	Entrepreneurship Course	0	2	0	2	2
4	Research	EVS514	Dissertation - II	0	0	12	24	12
							34	**22**
Total Credits								**47**

Total Credits after 2 years M.Sc. Environmental Science and Sustainability = 97

ADAMAS UNIVERSITY
School of Basic and Applied Sciences
Department of Chemistry
M.Sc. in Environmental Science and Sustainability
Programme Code: CHM4204
Academic Year: 2026-27

Semester I

Course Title: Principles of Ecology
Programme: M.Sc. Environmental Science and Sustainability
Semester: I
Course Code: EVS451
Course Type: Core Course
L-T-P-C: 3-0-1-4

Course Objectives

- To impart an in-depth understanding of ecosystem structure, functions, and ecological processes.
- To analyse population dynamics, community interactions, and regulatory mechanisms in nature.
- To introduce behavioural ecology and its evolutionary significance.
- To explore concepts of ecological niches, habitat differentiation, and succession models.
- To sensitise students towards biodiversity conservation strategies and ecological resilience.

Course Outcomes

Upon successful completion of this course, students will be able to:
CO1: Explain ecosystem structures, functions, and the flow of energy and nutrients.
CO2: Evaluate population characteristics, growth models, and regulatory factors.
CO3: Analyse community structures, species interactions, and diversity indices.
CO4: Interpret ecological niches, succession models, and principles of behavioural ecology.
CO5: Appraise biodiversity patterns and conservation strategies at various scales.
CO6: Apply ecological theories in laboratory and field-based practical scenarios.

Module I: Ecosystem Structure and Energy Flow

- Components and types of ecosystems
- Ecosystem functions: primary production, decomposition, and nutrient cycling
- Energy flow models: unidirectional flow, trophic levels, ecological efficiencies
- Food chains, food webs, and ecological pyramids
- Productivity: Gross and Net, measurement techniques
- Ecosystem Services

Module II: Population Ecology

- Population properties: size, density, age structure, dispersion
- Population growth models: exponential and logistic
- Carrying capacity and population regulation (density-dependent and independent factors)
- Life tables and survivorship curves
- r- and K-selection theory

Module III: Community Ecology

- Community concepts: structure, stratification, zonation
- Species diversity: alpha, beta, gamma diversity
- Ecotone and edge effect
- Species interactions: predation, competition, mutualism, commensalism, parasitism
- Community stability and resilience

Module IV: Niche, Succession and Behavioural Ecology

- Habitat and ecological niche: fundamental and realised niche
- Gause's competitive exclusion principle
- Ecological succession: primary and secondary; models (facilitation, tolerance, inhibition)
- **Behavioural Ecology**:
    - Instinct and. learning (classical & operant conditioning, imprinting)
    - Sexual selection and mating systems
    - Social bonding and communication (visual, auditory, chemical)
    - Signalling theory, Red Queen Hypothesis, Handicap Principle
    - Evolutionarily Stable Strategy (ESS)
    - Chemical ecology and pheromones

Module V: Biodiversity and Conservation Biology

- Types of biodiversity: genetic, species, ecosystem
- Biodiversity patterns (latitudinal gradients, species-area relationships)
- Biodiversity hotspots and global conservation priorities
- Threats to biodiversity: habitat loss, invasive species, overexploitation, climate change
- In-situ and ex-situ conservation strategies
- Role of IUCN, CBD, CITES, national biodiversity laws

Practical/Field Component

- Measurement of abiotic factors: temperature, light, pH, humidity
- Estimation of primary productivity (light-dark bottle method or chlorophyll method)
- Quadrat and transect methods for population and community analysis
- Species interaction studies (e.g., allelopathy, competition)
- Behavioural observation of local fauna (e.g., food preferences, grooming, territory marking)
- Visit to a biodiversity park, wildlife sanctuary or botanical garden
- Analysis of biodiversity data and calculation of important diversity indices

Textbooks and Reference Books/ Other Resources:

1. Alcock, J. (2013). *Animal Behavior: An Evolutionary Approach* (10th ed.). Sinauer Associates.
2. Chapman, J. L., & Reiss, M. J. (2009). *Ecology: Principles and Applications* (2nd ed.). Cambridge University Press.
3. Begon, M., Townsend, C. R., & Harper, J. L. (2021). *Ecology: From Individuals to Ecosystems* (5th ed.). Wiley-Blackwell.
4. Krebs, C. J. (2016). *Ecology: The Experimental Analysis of Distribution and Abundance* (6th ed.). Pearson.
5. Odum, E. P., & Barrett, G. W. (2005). *Fundamentals of Ecology* (5th ed.). Brooks Cole.
6. Smith, T. M., & Smith, R. L. (2020). *Elements of Ecology* (9th ed.). Pearson.
7. Stiling, P. (2014). *Ecology: Global Insights and Investigations* (1st ed.). McGraw-Hill Education.
8. Krebs, J. R., & Davies, N. B. (2009). *Behavioural Ecology: An Evolutionary Approach* (4th ed.). Wiley-Blackwell.
9. Groom, M. J., Meffe, G. K., & Carroll, C. R. (2006). *Principles of Conservation Biology* (3rd ed.). Sinauer Associates.

Course Title: Natural Resources and Management
Programme: M.Sc. Environmental Science and Sustainability
Semester: I
Course Code: EVS452
Course Type: Core Course
L-T-P-C: 4-0-0-4

Course Objectives

- To provide an in-depth understanding of different types of natural resources, their global distribution, and ecological significance.
- To analyse the drivers of resource depletion and degradation in terrestrial and aquatic systems.
- To introduce students to the principles and methods of sustainable resource management.
- To examine policy frameworks and community-based strategies for conserving and managing resources.
- To develop an interdisciplinary perspective integrating ecological, economic, and social dimensions of resource use.

Course Outcomes

Upon successful completion of this course, students will be able to:
CO1: Classify and explain the characteristics, uses, and ecological functions of renewable and non-renewable natural resources.
CO2: Evaluate the environmental impacts of resource exploitation and the challenges in resource governance.

CO3: Apply principles of sustainability and ecosystem management in the context of forests, water, land, and minerals.
CO4: Critically analyse natural resource policies, laws, and institutional frameworks at the national and global level.
CO5: Integrate indigenous knowledge and community participation into resource conservation models.
CO6: Propose sustainable strategies for natural resource restoration and resilience against climate and anthropogenic pressures.

Module I: Introduction to Natural Resources

- Definition, classification, and distribution of natural resources
- The Anthropocene, Great Acceleration
- Resource economics and ecological carrying capacity
- Renewable and non-renewable resources
- Resource-use conflicts and the tragedy of the commons

Module II: Bioresource Types, Valuation, and Management Strategies

- Classification of Bioresources: Forest, marine, freshwater, and agro-bioresources
- Non-Timber Forest Products (NTFPs) and medicinal plants: economic and ecological importance
- Valuation of Ecosystem Services: Techniques for economic valuation of bioresources and ecological functions
- Traditional and Indigenous Knowledge Systems: Role in sustainable bioresource use and conservation
- Conservation and Utilisation Principles: Concepts of sustainability in bioresource extraction and management
- Participatory Management Models: Community-based Forest and fisheries management practices
- Ecological Agriculture and Agroforestry: Integrative practices for sustainable land use
- Biodiversity Action Plans and Bioprospecting: National and global frameworks for conservation and equitable benefit sharing
- Tools for Bioresource Monitoring: Ecological footprint, carrying capacity, GIS and remote sensing applications
- Policy and Governance Frameworks: Overview of the Convention on Biological Diversity (CBD), Forest Rights Act (India), IPBES, and related environmental governance structures
- Case Studies: Successful models from India and abroad in bioresource management and policy implementation

Module III: Water and Aquatic Resources

- Surface water and groundwater dynamics
- Wetland ecosystems
- Dams and interlinking of rivers
- Integrated water resource management (IWRM)

Module IV: Mineral and Energy Resources

- Concept of major and minor minerals, Strategic and rare earth minerals

- Mining processes and environmental impacts
- Introduction to Conventional and non-conventional energy resources

Module V: Resource Management Governance Frameworks

- Ecosystem-based and adaptive resource management
- National and international resource governance (UNCCD, CBD, FAO), National Forest Policy, 1988; National Environmental Policy, 2006.
- Resource accounting and environmental auditing
- Community-based resource management and case studies (e.g., Joint Forest Management, water user associations)

Textbooks and Reference Books/ Other Resources:

1. Barbier, E. B. (2011). *Capitalizing on nature: Ecosystems as natural assets*. Cambridge University Press.
2. Singh, J. S., Singh, S. P., & Gupta, S. R. (2017). *Ecology, environmental science and conservation*. S. Chand.
3. Agarwal, A., & Narain, S. (1999). *Community and household water management: The key to environmental regeneration and poverty alleviation*. Centre for Science and Environment.
4. Tietenberg, T., & Lewis, L. (2016). *Environmental and natural resource economics* (10th ed.). Routledge.
5. Gadgil, M., & Guha, R. (1995). *Ecology and equity: The use and abuse of nature in contemporary India*. Penguin Books.
6. United Nations Environment Programme (UNEP). (2016). *Global Environment Outlook GEO-6: Regional Assessments*. Cambridge University Press.

Course Title: Chemistry for Environment
Programme: M.Sc. Environmental Science and Sustainability
Semester: I
Course Code: EVS453
Course Type: Core Course
L-T-P-C: 3-0-1-4

Course Objectives

- To impart an advanced understanding of chemical principles governing environmental systems.
- To explore the chemical composition and interactions within air, water, soil, and biological media.
- To understand environmental processes such as redox reactions, acid-base equilibria, and complexation.
- To evaluate the behaviour, fate, and transformation of pollutants in various environmental compartments.
- To build analytical and interpretive skills for environmental monitoring and chemical risk analysis.

Course Outcomes

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

CO1: Explain fundamental and applied concepts of environmental chemistry relevant to air, water, and soil.

CO2: Analyse chemical reactions such as oxidation-reduction, acid-base, precipitation, and complexation in natural systems.

CO3: Apply chemical principles to understand pollutant mobility, speciation, and degradation pathways.

CO4: Evaluate chemical interactions that influence the toxicity and bioavailability of contaminants.

CO5: Integrate chemical data into environmental assessments and regulatory frameworks.

CO6: Demonstrate hands-on skills in standard chemical analysis techniques for environmental monitoring.

Module I: Fundamentals of Environmental Chemistry

- Stoichiometry, chemical kinetics, thermodynamics
- Acid-base equilibria and buffering systems
- Redox potential and electrochemical reactions
- Photochemistry and environmental implications

Module II: Atmospheric Chemistry

- Composition and structure of the atmosphere
- Reactions of nitrogen, sulphur, carbon, and halogens
- Photochemical smog, ozone formation and depletion
- Greenhouse gases and global warming potential
- Oxidative potential of $PM_{2.5}$

Module III: Aquatic Chemistry

- Physical properties of water and water as a solvent
- Dissolved oxygen (DO), BOD, COD-significance and estimation
- Hydrolysis, precipitation, complexation, and redox in aquatic systems
- Heavy metals, metalloids and their chemical behaviour in water

Module IV: Soil and Geochemical Chemistry

- Soil composition, ion exchange, and buffering capacity
- Chemical speciation of nutrients and pollutants in soil
- Soil redox chemistry and microbial transformations
- Leaching, adsorption-desorption phenomena

Module V: Environmental Chemical Processes and Toxicity

- Transformation of organic pollutants: hydrolysis, photolysis, biodegradation
- Pesticides, POPs, PCBs, PAHs, dioxins and furans-chemical properties and persistence
- Concept of chemical toxicity, bio-entry, biotransformation, bioaccumulation, and biomagnification
- Introduction to environmental chemical modelling and Predictive toxicology (QSAR)

Practical Components

1. Determination of pH, electrical conductivity, and total dissolved solids in water samples
2. Estimation of dissolved oxygen (DO) by Winkler's method
3. Determination of biological oxygen demand (BOD) of a water sample
4. Chemical oxygen demand (COD) estimation using dichromate reflux method
5. Titrimetric analysis for hardness and alkalinity of water
6. Chloride estimation by argentometric method
7. Soil pH, moisture content, and organic matter determination
8. Air quality estimation (if facilities exist): SO_2/NO_2 estimation using spectrophotometric techniques
9. Heavy metal analysis in water or soil using colorimetric/spectroscopic methods
10. Case study-based interpretation of environmental chemistry data using real-world datasets

Textbooks and Reference Books/ Other Resources:

1. Baird, C., & Cann, M. (2012). *Environmental chemistry* (5th ed.). W. H. Freeman.
2. Manahan, S. E. (2017). *Environmental chemistry* (10th ed.). CRC Press.
3. Harrison, R. M. (2007). *Pollution: Causes, effects and control* (4th ed.). Royal Society of Chemistry.
4. Schnoor, J. L. (1996). *Environmental modelling: Fate and transport of pollutants in water, air, and soil*. Wiley-Interscience.
5. Alloway, B. J., & Ayres, D. C. (1997). *Chemical principles of environmental pollution* (2nd ed.). Springer.
6. Sawyer, C. N., McCarty, P. L., & Parkin, G. F. (2003). *Chemistry for environmental engineering and science* (5th ed.). McGraw-Hill.

Course Title: Concepts of Clean and Sustainable Energy
Programme: M.Sc. Environmental Science and Sustainability
Semester: I
Course Code: EVS454
Course Type: Discipline-Specific Elective (DSE)
L-T-P-C: 3-0-1-4

Course Objectives

- To introduce the principles and technologies of clean and renewable energy sources.
- To understand the environmental, economic, and social implications of different energy systems.
- To examine the technological developments in solar, wind, biomass, hydro, and hydrogen energy.
- To foster a systems-thinking approach to sustainable energy transitions and energy efficiency.
- To develop analytical and decision-making skills for sustainable energy planning and policy evaluation.

Course Outcomes

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

CO1: Describe the fundamental principles of renewable and clean energy systems.

CO2: Evaluate the technical, economic, and ecological viability of various energy alternatives.

CO3: Compare different clean energy technologies in terms of efficiency, emissions, and lifecycle impacts.

CO4: Apply key concepts of energy modelling and sustainability indicators in evaluating energy options.

CO5: Analyse national and global policies, trends, and challenges in sustainable energy transitions.

CO6: Conduct basic laboratory/practical work related to clean energy systems and critically assess outcomes.

Module I: Fundamentals of Energy Science

- Concepts: energy, work, power, thermodynamics
- Primary and secondary energy sources
- Energy carriers and transformations
- Energy consumption trends-global and Indian perspectives
- Basics of energy audit and efficiency

Module II: Solar Energy

- Solar radiation: characteristics and measurement
- Concept of solar flux and solar constant
- Photovoltaic (PV) technology: types, efficiency, applications
- Solar thermal systems: water heating, cooking, space heating
- Emerging solar technologies (CSP, BIPV, solar fuels)
- Microclimate analysis, shadow analysis, Bauer of Engineers standards
- Grid integration and energy storage in solar systems, Net metering

Module III: Wind, Hydro, and Biomass Energy

- Wind energy: site selection, wind turbines, off/onshore systems
- Hydropower: micro, small, large-scale systems; environmental concerns
- Biomass: sources, conversion technologies (biogas, biodiesel, bioethanol)
- Waste-to-energy: incineration, pyrolysis, gasification
- Sustainability and lifecycle issues

Module IV: Hydrogen, Fuel Cells & Other Technologies

- Hydrogen: production methods, storage, safety, National Green Hydrogen Mission
- Fuel cells: working principle, types, efficiency
- Ocean energy: tidal, wave, and OTEC systems
- Geothermal energy and nuclear power-overview and controversies
- Role of smart grids and AI in energy management

Module V: Sustainable Energy Transitions and Policy

- Sustainable development and energy: Sustainable Energy and Energy
- Sustainability and lifecycle issues
- Role of smart grids and AI in energy management

- National Electric Mobility Mission, PAT Scheme, UJJWALA, International Solar Alliance (ISA)
- Global frameworks: UNFCCC, IRENA, RE100, IEA
- Transition pathways, carbon neutrality, and decentralised systems

Practical Component

1. Measurement of solar radiation using pyranometer
2. Performance evaluation of a solar PV panel
3. Demonstration of solar water heater/solar cooker
4. Small wind turbine design and analysis using software tools
5. Estimation of biogas yield from organic waste
6. Energy audit of a small building (load calculation and savings estimate)
7. Design and simulation of a hybrid renewable energy system using HOMER or RETScreen (demo or guided)
8. Comparative life cycle emission calculation for energy options (manual or software-based)

Textbooks and Reference Books/ Other Resources:

1. Boyle, G. (2012). *Renewable energy: Power for a sustainable future* (3rd ed.). Oxford University Press.
2. Duffie, J. A., & Beckman, W. A. (2013). *Solar engineering of thermal processes* (4th ed.). Wiley.
3. Tester, J. W., Drake, E. M., Driscoll, M. J., Golay, M. W., & Peters, W. A. (2012). *Sustainable energy: Choosing among options* (2nd ed.). MIT Press.
4. Twidell, J., & Weir, T. (2015). *Renewable energy resources* (3rd ed.). Routledge.
5. Kalogirou, S. A. (2009). *Solar energy engineering: Processes and systems*. Academic Press.
6. Panwar, N. L., Kaushik, S. C., & Kothari, S. (2011). *Role of renewable energy sources in environmental protection: A review*. *Renewable and Sustainable Energy Reviews*, 15(3), 1513-1524.
7. Gielen, D., Boshell, F., Saygin, D., Bazilian, M. D., Wagner, N., & Gorini, R. (2019). *The role of renewable energy in the global energy transformation*. *Energy Strategy Reviews*, 24, 38-50.

Course Title: Climate Change Science and Policy
Programme: M.Sc. Environmental Science and Sustainability
Semester: I
Course Code: EVS455
Course Type: Discipline-Specific Elective (DSE)
L-T-P-C: 3-0-1-4

Course Objectives

- To understand the scientific basis and observed evidence of climate change.

- To analyse the physical, chemical, and biological drivers and feedbacks in the climate system.
- To introduce the global and regional policy frameworks for addressing climate change.
- To assess adaptation and mitigation strategies at multiple scales.
- To develop critical thinking on the political economy and ethics of climate governance.

Course Outcomes

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

CO1: Explain the scientific mechanisms underlying global climate change.

CO2: Interpret climate data and model projections to identify trends and uncertainties.

CO3: Evaluate the impacts of climate change on ecosystems, health, water, agriculture, and human systems.

CO4: Critically analyse international climate policies such as the UNFCCC, Kyoto Protocol, and Paris Agreement.

CO5: Compare adaptation and mitigation frameworks and tools across regions.

CO6: Apply conceptual and practical knowledge through lab activities or case-based discussions on climate policy and communication.

Module I: Climate System and Climate Change Science

- Structure and functioning of the Earth's climate system
- Greenhouse gases and radiative forcing
- Natural and anthropogenic drivers
- Climate feedbacks (ice-albedo, carbon cycle, water vapour)
- Climate variability: ENSO, monsoons, aerosols, solar cycles

Module II: Greenhouse Gas Accounting

- Emission scopes; Scope 1, 2, 3
- Quantification and monitoring of Greenhouse Gas emissions, GHG Inventorisation, Principles of emission trading (ISO 14064-1:2018, ISO 14064-2:2019, ISO 14064-3:2019)

Module III: Observations, Modelling and Projections

- Evidence from temperature, sea level, and ice core data
- IPCC climate models: overview and limitations
- Scenarios: SRES, RCPs, SSPs
- Uncertainty and confidence in projections
- Climate change communication: scientific visualisation and narratives

Module IV: Climate Change Impacts and Vulnerability

- Sectoral impacts: water, agriculture, biodiversity, coastal zones
- Climate extremes: heatwaves, floods, droughts, cyclones
- Human health and livelihood risks
- Vulnerability mapping and risk assessment
- Equity and justice in impact distribution (Global North vs. South)

Module V: Global and National Climate Policy Frameworks

- Evolution of global climate governance: UNFCCC, IPCC
- Kyoto Protocol, Paris Agreement, COP negotiations
- Common but differentiated responsibilities (CBDR), NDCs
- India's climate policy: NAPCC, SAPCCs
- Climate finance mechanisms: GCF, Adaptation Fund, carbon markets
- Adaptation and Mitigation; Adaptation frameworks and indicators (resilience, capacity, vulnerability); Mitigation strategies: low carbon development, afforestation, CCUS
- Introduction to Nature-based Solutions (NbS), REDD+, carbon farming
- Climate justice, loss and damage, indigenous knowledge

Practical Component

1. Analysis of historical temperature and precipitation datasets
2. Interpretation of IPCC summary for policymakers
3. Climate vulnerability mapping using basic GIS or online tools
4. Life Cycle Assessment (LCA) of a product with carbon footprint estimation
5. Simulated COP negotiation: role-playing exercise
6. Case study review: comparison of NDCs of India and another country
7. Understanding emission scenarios using online platforms (e.g., Climate Interactive En-ROADS)

Textbooks and Reference Books/ Other Resources:

1. IPCC. (2021). *Climate Change 2021: The Physical Science Basis*. Cambridge University Press.
2. Houghton, J. (2015). *Global warming: The complete briefing* (5th ed.). Cambridge University Press.
3. Dessler, A. E. (2021). *Introduction to modern climate change* (3rd ed.). Cambridge University Press.
4. Klein, R. J. T., Huq, S., Denton, F., Downing, T. E., Richels, R. G., Robinson, J. B., & Toth, F. L. (2007). *Inter-relationships between adaptation and mitigation*. In *Climate Change 2007: Impacts, Adaptation and Vulnerability* (pp. 745-777). IPCC.
5. Roberts, J. T., & Parks, B. C. (2007). *A climate of injustice: Global inequality, North-South politics, and climate policy*. MIT Press.
6. Agarwal, A., & Narain, S. (1991). *Global warming in an unequal world: A case of environmental colonialism*. Centre for Science and Environment.
7. United Nations Environment Programme (UNEP). (2023). *Emissions Gap Report 2023*. UNEP.

Course Title: Statistics and Data Science in Environmental Systems
Programme: M.Sc. Environmental Science and Sustainability
Semester: I
Course Code: EVS456
Course Type: Research methods (RM)
L-T-P-C: 3-0-1-4

Course Objectives

• To build foundational and advanced statistical knowledge relevant to environmental systems.
• To develop competency in analysing environmental datasets using statistical tools.
• To equip students with skills for designing experiments and interpreting results in environmental research.
• To familiarise students with scientific writing, data visualisation, and reproducibility in environmental science.

Course Outcomes

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

CO1: Understand and apply core statistical concepts in the context of environmental systems.
CO2: Design appropriate sampling methods and experiments for environmental data collection.
CO3: Use R programming for descriptive statistics, inferential analysis, and data visualisation.
CO4: Analyse environmental time-series and multivariate data using appropriate statistical tools.
CO5: Perform hypothesis testing and interpret outcomes for environmental decision-making.
CO6: Prepare and present statistical reports using real-world environmental datasets.

Module I: Foundations of Environmental Statistics

- Types of data: nominal, ordinal, interval, ratio
- Measures of central tendency and dispersion
- Probability distributions: normal, binomial, Poisson
- Sampling methods: random, stratified, systematic

Module II: Inferential Statistics and Hypothesis Testing

- Hypothesis formulation and significance testing
- One-sample and two-sample t-tests, paired t-test
- Chi-square tests, goodness of fit
- One-way and two-way ANOVA
- Application in pollution data and biodiversity indices

Module III: Regression and Correlation Analysis

- Pearson and Spearman correlation
- Simple and multiple linear regression
- Model assumptions, residual analysis
- Case studies: CO_2 vs temperature, rainfall vs crop yield
- Performing regression

Module IV: Foundations of Research and Design

- Introduction to research: meaning, objectives, and types (basic, applied, exploratory, descriptive, analytical)
- Research problem formulation: identification, selection, and justification
- Literature review: sources, tools, and referencing techniques
- Framing research questions, objectives, and hypotheses

- Research design: experimental, observational, cross-sectional, longitudinal
- Variables: dependent, independent, and confounding variables
- Sampling techniques: probability and non-probability sampling
- Basic concepts of sample size determination

Module V: Data Handling, Analysis, and Research Ethics

- Data collection methods: primary and secondary data
- Tools and techniques: surveys, questionnaires, interviews, field observations
- Data quality: reliability and validity
- Data processing: coding, classification, and tabulation
- Data analysis: introduction to descriptive and inferential statistics
- Scientific writing: structure of research report/thesis
- Plagiarism and academic integrity
- Ethics in research: consent, confidentiality, and responsible conduct

Practical Component

1. Basic use of statistical software (Excel/R/SPSS – overview)
2. Interpretation and presentation of data: tables, graphs, charts
3. Referencing styles and citation practices
4. Preparation of a mini-research report based on secondary data
5. Research Proposal Writing

Textbooks and Reference Books/ Other Resources:

1. Berthouex, P. M., & Brown, L. C. *Statistics for Environmental Engineers*. 2nd ed., CRC Press, 2002.
2. Mendenhall, W., Beaver, R. J., & Beaver, B. M. *Introduction to Probability and Statistics*. 14th ed., Cengage Learning, 2013.
3. Kothari, C.R., & Garg, G. *Research Methodology: Methods and Techniques*. 4th ed., New Age International Publishers
4. Creswell, John W. Research Design: Qualitative, Quantitative, and Mixed Methods Approaches. 6th ed., SAGE Publications Inc.

Course Title: Applications of Advanced Excel, R and Python in Environmental Science
Programme: M.Sc. Environmental Science and Sustainability
Semester: I
Course Code: EVS457
Course Type: Skill Enhancement Course (SEC)
L-T-P-C: 1-0-1-2

Course Objectives

- To familiarise students with computational tools for environmental data handling and analysis.
- To develop practical skills in Advanced Excel, R, and Python for statistical and environmental modelling.
- To integrate data visualisation and dashboard design in environmental contexts.

- To introduce automation, scripting, and reproducible workflows for efficient data processing.
- To enhance the ability to communicate environmental insights using digital tools.

Course Outcomes

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

CO1: Use Advanced Excel functions and tools for environmental data entry, analysis, and reporting.

CO2: Apply R programming for statistical computing and data visualisation in environmental research.

CO3: Use Python for data handling, simple analysis, and environmental automation tasks.

CO4: Prepare dashboards and visual summaries for environmental indicators and trends.

CO5: Integrate spreadsheet and coding tools to analyse real-world environmental datasets.

CO6: Demonstrate basic scripting, reproducibility, and presentation of findings using digital platforms.

Module I: Advanced Excel for Environmental Data

- Logical, statistical, and lookup functions (IF, VLOOKUP, INDEX-MATCH, etc.)
- Pivot tables and charts for air, water, and biodiversity data
- Conditional formatting and data validation
- Dashboard creation for sustainability indicators
- Solver and Goal Seek for environmental optimisation problems

Module II: Introduction to R for Environmental Applications

- Installing R and RStudio; working environment setup
- Data structures, importing datasets, and data wrangling (dplyr, tidyr)
- Descriptive statistics and plots (ggplot2)
- Correlation and regression on climate and pollution datasets
- Reproducible reporting with R Markdown

Module III: Introduction to Python for Environmental Applications

- Installing Anaconda, Jupyter Notebook basics
- Data structures, NumPy and pandas for environmental datasets
- Plotting with matplotlib and seaborn
- Simple time-series analysis for climate data
- Automation scripts (e.g., data cleaning for CSV files)

Module IV: Environmental Case Studies and Hands-on Projects

- AQI and WQI calculations in Excel, R and Python
- Biodiversity index computation
- Time-series rainfall/temperature plotting and trends
- Water balance models and graphical interpretation
- Land use/land cover data handling in spreadsheet and script-based tools

Module V: Integrated Tools and Presentation

- Data integration across Excel, R, and Python
- Environmental dashboards: comparison of outputs across tools
- Storyboarding and communicating findings

- Data ethics, metadata, and file management
- Mini project presentations (group/individual)

Practical Component (Indicative Activities)

1. Create an AQI dashboard using Excel
2. Use R to clean and analyse biodiversity data
3. Plot temperature and rainfall trends using Python
4. Perform linear regression on pollution vs health data in R
5. Combine outputs from Excel, R, and Python in a final group mini-project

Textbooks and Reference Books/ Other Resources:

1. Bhatnagar, R. (2020). *Data Analysis and Visualization Using Python: Analyze Data to Create Visualizations for BI Systems*. BPB Publications.
2. Crawley, M. J. (2013). *The R book* (2nd ed.). Wiley.
3. Field, A. (2013). *Discovering statistics using IBM SPSS statistics* (4th ed.). Sage Publications.
4. McKinney, W. (2022). *Python for data analysis: Data wrangling with pandas, NumPy, and Jupyter* (3rd ed.). O'Reilly Media.
5. Swayne, D. F., Cook, D., Buja, A., & Hofmann, H. (2002). *Interactive and dynamic graphics for data analysis: With R and GGobi*. Springer.

Semester II

Course Title: Air and Noise Pollution and Control Technologies
Programme: M.Sc. Environmental Science and Sustainability
Semester: II
Course Code: EVS460
Course Type: Core course
L-T-P-C: 3-0-1-4

Course Objectives

- To provide a foundational understanding of the sources, types, and effects of air and noise pollution.
- To examine the physical and chemical processes involved in the transport, transformation, and removal of pollutants.
- To introduce regulatory frameworks, emission standards, and monitoring techniques.
- To develop an understanding of the design and application of control technologies for air and noise pollution.
- To integrate field- and lab-based learning with data analysis for problem-solving and management of pollution.

Course Outcomes

Upon successful completion of this course, students will be able to:
CO1: Understand the nature, classification, and sources of air and noise pollution.
CO2: Analyse meteorological factors and their influence on pollutant dispersion.

CO3: Assess the impacts of air and noise pollution on ecosystems and public health.
CO4: Explain the principles, design, and functioning of major air and noise pollution control devices.
CO5: Interpret pollution monitoring data and apply relevant standards and guidelines.
CO6: Apply practical knowledge in monitoring, analysing, and proposing control strategies for real-life pollution scenarios.

Module I: Fundamentals of Air Pollution

- Definitions, sources, types of air pollutants (primary & secondary)
- Indoor vs outdoor air pollution
- Emission inventory and classification
- Concept of Air Quality Index (AQI)
- Effects on human health, vegetation, materials, and climate
- Global air pollution issues (acid rain, smog, ozone depletion, climate change)

Module II: Meteorology and Pollutant Dispersion

- Atmospheric structure and temperature profiles
- Wind circulation, stability, and mixing height
- Lapse rate and inversion phenomena
- Gaussian plume model-basic formulation and application
- Dispersion modelling case studies (e.g., stack emissions)

Module III: Air Pollution Control Technologies

- Particulate control devices: gravitational settling chambers, cyclone separators, fabric filters, electrostatic precipitators, scrubbers
- Gaseous pollutant control: adsorption, absorption, combustion
- Source-specific control: vehicles, industries, power plants
- Clean fuel technologies and green innovations
- Air quality management and emission standards (NAAQS, CPCB)

Module IV: Noise Pollution and Control

- Basic acoustics and noise metrics (dB, frequency, Leq, Ldn)
- Sources of noise: transport, industrial, community
- Effects of noise on health and environment
- Noise control techniques: barriers, insulation, zoning, policy approaches

Module V: Practical Applications and Monitoring

- Air and noise monitoring techniques (gravimetric methods, sound level meters, high volume samplers, real-time sensors)
- Calibration and data handling
- Sample collection and analysis of PM_{10}, $PM_{2.5}$, SO_2, NO_x
- Noise measurement instruments, Noise level mapping and evaluation
- Case study/project: air or noise audit of a campus/urban area

Practical Component

- Determination of AQI using multivariate analysis
- Determination of ambient particulate matter (PM_{10}/$PM_{2.5}$)
- Measurement of ambient SO_2 and NO_x using standard techniques
- Use of a sound level meter for noise mapping

- Stack monitoring (demonstration or simulation)
- Mini-project: assessment of pollution load and control planning in a selected site

Textbooks and Reference Books/ Other Resources:

1. Rao, C. S. (2018). *Environmental Pollution Control Engineering* (2nd ed.). New Age International Publishers.
2. Peavy, H. S., Rowe, D. R., & Tchobanoglous, G. (2013). *Environmental Engineering*. McGraw-Hill Education.
3. Garg, S. K. (2012). *Environmental Engineering: Volume I-Water Supply Engineering; Volume II-Sewage Disposal and Air Pollution Engineering*. Khanna Publishers.
4. Manahan, S. E. (2017). *Environmental Chemistry* (10th ed.). CRC Press.
5. Sharma, B. K. (2021). *Environmental Chemistry* (12th ed.). Goel Publishing House.
6. Central Pollution Control Board (CPCB). (Latest Editions). *National Ambient Air Quality Standards and Guidelines*. Government of India.

Course Title: Water Pollution and Control Technologies
Programme: M.Sc. Environmental Science and Sustainability
Semester: II
Course Code: EVS461
Course Type: Core course
L-T-P-C: 3-0-1-4

Course Objectives

• To introduce the types, sources, and characteristics of water pollutants and their environmental and health impacts.
• To understand water quality parameters, standards, and monitoring techniques.
• To explain the physical, chemical, and biological processes in wastewater treatment.
• To provide insights into the design and operational aspects of water and wastewater treatment technologies.
• To equip students with hands-on skills in water sampling, analysis, and designing pollution control strategies.

Course Outcomes

Upon successful completion of this course, students will be able to:
CO1: Identify major sources and types of water pollutants and understand their effects on ecosystems and health.
CO2: Apply standard methods for measuring and interpreting water quality parameters.
CO3: Understand the principles and mechanisms of conventional and advanced water treatment technologies.
CO4: Analyse the design and operation of treatment units like sedimentation tanks, aeration systems, and bioreactors.
CO5: Interpret environmental standards (e.g., BIS, CPCB, WHO) for water and wastewater.
CO6: Execute laboratory-based monitoring and analysis of water pollutants and recommend

mitigation strategies.

Module I: Introduction to Water Pollution

- Sources: point and non-point
- Types: physical, chemical, biological, radiological pollutants
- Effects on aquatic ecosystems and human health
- Case studies: Ganga, Yamuna, groundwater arsenic, etc.
- Water quality indices and classification

Module II: Water Quality Assessment

- Physical parameters: temperature, turbidity, colour
- Chemical parameters: pH, DO, BOD, COD, nitrates, phosphates, heavy metals
- Concept of Water Quality Index (WQI)
- Biological indicators and microbial pollution
- Sampling procedures, preservation, and analysis techniques
- Water quality standards: BIS, CPCB, WHO

Module III: Wastewater Treatment-Fundamentals

- **Introduction to Wastewater Treatment**
  - Objectives and significance of wastewater treatment
  - Characteristics of municipal and industrial wastewater
  - Concepts of STP and ETP; STP and ETP guidelines
- **Primary Treatment Processes**
  - Preliminary treatment: screening, grit removal, skimming
  - Sedimentation and primary clarifiers
  - Flotation techniques (Dissolved Air Flotation)
  - Removal efficiency and operational considerations
- **Secondary Biological Treatment Processes**
  - Principles of aerobic and anaerobic wastewater treatment

    Aerobic Treatment Systems
  - Activated Sludge Process (ASP): principles, components, operation and performance
  - Trickling Filters: types, design concepts and applications
  - Sequencing Batch Reactor (SBR): treatment cycle, advantages and limitations
  - Rotating Biological Contactor (RBC)
  - Comparison of aerobic treatment technologies
- **Anaerobic Treatment Systems**
  - Anaerobic digestion principles
  - Upflow Anaerobic Sludge Blanket (UASB) reactor: design, operation and applications
  - Biogas generation and resource recovery
  - Advantages and limitations of anaerobic treatment
  - Sludge handling and disposal
  - Case Studies of STP and ETP operations

Module IV: Advanced Treatment and Pollution Control Technologies

- Tertiary treatment: nutrient removal, filtration, disinfection (UV, ozonation,

- chlorination)
- Membrane technologies: reverse osmosis, nanofiltration
- Constructed wetlands
- Water reuse, recycling, and zero liquid discharge (ZLD)

Module V: Policy Aspects

- Water pollution regulations: Water Act 1974, Environment Protection Act 1986
- Urban and rural sanitation missions (e.g., Swachh Bharat, Jal Jeevan Mission)
- Sustainable Development Goal 6: Clean Water and Sanitation
- Public-private partnerships and case studies in India

Practical Component

- Analysis of pH, DO, BOD, COD in water samples
- Determination of turbidity, total solids, and conductivity
- Sampling and testing for nitrates, phosphates, and chlorides
- Identification of coliform bacteria (MPN method/demo)
- Determination of AQI using multivariate analysis

Textbooks and Reference Books/ Other Resources:

1. Peavy, H. S., Rowe, D. R., & Tchobanoglous, G. (2013). Environmental Engineering. McGraw-Hill Education.
2. Metcalf & Eddy, Inc. (2014). Wastewater Engineering: Treatment and Resource Recovery (5th ed.). McGraw-Hill Education.
3. Sawyer, C. N., McCarty, P. L., & Parkin, G. F. (2017). Chemistry for Environmental Engineering and Science (5th ed.). McGraw-Hill Education.
4. Sharma, B. K. (2021). Environmental Chemistry (12th ed.). Goel Publishing House.
5. CPCB. (Latest). Water Quality Criteria and Guidelines. Central Pollution Control Board, Ministry of Environment, Forest & Climate Change, Government of India.
6. Manahan, S. E. (2017). Environmental Chemistry (10th ed.). CRC Press.

Course Title: Waste Management and Resource Recovery
Programme: M.Sc. Environmental Science and Sustainability
Semester: II
Course code: EVS462
Course Type: Core Course
L-T-P-C: 3-0-1-4

Course Objectives

- To impart foundational and advanced understanding of solid and hazardous waste types, sources, and impacts on environment and health.
- To familiarise students with the principles, policies, and practices of waste minimisation, segregation, and management.
- To introduce technologies for waste treatment, recycling, and energy recovery.

- To develop analytical and practical skills in sustainable waste handling, reuse, and circular economy principles.
- To provide insights into case studies and best practices in municipal, biomedical, e-waste, and industrial waste management in India and globally.

Course Outcomes

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

- **CO1:** Identify and categorise different types of wastes including municipal, biomedical, e-waste, and industrial waste.
- **CO2:** Understand the legislative frameworks and policies guiding waste management in India.
- **CO3:** Demonstrate knowledge of scientific and technological options for waste treatment, reduction, and safe disposal.
- **CO4:** Evaluate resource recovery options from waste including composting, biomethanation, and energy recovery.
- **CO5:** Apply principles of life cycle assessment and circular economy in waste and resource management.
- **CO6:** Conduct practical waste audits, design waste management plans, and propose sustainable solutions.

Module I: Fundamentals of Waste Management

- Definition, classification, and sources of waste
- Physical, chemical, and biological characteristics of waste
- Solid waste management hierarchy: prevention, minimisation, reuse, recycling, recovery, disposal
- Impacts of improper waste management on health and environment

Module II: Waste Collection, Segregation and Storage

- Municipal solid waste (MSW) collection, segregation and transportation
- Storage and transfer stations
- On-site handling techniques
- Case studies of smart cities and waste segregation practices
- Role of informal sector and waste pickers

Module III: Waste Treatment Technologies

- Composting: windrow, in-vessel, vermicomposting
- Anaerobic digestion and biomethanation
- Incineration and gasification
- Sanitary landfill design and leachate management
- Biomedical and hazardous waste treatment options

Module IV: Resource Recovery and Circular Economy

- Concepts of resource efficiency and circular economy
- Material recovery facilities (MRFs)
- Energy recovery: waste-to-energy (WTE), refuse-derived fuel (RDF)
- E-waste recycling technologies
- Industrial symbiosis and sustainable resource management

Module V: Legislation, Policy and Best Practices

- Waste Management Rules, 2016 and amendments (Plastic, Biomedical, E-Waste, Hazardous Waste, Construction and Demolition, Solid Waste), E-Waste Management Rules 2022
- Extended Producer Responsibility (EPR)
- Life Cycle Assessment (LCA) and carbon footprint of waste
- National and international case studies: Swachh Bharat Mission, Kigali, Curitiba
- Community participation and awareness strategies

Practical Component

- Waste characterisation study and audit (institutional or household)
- Compost preparation using organic waste
- Visit to composting units / landfill site / WTE plant
- Estimation of moisture content, calorific value, and pH of solid waste
- Case study report on e-waste, plastic waste or biomedical waste management

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. Peavy, H. S., Rowe, D. R., & Tchobanoglous, G. (2013). *Environmental Engineering*. McGraw-Hill Education.
3. Agamuthu, P., & Fauziah, S. H. (2020). *Waste Management and Resource Recovery*. CRC Press.
4. Kumar, S., Bhattacharyya, J. K., Vaidya, A. N., & Chakrabarti, T. (2017). *Municipal Solid Waste Management in India: A Decentralized Approach*. TERI Press.
5. Sharma, S., & Jain, V. (2021). *Waste Management: Concepts and Practices*. Springer.
6. CPCB. (2016). *Waste Management Rules (Plastic, Biomedical, E-waste, Hazardous)*. Central Pollution Control Board, Government of India.
7. UNEP. (2019). *Global Waste Management Outlook*. United Nations Environment Programme.
8. Chakrabarti, S. (2019). *Treatment of urban solid waste: Engineering and integrated management*. The Energy and Resources Institute (TERI).

Course Title: Environmental Economics and Green Accounting
Programme: M.Sc. Environmental Science and Sustainability
Semester: II
Course Code: EVS463
Course Type: Discipline-Specific Elective (DSE)
L-T-P-C: 4-0-0-4

Course Objectives

- To introduce fundamental concepts and theories of environmental economics.
- To explore economic valuation of environmental goods and services.
- To understand green accounting principles and methods for integrating environmental costs into economic accounts.

- To analyse policy instruments for environmental management and sustainable development.
- To develop skills for applying economic tools to real-world environmental decision-making.

Course Outcomes

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

- **CO1:** Explain key concepts and principles of environmental economics and sustainability.
- **CO2:** Apply economic valuation techniques to assess environmental goods and ecosystem services.
- **CO3:** Demonstrate knowledge of green accounting frameworks and their applications.
- **CO4:** Analyse environmental policies and market-based instruments for pollution control and resource management.
- **CO5:** Critically evaluate economic impacts of environmental degradation and climate change.
- **CO6:** Develop green accounting reports incorporating natural capital and environmental costs.

Module I: Introduction to Environmental Economics

- Definitions, scope, and relationship with ecological economics
- Debate on environmental and development
- Market failure, externalities, public goods, and common property resources
- Sustainable development and economic growth
- Introduction to the concept of Planetary Boundaries and Concept of Doughnut Economics

Module II: Economic Valuation of Environmental Resources

- Methods of valuation: contingent valuation, travel cost method, hedonic pricing
- Cost-benefit analysis in environmental projects
- Ecosystem services valuation

Module III: Green Accounting Concepts and Frameworks

- Environmental accounting basics
- System of Environmental-Economic Accounting (SEEA)
- Natural capital accounting and material flow analysis

Module IV: Environmental Policy Instruments

- Regulatory vs market-based instruments (taxes, subsidies, tradable permits)
- Environmental standards and enforcement
- Climate change economics and carbon markets

Module V: Applications and Case Studies

- Green GDP and sustainable indicators
- Economic impacts of pollution and climate change
- Case studies on green accounting implementation in industries and governments

Textbooks and Reference Books/ Other Resources:

1. Pearce, D., & Turner, R. K. (1990). *Economics of Natural Resources and the Environment*. Johns Hopkins University Press.
2. Tietenberg, T., & Lewis, L. (2016). *Environmental and Natural Resource Economics* (11th ed.). Routledge.
3. Munasinghe, M., & Shearer, W. (1995). *Environmental Economics and Sustainable Development*. World Bank.
4. United Nations. (2014). *System of Environmental-Economic Accounting 2012: Central Framework*. United Nations.
5. Conrad, K., & Olson, K. (Eds.). (2019). *Green Accounting and Environmental Sustainability*. Springer.

Course Title: Environmental Impact Assessment and Legal Frameworks
Programme: M.Sc. Environmental Science and Sustainability
Semester: II
Course Code: EVS464
Course Type: Multidisciplinary Elective (MDE)
L-T-P-C: 4-0-0-4

Course Objectives

- To introduce the fundamental concepts and procedures of Environmental Impact Assessment (EIA).
- To provide knowledge on the environmental laws and regulatory frameworks relevant to EIA and environmental governance.
- To develop skills in preparing and critically analysing EIA reports.
- To familiarise students with national and international policies and protocols governing environmental protection.
- To understand the role of public participation, monitoring, and compliance in environmental decision-making.

Course Outcomes

Upon successful completion of this course, students will be able to:
CO1: Understand the principles, objectives, and legal basis of Environmental Impact Assessment.
CO2: Explain the process and methodologies used in conducting an EIA.
CO3: Analyse environmental laws and regulations at national and international levels.
CO4: Prepare basic components of an EIA report and perform impact prediction and mitigation planning.
CO5: Evaluate the role of public participation and environmental governance in sustainable development.
CO6: Apply legal frameworks and EIA guidelines to real-world environmental projects and policy decisions.

Module I: Introduction to Environmental Impact Assessment (EIA)

- Definition, objectives, and significance of EIA

- Historical evolution and global perspectives
- Types of environmental impacts and classification
- EIA Framework in India, Categories A, B1, B2, Screening, scoping, and baseline studies, Procedures for Environmental Clearence.
- Role of Environmental Impact Statements (EIS) and Environmental Management Plans (EMP)

Module II: Public Participation, Environmental Governance, and Compliance

- Stakeholder consultation and public hearing processes
- Role of NGOs and civil society in EIA
- Compliance monitoring, enforcement, and penalties
- Case studies of EIA successes and failures in India

Module III: EIA Methodologies and Techniques

- Methods of impact identification and prediction (checklists, matrices, networks)
- Quantitative and qualitative techniques
- Risk assessment and hazard analysis
- Cost-benefit analysis and multi-criteria decision-making
- Environmental monitoring and post-project evaluation

Module IV: Environmental Legal Frameworks in India

- Environment (Protection) Act, 1986 – umbrella legislation
- Air (Prevention and Control of Pollution) Act, 1981
- Water (Prevention and Control of Pollution) Act, 1974
- Forest (Conservation) Act, 1980 and Wildlife Protection Act, 1972
- Coastal Regulation Zone (CRZ) Notifications
- Role of Environmental Tribunals and case law examples (e.g., Vellore Citizens, MC Mehta series)
- National Green Tribunal Act, 2010
- Public Liability Insurance Act, 1991
- Biological Diversity Act, 2002
- Batteries (Management and Handling) Rules, 2001; amended as Battery Waste Management Rules, 2022
- Ozone Depleting Substances (Regulation and Control) Rules, 2000
- Environment Impact Assessment (EIA) Notification, 2006 (amended periodically)
- Noise Pollution (Regulation and Control) Rules, 2000
- Fly Ash Notification, 1999 (amended in 2021)
- Compensatory Afforestation Fund Act, 2016 (CAMPA Act) – Utilisation of compensatory afforestation funds.
- Plant Varieties Protection and Farmers' Rights Act, 2001
- Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006 (FRA)
- Wetlands (Conservation and Management) Rules, 2017
- Inter-State Water Disputes Act, 1956
- Doctrine of Public Trust, Polluter Pays, Precautionary Principle – Recognised under Article 21 of the Constitution (Right to Life); MC Mehta Cases – Including Ganga pollution, vehicular pollution in Delhi, Oleum gas leak, etc; Vellore Citizens Welfare

Forum v. Union of India (1996) – Precautionary and Polluter Pays Principles; Indian Council for Enviro-Legal Action v. Union of India (1996) – Strict liability for hazardous industries.

Module V: International Environmental Policies and Protocols

- Kyoto Protocol and Paris Agreement
- Basel Convention, 1989; Stockholm Convention on Persistent Organic Pollutants is an international environmental treaty, 2001
- Sustainable Development Goals (SDGs)
- Role of international financial institutions in environmental compliance

Textbooks and Reference Books/ Other Resources:

1. Glasson, J., Therivel, R., & Chadwick, A. (2013). *Introduction to Environmental Impact Assessment* (4th ed.). Routledge.
2. Canter, L. W. (1996). *Environmental Impact Assessment* (2nd ed.). McGraw-Hill.
3. Government of India. (2006). *Environmental Impact Assessment Notification*. Ministry of Environment, Forest and Climate Change.
4. Singh, A., & Jain, M. K. (2020). *Environmental Law in India* (3rd ed.). LexisNexis.
5. Jay, S., Jones, C., Slinn, P., & Wood, C. (2007). Environmental impact assessment: Retrospect and prospect. *Environmental Impact Assessment Review, 27*(4), 287-300. https://doi.org/10.1016/j.eiar.2006.12.001
6. UNEP. (2018). *Environmental Governance: A Guide to the Role of International Law*. United Nations Environment Programme.

Course Title: Industry, Ecological and Institutional Exposure Visit
Programme: M.Sc. Environmental Science and Sustainability
Semester: II
Course code: EVS465
Course Type: Skill Enhancement Course (SEC)
L-T-P-C: 0-0-0-2
No weekly lectures/tutorials/practicals; credits shall be awarded for field-based and experiential learning.

Course Objectives

- To provide hands-on exposure to industrial environmental management practices, ecological field study techniques and institutional environmental research/monitoring systems.
- To enhance practical understanding of environmental regulations, compliance mechanisms and sustainability challenges in industries and institutions.
- To familiarise students with laboratories of eminence, centres of excellence, research institutions, monitoring stations, analytical laboratories, regulatory bodies, NGOs and other professionally relevant organisations.
- To develop observational, analytical and documentation skills through direct exposure to industrial sites, ecological habitats and institutional facilities.

- To encourage integration of theoretical knowledge with practical field, industrial and institutional experiences.
- To strengthen students' employability, research orientation, teamwork and professional communication skills.

Course Outcomes

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

CO1: Identify and assess environmental management practices in industrial settings.
CO2: Observe and document ecological features, biodiversity and ecosystem conditions in natural or semi-natural habitats.
CO3: Describe the role of reputed institutions, laboratories, regulatory bodies, NGOs and centres of excellence in environmental monitoring, research, conservation and sustainability practice.
CO4: Correlate environmental regulations with actual industrial, institutional and field-level compliance mechanisms.
CO5: Prepare detailed visit/field reports integrating industrial, ecological and institutional observations.
CO6: Demonstrate improved communication, teamwork, professional conduct and presentation skills through group-based experiential learning.

Course Content / Activity Components

1. Pre-Visit Preparation and Briefing: Objectives of industrial, ecological and institutional visits; safety protocols; field ethics; code of conduct; data recording methods; observation checklist; visit diary; report format and presentation guidelines.
2. Industrial Exposure Visit: Observation of environmental management systems, pollution control technologies, effluent treatment plants, sewage treatment plants, solid and hazardous waste management systems, air pollution control systems, occupational health and safety practices, sustainability initiatives, ESG practices and compliance mechanisms.
3. Ecological Exposure Visit: Habitat and biodiversity survey; identification of flora and fauna; basic ecological sampling methods; habitat assessment; ecosystem services; ecological interactions; human impacts; conservation issues; restoration practices and nature-based solutions.
4. Institutional Exposure Visit: Visit to laboratories of eminence, centres of excellence, reputed research institutions, environmental monitoring facilities, analytical laboratories, regulatory bodies, government agencies, NGOs, sustainability organisations, environmental consultancies or similar professionally relevant institutions. Students shall observe institutional roles in environmental monitoring, instrumental analysis, regulatory support, research, conservation, sustainability reporting, community engagement and policy implementation.
5. Data Recording, Analysis and Interpretation: Compilation of field observations; interpretation of industrial, ecological and institutional data; comparison of observed practices with regulatory or scientific standards; identification of environmental issues and preparation of recommendations.

6. Report Writing and Presentation: Preparation of visit diary, field notes, photographic documentation, analytical report and oral presentation. The report shall integrate observations from industry, ecology and institutional exposure components.

Syllabus Description

This course offers experiential learning through **industry visits, ecological field visits and institutional exposure visits**, enabling students to observe environmental practices in real-world contexts. Students will engage with industrial environmental management systems, ecological habitats, biodiversity assessment, environmental monitoring facilities, laboratories of eminence, centres of excellence, research institutions, regulatory bodies, NGOs and sustainability organisations. The course will culminate in detailed visit reports and presentations integrating industrial, ecological and institutional learning.

Textbooks and Reference Books / Other Resources

1. Kitchin, R. M. (2019). *Environmental Field Methods and Techniques*. Oxford University Press.
2. Mishra, P. C., & Tiwari, M. (2018). *Ecological Field Techniques*. Springer.
3. Odum, E. P., & Barrett, G. W. (2005). *Fundamentals of Ecology* (5th ed.). Brooks Cole.
4. Ramesh, R., & Singh, A. (2019). *Environmental Management and Sustainability Practices in Industries*. Wiley.
5. Relevant manuals/guidelines of CPCB, SPCB, MoEFCC, BIS, APHA, UNEP, IUCN and institutional visit-specific technical documents

Exit option with Post-Graduate Diploma after the first year or two semesters with the completion of courses equivalent to 50 credits

2nd Year of PG curricular structure for 2-year PG Programmes
PG Curricular Structure with Coursework and Research

Semester III

Course Title: Environmental Geosciences and Hydrology
Programme: M.Sc. Environmental Science and Sustainability
Semester: III
Course Code: EVS501
Course Type: Core Course
L-T-P-C: 3-0-1-4

Course Objectives

- To introduce the fundamentals of geosciences with emphasis on environmental applications.
- To understand the hydrological cycle and its role in ecosystem and environmental processes.
- To study groundwater systems, surface water hydrology, and water resource management.

- To develop skills in hydrological data analysis and environmental geoscience techniques.
- To explore human impacts on geological and hydrological systems and strategies for sustainable management.

Course Outcomes

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

CO1: Explain key concepts in environmental geosciences and the hydrological cycle.

CO2: Analyse groundwater flow, surface water dynamics, and watershed processes.

CO3: Apply geoscientific tools and hydrological models for environmental problem-solving.

CO4: Evaluate impacts of anthropogenic activities on geological and hydrological environments.

CO5: Demonstrate practical skills in hydrological data collection, analysis, and interpretation.

CO6: Propose sustainable management practices for water and geological resources.

Module I: Fundamentals of Environmental Geosciences

- Introduction to Earth systems
- Minerals, rocks, and soil formation
- Geological processes affecting the environment (weathering, erosion, sedimentation)
- Concept of watershed management, Run-off (overland flow, base flow), Hydrograph

Module II: Hydrological Cycle and Surface Water Hydrology

- Components of the hydrological cycle
- Precipitation, evaporation, transpiration, infiltration and percolation
- Streamflow measurement, Groundwater measurement

Module III: Groundwater Hydrology

- Groundwater occurrence, aquifers, porosity, hydraulic conductivity, transmissivity, storage coefficient
- Darcy's law, groundwater flow and recharge
- Contamination and remediation of groundwater

Module IV: Environmental Geoscience Techniques and Applications

- Remote sensing and GIS applications in geosciences
- Geophysical methods for subsurface investigation
- Soil and sediment analysis for environmental assessment

Module V: Water Resources Management and Environmental Impacts

- Water quality parameters and pollution sources
- Sustainable water resource management and conservation, Demand monitoring, supply monitoring
- Water Footprint (ISO14046:2014)
- Case studies on anthropogenic impacts and mitigation strategies

Practical/Field Component

- Identification of common rocks and minerals.
- Interpretation of topographic maps and drainage patterns.
- Groundwater level data interpretation.
- Watershed delineation using maps/GIS.

- Field visit to riverbank, wetland, quarry or groundwater site.

Textbooks and Reference Books/ Other Resources:

1. Fetter, C. W. (2018). *Applied Hydrogeology* (4th ed.). Waveland Press.
2. Chorley, R. J., & Kennedy, B. A. (1971). *Physical Geography: A Systems Approach* (3rd ed.). Prentice Hall.
3. Freeze, R. A., & Cherry, J. A. (1979). *Groundwater*. Prentice Hall.
4. Davis, S. N., & De Wiest, R. J. M. (1966). *Hydrogeology*. Wiley.
5. Linsley, R. K., Kohler, M. A., & Paulhus, J. L. H. (1982). *Hydrology for Engineers* (3rd ed.). McGraw-Hill.
6. Singh, V. P. (2012). *Elementary Hydrology*. Prentice-Hall of India.

Course Title: Environmental Biotechnology and Bioremediation
Programme: M.Sc. Environmental Science and Sustainability
Semester: III
Course code: EVS502
Course Type: Core Course
L-T-P-C: 3-0-1-4

Course Objectives

- To introduce fundamental principles and concepts of environmental biotechnology.
- To understand microbial roles in the biodegradation of pollutants.
- To study various bioremediation techniques and their applications in environmental cleanup.
- To develop skills for monitoring and managing biotechnological processes in pollution control.
- To explore advances in genetic engineering and bioaugmentation for enhanced bioremediation.

Course Outcomes

Upon successful completion of this course, students will be able to:
CO1: Explain core concepts of environmental biotechnology and microbial ecology.
CO2: Identify microorganisms and enzymes involved in degradation of environmental pollutants.
CO3: Apply bioremediation strategies to treat contaminated soil, water, and air.
CO4: Evaluate biotechnological tools such as bioaugmentation, biostimulation, and phytoremediation.
CO5: Perform basic laboratory techniques related to microbial culture and pollutant degradation assays.
CO6: Critically assess recent advances and case studies in environmental biotechnology and bioremediation.

Module I: Introduction to Environmental Biotechnology

- Principles of biotechnology

- Microbial diversity and metabolism relevant to environmental applications
- Role of microbes in biogeochemical cycles

Module II: Biodegradation of Pollutants

- Mechanisms of microbial degradation of organic and inorganic pollutants
- Enzymatic pathways involved in biodegradation
- Factors influencing biodegradation efficiency

Module III: Bioremediation Techniques

- In situ and ex situ bioremediation methods
- Bioaugmentation, biostimulation, and natural attenuation
- Phytoremediation and mycoremediation approaches

Module IV: Environmental Biotechnology Tools and Monitoring

- Molecular techniques in environmental microbiology (RDT, DNA sequencing)
- Biosensors and bioassays for pollution monitoring
- Use of bioreactors in waste treatment

Module V: Applications and Case Studies

- Bioremediation of industrial effluents, oil spills, heavy metals, and pesticides
- Bioremediation case studies
- Regulatory and safety aspects of environmental biotechnology

Practical Component

- Isolation/observation of environmental microbes from soil or water.
- Demonstration of microbial growth and culture techniques.
- Assessment of biodegradation/bioremediation case studies.
- Phytoremediation or biosorption-based demonstration.
- Visit to composting, biogas, STP or bioremediation site.

Textbooks and Reference Books/ Other Resources:

1. Rittmann, B. E., & McCarty, P. L. (2001). *Environmental Biotechnology: Principles and Applications*. McGraw-Hill.
2. Singh, A., & Ward, O. P. (2004). *Biodegradation and Bioremediation*. Springer.
3. Glazer, A. N., & Nikaido, H. (2007). *Microbial Biotechnology: Fundamentals of Applied Microbiology* (2nd ed.). Cambridge University Press.
4. Maleki, A., & Sreekrishnan, T. R. (2013). *Bioremediation of Contaminated Environments: Techniques and Applications*. Nova Science Publishers.

Course Title: Land Use/Land Cover and Urbanisation
Programme: MSc Environmental Science and Sustainability
Semester: III
Course Code: EVS503
Course Type: Core Course
L-T-P-C: 3-0-1-4

Course Objectives:

- To provide foundational understanding of land use and land cover (LULC) systems and their significance in urban sustainability and ecological planning.

- To examine the drivers and impacts of urbanisation on land, water, and environmental systems.
- To equip students with practical skills in remote sensing and GIS for LULC change detection and urban growth analysis.
- To introduce national standards and codes such as NBC, ECBC, GRIHA, and LEED that guide sustainable urban planning and infrastructure.
- To promote interdisciplinary knowledge for applying nature-based, low-carbon, and climate-resilient strategies in urban and peri-urban regions.

Course Outcomes (COs):

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

CO1: Understand the concepts and classifications of land use and land cover and their relevance to environmental science.

CO2: Apply remote sensing and GIS techniques for LULC mapping and urban growth analysis.

CO3: Critically evaluate patterns of urbanisation and their socio-ecological impacts.

CO4: Interpret and apply building codes, green rating systems, and energy efficiency standards in urban planning.

CO5: Assess sustainable land management and urban resilience strategies.

CO6: Integrate policy, planning tools, and citizen participation for equitable and ecologically responsible urban development.

Module I: Fundamentals of Land Use and Land Cover

- Definitions and classification systems (Anderson, FAO, NRSC)
- Natural and anthropogenic drivers of LULC change
- Environmental implications of LULC transitions
- LULC mapping in Indian context***

Module II: Techniques for LULC Assessment and Urban Growth Mapping

- Overview of satellite platforms (Landsat, Sentinel, IRS)
- Pre-processing and supervised/unsupervised classification
- Change detection techniques and accuracy validation
- Introduction to QGIS and open-source LULC datasets
- Field verification and ground truthing

Module III: Urbanisation and Land Transformation

- Urban growth theories and models
- Urban sprawl, infrastructure expansion, and informal settlements
- Urban landscapes: green corridors, bioswales, urban forestry, Low-impact development (LID): green roofs, permeable pavements, rain gardens, vertical gardening
- Environmental, hydrological, and social impacts of urbanisation
- Community participation, inclusive development, and environmental justice in urban planning.
- Case studies from Indian metropolitan and peri-urban regions

Module IV: Building Codes, Green Rating Systems, and Urban Planning Frameworks

- **National Building Code (NBC) of India 2016**-land use zoning, setbacks, FAR, building safety
- **Energy Conservation Building Code (ECBC)**-building energy efficiency compliance for residential and commercial sectors
- **Green Rating for Integrated Habitat Assessment (GRIHA)**-criteria, indicators, and project implementation
- **Leadership in Energy and Environmental Design (LEED)**-global standards and relevance in Indian urban projects
- Urban bylaws and municipal planning regulations
- Smart Cities Mission, AMRUT, and URDPFI guidelines

Module V: Sustainable Urban Development, Transportations

- Principles of sustainable urban land use and planning
- Urban transportation systems: modes, networks, and spatial equity, challenges of vehicular emissions, congestion, and last-mile connectivity
- Policies and schemes: **FAME I & II**, National Electric Mobility Mission, urban e-mobility transitions
- Planning for **electric vehicle (EV)** infrastructure: charging networks, land allocation, and grid integration
- Climate-resilient cities and adaptive planning approaches, Miyawaki Technique of afforestation, Urban SDGs (especially SDG 11) and environmental performance indicators

Practical Component

- LULC classification using Google Earth/QGIS/open satellite imagery.
- Urban expansion mapping through temporal images.
- Calculation of built-up, vegetation and water-body changes.
- Urban heat island or impervious surface interpretation.
- Mini-project on urban environmental change.

Textbooks and Reference Books/ Other Resources:

1. Anderson, J. R., Hardy, E. E., Roach, J. T., & Witmer, R. E. (1976). *A Land Use and Land Cover Classification System for Use with Remote Sensor Data* (Vol. 964). U.S. Geological Survey.
2. Bureau of Indian Standards. (2016). *National Building Code of India 2016*. New Delhi: BIS.
3. Bhatta, B. (2010). *Analysis of Urban Growth and Sprawl from Remote Sensing Data*. Springer.
4. GRIHA Council. (2020). *GRIHA Manual: Green Rating for Integrated Habitat Assessment* (Vol. 1-4). New Delhi: The Energy and Resources Institute.
5. ISHRAE & Bureau of Energy Efficiency. (2018). *Energy Conservation Building Code (ECBC)*. New Delhi: Ministry of Power, Govt. of India.
6. Lillesand, T., Kiefer, R. W., & Chipman, J. (2015). *Remote Sensing and Image Interpretation* (7th ed.). Wiley.
7. Ministry of Housing and Urban Affairs. (2014). *URDPFI Guidelines, 2014*. New Delhi: Government of India.

8. Ramachandran, R. (2012). *Urbanisation and Urban Systems in India*. Oxford University Press.
9. UN-Habitat. (2020). *World Cities Report: The Value of Sustainable Urbanization*. United Nations Human Settlements Programme.
10. USGBC. (2021). *LEED v4 for Building Design and Construction*. U.S. Green Building Council.

Course Title: Instruments for Environmental Applications
Programme: M.Sc. Environmental Science and Sustainability
Semester: III
Course Code: EVS504
Course Type: Discipline-Specific Elective (DSE)
L-T-P-C: 3-0-1-4

Course Objectives

- To introduce the principles and working mechanisms of analytical instruments used in environmental monitoring and research.
- To develop hands-on competence in operating common instruments for air, water, soil, and biological sample analysis.
- To understand calibration, maintenance, and standard operating procedures (SOPs) of instruments.
- To promote data interpretation and analysis skills derived from instrumental techniques.
- To enable students to critically select appropriate instrumentation for environmental problem-solving and research design.

Course Outcomes

Upon successful completion of this course, students will be able to:
CO1: Understand the theoretical principles behind environmental instruments.
CO2: Identify and classify instruments used for different environmental compartments (air, water, soil).
CO3: Operate and troubleshoot basic laboratory and field instruments.
CO4: Analyse environmental samples and interpret instrumental data effectively.
CO5: Apply instrument-based methods in research and environmental quality assessment.
CO6: Demonstrate familiarity with QA/QC, calibration, and SOPs in an environmental laboratory context.

Module I: Fundamentals of Environmental Instrumentation

- Classification of instruments (analytical, field)
- Concepts of accuracy, precision, sensitivity, detection limits
- Calibration techniques and standard curves
- SOPs, quality assurance/quality control (QA/QC) protocols
- Types of sampling techniques-air, water, soil and noise

- Sample preparation and preservation techniques

Module II: Advanced Analytical Techniques

- Principles and applications of Absorptions and Emission Spectroscopy
- Fourier-transform infrared spectroscopy (FTIR)
- Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES)
- X-Ray Diffraction (XRD) and Scanning Electron Microscopy (SEM)-basic principles
- Chromatography: principle and applications
- Remote sensing sensors and satellite instruments for environmental data

Module III: Instruments for Air Quality Monitoring

- High-volume air sampler and respirable dust sampler
- Gas analysers (CO, NOx, SO_2, O_3-principles and usage)
- Aethalometer and $PM_{2.5}$/PM_{10} samplers
- VOC detectors and real-time particulate monitors
- Stack monitoring equipment and noise level meters

Module IV: Water and Wastewater Quality Instruments

- pH meter, conductivity meter, DO meter, turbidity meter
- Ion-selective electrodes (ISE)
- Multiparameter water quality probes

Module V: Soil, Sediment and Biological Sample Analysis

- Kjeldahl digestion and distillation unit (for nitrogen)
- Application of advanced instrumental techniques in soil and sediment analysis
- Field kits for nutrient, pesticide, and heavy metal detection

Practical Component

- Measurement of air particulate matter using a portable air sampler
- Use of spectrophotometer for colourimetric estimation of nitrates/phosphates
- Soil pH, EC, and heavy metal analysis using AAS/Flame photometry
- Demonstration/field visit to centralised air or water monitoring stations
- Visit to a laboratory of eminence/reputed laboratory/centre of excellence engaged in environmental monitoring, instrumental analysis, pollution assessment or sustainability research.

Textbooks and Reference Books/ Other Resources:

1. Khopkar, S. M. (2004). *Environmental Pollution Analysis*. New Age International Publishers.
2. Patnaik, P. (2007). *Handbook of Environmental Analysis: Chemical Pollutants in Air, Water, Soil, and Solid Wastes*. CRC Press.
3. Manahan, S. E. (2011). *Environmental Chemistry* (9th ed.). CRC Press.
4. Skoog, D. A., Holler, F. J., & Crouch, S. R. (2017). *Principles of Instrumental Analysis* (7th ed.). Cengage Learning.
5. Down, M., & Lehr, J. H. (2005). *Environmental Instrumentation and Analysis Handbook*. Wiley-Interscience.
6. APHA. (2017). *Standard Methods for the Examination of Water and Wastewater* (23rd ed.). American Public Health Association.

Course Title: Disaster Management and Environmental Resilience
Programme: M.Sc. Environmental Science and Sustainability
Semester: III
Course Code: EVS505
Course Type: Discipline-Specific Elective (DSE)
L-T-P-C: 3-0-1-4

Course Objectives:

- To understand the fundamental concepts and types of disasters, including natural and anthropogenic.
- To analyse disaster risk, vulnerability, and resilience from an environmental perspective.
- To study policies, frameworks, and strategies for disaster risk reduction and management.
- To examine the role of ecosystems and environmental planning in building resilience.
- To develop practical knowledge for managing disasters and fostering environmental resilience at local, regional, and global scales.

Course Outcomes:

Upon successful completion of this course, students will be able to:
CO1: Explain the nature, types, and causes of disasters and their environmental impacts.
CO2: Assess disaster risk, vulnerability, and resilience using scientific and policy frameworks.
CO3: Evaluate disaster management strategies including mitigation, preparedness, response, and recovery.
CO4: Understand and apply environmental resilience concepts to disaster risk reduction.
CO5: Analyse national and international disaster management policies and legal frameworks.
CO6: Propose sustainable and environment-friendly approaches for disaster risk reduction and resilience building.

Module I: Introduction to Disasters and Disaster Management

- Definition, types and classification of disasters (natural and man-made)
- Disaster cycle: prevention, preparedness, response, recovery
- Disaster impacts on environment, society, and economy
- Concepts of Hazard, Hazid (hazard identification), Hazan (hazard analysis), and Hazop (hazard and operability studies), risk, vulnerability, resilience

Module II: Disaster Risk Assessment and Vulnerability Analysis

- Hazard identification and risk assessment methods
- Tools and techniques for vulnerability and capacity assessment
- Geographic Information Systems (GIS) and remote sensing in disaster management
- Community-based disaster risk management

Module III: Environmental Resilience and Ecosystem-based Approaches

- Definition and principles of environmental resilience
- Role of ecosystems (forests, wetlands, mangroves) in disaster risk reduction

- Climate change adaptation and its integration with disaster management
- Nature-based solutions and green infrastructure

Module IV: Disaster Management Policies, Frameworks, and Legal Aspects

- National policies and frameworks (e.g., Disaster Management Act, NDMA guidelines, Sendai Framework)
- International conventions and agreements on disaster risk reduction
- Institutional roles and coordination mechanisms
- Legal and ethical issues in disaster management

Module V: Case Studies, Tools and Techniques for Disaster Management

- Case studies of major disasters and lessons learned
- Early warning systems and communication strategies
- Role of technology and innovation in disaster management
- Designing disaster-resilient communities and infrastructure

Practical / Field Component

- Preparation of hazard, exposure and vulnerability matrix.
- Disaster risk mapping using secondary data.
- Mock preparation of disaster preparedness plan for campus/community.
- Case-study analysis of flood, cyclone, landslide or heatwave.
- Resilience planning exercise for a selected locality.

Textbooks and Reference Books/ Other Resources:

1. Alexander, D. (2013). *Disaster and Emergency Planning for Preparedness, Response, and Recovery*. Wiley-Blackwell.
2. Coppola, D. P. (2015). *Introduction to International Disaster Management* (3rd ed.). Butterworth-Heinemann.
3. UNDRR (United Nations Office for Disaster Risk Reduction). (2015). *Sendai Framework for Disaster Risk Reduction 2015-2030*. UNDRR.
4. Kates, R. W., Colten, C. E., Laska, S., & Leatherman, S. P. (2006). Reconstruction of New Orleans after Hurricane Katrina: A Research Perspective. *Proceedings of the National Academy of Sciences, 103*(40), 14653-14660. https://doi.org/10.1073/pnas.0605726103
5. Paton, D., & Johnston, D. (2006). *Disaster Resilience: An Integrated Approach*. Charles C Thomas Publisher.
6. Smith, K., & Petley, D. N. (2009). *Environmental Hazards: Assessing Risk and Reducing Disaster* (5th ed.). Routledge.
7. Berkes, F., Colding, J., & Folke, C. (2003). *Navigating Social-Ecological Systems: Building Resilience for Complexity and Change*. Cambridge University Press.

Course Title: Environmental Health, Biochemistry and Toxicology
Programme: M.Sc. Environmental Science and Sustainability
Semester: III

Course Code: EVS506
Course Type: Discipline-Specific Elective (DSE)
L-T-P-C: 3-0-1-4

Course Objectives:

- To understand the fundamental concepts of environmental health and its impact on human well-being.
- To study the biochemical basis of toxicology and how chemicals interact with living organisms.
- To explore sources, types, and mechanisms of environmental toxins and pollutants.
- To examine the pathways of exposure, bioaccumulation, and detoxification processes.
- To develop practical skills in assessing toxicological effects and environmental health risks.

Course Outcomes:

Upon successful completion of this course, students will be able to:
CO1: Explain the concepts of environmental health and the biochemical basis of toxicology.
CO2: Identify various environmental toxins, their sources, and modes of action in biological systems.
CO3: Analyse the biochemical mechanisms of toxicity and detoxification in organisms.
CO4: Evaluate the pathways and impact of toxic substances on human health and ecosystems.
CO5: Apply laboratory techniques to detect and quantify toxic substances and their effects.
CO6: Interpret toxicological data to assess environmental health risks and suggest mitigation strategies.

Module I: Introduction to Environmental Health and Toxicology

- Definition and scope of environmental health
- Environmental factors affecting human health
- Basic concepts of toxicology: dose-response relationship, toxicity types
- Biochemical principles related to toxicology; Phase I, II reactions

Module II: Environmental Toxins and Pollutants

- Types of environmental toxins: biological and chemical
- Sources and pathways of environmental toxins, persistence and mobility of toxins in the environment

Module III: Biochemical Mechanisms of Toxicity

- Absorption, distribution, metabolism, excretion and toxicity (ADMET) of toxins
- Cellular and molecular mechanisms of toxicity
- Oxidative stress and free radical damage, principle of Comet assay
- Stress enzymes and detoxification pathways

Module IV: Toxic Effects on Human Health and Ecosystems

- Toxic impacts on major organ systems (liver, kidney, nervous system, etc.)
- Basics of Carcinogenesis, mutagenesis, and teratogenesis
- Ecotoxicology
- Case studies of major environmental toxicants and health crises

Module V: Toxicity Assessment

- Laboratory techniques: sample collection, preparation, and analysis
- Biochemical assays for toxicity evaluation (e.g., enzyme activity, biomarkers, comet assay, micronucleation, germination study)
- Toxicological risk assessment and management
- Interpretation and reporting of toxicology data

Practical Component:

- Dose-response and LD_{50}/LC_{50} interpretation using sample data.
- Basic biochemical estimation: protein/carbohydrate or enzyme activity demonstration.
- Water/food/environmental sample toxicity case interpretation.
- Health-risk assessment from pollutant exposure data.
- Detection and quantification of heavy metals in water/soil samples using colorimetric and spectrophotometric methods
- Enzyme assays related to detoxification (e.g., catalase, glutathione S-transferase)
- Bioassays using model organisms for toxicity testing
- Preparation and analysis of environmental samples for toxic substances
- Preparation of toxicological case-study report.

Textbooks and Reference Books/ Other Resources:

1. Klaassen, C. D. (Ed.). (2013). *Casarett & Doull's Toxicology: The Basic Science of Poisons* (8th ed.). McGraw-Hill Education.
2. McConnell, R., & Faustman, E. M. (2019). *Environmental Toxicology: Biological and Health Effects of Pollutants*. CRC Press.
3. Cunningham, W. P., & Saigo, B. W. (2019). *Environmental Science: A Global Concern* (15th ed.). McGraw-Hill Education.
4. Hodgson, E. (2004). *A Textbook of Modern Toxicology* (3rd ed.). Wiley-Interscience.
5. Murthy, S. N. (2012). *Environmental Health and Toxicology*. New Age International Publishers.
6. Sharma, R. K., & Kaur, J. (2015). *Biochemical Toxicology: Principles and Methods*. Academic Press.

Course Title: Sustainable Finance
Programme: M.Sc. Environmental Science and Sustainability
Semester: III
Course Code: EVS507
Course Type: Discipline-Specific Elective (DSE)
L-T-P-C: 3-0-1-4

Course Objectives:

- To introduce the principles and practices of sustainable finance and its role in promoting environmental and social well-being.
- To understand the financial mechanisms that support sustainable development goals (SDGs).

- To analyse the integration of environmental and social risks into financial decision-making.
- To explore green financial products, markets, and institutions.
- To evaluate frameworks for measuring and reporting sustainability in finance.

Course Outcomes:
Upon successful completion of this course, students will be able to:
CO1: Describe the concept and scope of sustainable finance and its importance in global finance.
CO2: Explain various financial instruments and products that promote sustainability, such as green bonds, social bonds, and sustainability-linked loans.
CO3: Assess environmental and social risks in investment and lending decisions.
CO4: Analyse the role of financial markets, institutions, and regulators in driving sustainable finance.
CO5: Interpret sustainability reporting and disclosure frameworks relevant to finance.
CO6: Critically evaluate case studies on sustainable finance initiatives and their impacts.

Module I: Introduction to Sustainable Finance
- Definition, history, and evolution of sustainable finance
- Sustainable development goals (SDGs) and finance
- Role of finance in achieving environmental sustainability
- Principles of responsible investment (excluding ESG focus)

Module II: Financial Instruments for Sustainability
- Green bonds and green loans
- Social bonds and sustainability bonds
- Sustainability-linked loans and green securitization
- Impact investing and blended finance

Module III: Risk Assessment in Sustainable Finance
- Environmental risks: climate change, resource depletion, pollution
- Social risks: labour standards, community impacts, human rights
- Integration of environmental and social risk into credit and investment analysis
- Tools for risk assessment and management in finance

Module IV: Financial Markets and Institutions
- Role of banks, insurance companies, pension funds, and asset managers
- Green finance initiatives by multilateral development banks (MDBs)
- Regulatory frameworks and policies supporting sustainable finance
- Market trends and challenges in sustainable finance

Module V: Sustainability Reporting and Case Studies
- Sustainability reporting standards relevant to finance (GRI, SASB, TCFD-overview only), basic concepts of ESG.
- Disclosure frameworks and transparency in financial markets
- Evaluation of sustainable finance projects and outcomes
- Case studies of sustainable finance in practice (international and Indian contexts)

Practical / Tutorial Component

1. Interpretation of ESG/sustainability reports of companies.
2. Green bond or climate finance case-study analysis.
3. Calculation of simple carbon cost or internal carbon pricing.
4. Preparation of ESG risk-opportunity matrix.
5. Group presentation on sustainable investment product or policy.

Textbooks and Reference Books/ Other Resources:

1. Weber, O., & Feltmate, B. (2016). *Sustainable Banking: Managing the Social and Environmental Impact of Financial Institutions*. University of Toronto Press.
2. Prasad, A., & Mitra, S. (2018). *Green Finance and Sustainability: Environmentally-Aware Business Models and Technologies*. Springer.
3. Deloitte. (2020). *Green Finance: Trends, Risks, and Opportunities*. Deloitte Insights.
4. International Finance Corporation. (2017). *Green Bonds: Country Experiences, Barriers and Options*. IFC.
5. KPMG. (2022). *Sustainable Finance-A Primer*. KPMG International.
6. United Nations Environment Programme Finance Initiative. (2019). *Financing a Sustainable Future*. UNEP FI.

Course Title: Internship
Programme: M.Sc. Environmental Science and Sustainability
Semester: III
Course Code: EVS508
Course Type: Internship
L-T-P-C: 0-0-0-2

Course Objectives

- To provide students with practical exposure to real-world environmental and sustainability practices in industries, research institutions, or regulatory bodies.
- To develop problem-solving skills and professional competencies through hands-on training.
- To bridge the gap between theoretical knowledge and field applications in environmental management.
- To cultivate interdisciplinary understanding by engaging in collaborative projects and work environments.
- To enable students to critically reflect on their roles as future environmental professionals through experiential learning.

Course Outcomes

Upon successful completion of the internship, students will be able to:
CO1: Apply theoretical concepts from coursework to real-life environmental and sustainability challenges.
CO2: Demonstrate technical and professional skills relevant to environmental fieldwork, research, or industrial applications.

CO3: Communicate effectively through technical documentation, presentations, and reporting of internship outcomes.
CO4: Exhibit professional ethics, teamwork, and workplace discipline in a multidisciplinary setting.
CO5: Reflect critically on experiences to identify learning gains and areas of improvement.
CO6: Develop networking, career awareness, and employability skills relevant to environmental science and sustainability sectors.

Course Details
The internship is a field-based experiential learning component designed to expose students to practical work in sectors aligned with environmental science, sustainability, ESG, pollution control, conservation, climate adaptation, resource management, or related disciplines. Students are expected to complete a minimum of 4-6 weeks of internship during the summer break prior to Semester III.
Host organisations may include:

- Environmental consulting firms
- Process or Manufacturing industries with environmental sustainability
- Research institutes and universities
- Non-governmental organisations (NGOs) and civil society organisations
- Government departments or regulatory bodies (e.g., SPCBs, CPCB, MoEF&CC)

Assessment Components:

- Internship Completion Certificate from host organisation
- Weekly logbook submission
- Final internship report (evaluated by internal faculty)
- Presentation and viva voce (graded by department panel)

Course Title: Dissertation-I
Programme: M.Sc. Environmental Science and Sustainability
Semester: III
Course Code: EVS509
Course Type: Research
L-T-P-C: 0-0-6-6

Course Objectives

- To initiate students into the process of independent, original research in environmental science and sustainability.
- To develop a research question and design a suitable methodology for investigating it.
- To equip students with critical skills in literature review, data collection, and research ethics.
- To provide students with hands-on experience in laboratory, field, modelling, or desk-based research techniques.
- To enable students to effectively communicate scientific ideas through structured academic writing and presentations.

Course Outcomes

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

CO1: Formulate a relevant and feasible research problem with clear objectives and hypotheses.

CO2: Conduct a comprehensive review of scientific literature and identify research gaps.

CO3: Design and implement a suitable methodology for data collection and analysis.

CO4: Demonstrate competence in laboratory, field, or computational tools as appropriate to the project.

CO5: Apply research ethics, safety protocols, and environmental responsibility throughout the research process.

CO6: Draft a detailed progress report and communicate findings effectively through presentations.

Course Details

Dissertation-I is the first phase of a two-part research project, carried out over the third and fourth semesters of the MSc programme. In this phase, students are expected to undertake the following:

- Selection of a research topic in consultation with an internal faculty supervisor.
- Preparation of a detailed research proposal including background, objectives, methodology, timeline, and expected outcomes.
- Completion of initial literature review, development of theoretical/conceptual framework, and pilot data collection if applicable.
- Submission of a mid-term progress report and presentation before a departmental research review committee.
- Demonstration of preparedness for full-scale implementation in Semester IV (Dissertation-II).

Assessment Components:

- Research Proposal (10%)
- Mid-term Review Presentation (20%)
- Progress Report (40%)
- Presentation and Viva Evaluation (30%)

Semester: IV

Course Title: ESG and Nature-Based Solutions

Programme: M.Sc. Environmental Science and Sustainability

Semester: IV

Course Code: EVS510

Course Type: Core Course

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

Course Objectives:

- To introduce the concepts of Environmental, Social, and Governance (ESG) criteria and their significance in sustainable development.
- To explore Nature-Based Solutions (NBS) as innovative strategies for climate change mitigation and adaptation.
- To understand the integration of ESG frameworks with NBS in corporate and policy contexts.
- To examine the role of natural ecosystems in enhancing resilience and delivering ecosystem services.
- To develop skills in assessing, planning, and implementing ESG-compliant nature-based interventions.

Course Outcomes:

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

CO1: Explain the fundamentals of ESG and its application in environmental and social governance.

CO2: Define and classify Nature-Based Solutions and their environmental, social, and economic benefits.

CO3: Assess the role of NBS in climate mitigation, adaptation, and biodiversity conservation.

CO4: Integrate ESG principles into the planning and implementation of nature-based projects.

CO5: Evaluate policy frameworks and corporate strategies promoting ESG and NBS integration.

CO6: Design and analyse case studies demonstrating the practical application of ESG and NBS in real-world scenarios.

Module I: Fundamentals of ESG

- Introduction to ESG: definitions, evolution, and global relevance
- Introduction to ESG Reporting Standards and Frameworks
- Overview of GRI, SASB, TCFD, CDP, CSRD, BRSR
- Differences and Intersections between Frameworks
- ESG Ratings Explained: MSCI, S&P Global, Sustainalytics, Refinitiv, ISS, CRISIL
- Limitations and Critiques of Rating Methodologies
- The role of investors and regulators in ESG adoption
- ESG emergence in Indian corporates, India's BRSR framework.
- Challenges and opportunities in ESG implementation

Module II: ESG Risk, Resilience and Metrics

- Risk Identification and Management: COSO, ERM, DRR, climate scenario analysis (IPCC, NGFS), Black Swan events.
- Materiality and Performance: Baseline and peer benchmarking, ESG KPIs, dashboards, audit practices, communication.
- Greenwashing and Accountability: Detection techniques, ESG litigation, trade and compliance, reputation management.

Module III: ESG in Practice-Markets, Sectors and Careers

- Sectoral Applications: ESG in oil & gas, textiles, tech, agriculture, education, circular economy, blockchain.

- Emerging Market Challenges: ESG in India, Africa, SE Asia, microfinance, informal economies, behavioural ESG.
- Leadership and Career Pathways: ESG roles, skillsets, change management, capacity building, entrepreneurial ecosystem, foresight thinking.

Module IV: Introduction to Nature-Based Solutions (NBS)

- Definition, principles and typologies of Nature-Based Solutions
- Ecosystem services, natural capital and biodiversity co-benefits
- NBS for climate change mitigation and adaptation
- Types of Nature-Based Solutions:
    - Forest-based solutions: afforestation, reforestation, assisted natural regeneration, urban forestry
    - Wetland-based solutions: natural wetlands, constructed wetlands, wetland restoration for wastewater treatment and flood regulation
    - Urban NBS: green roofs, green walls, urban parks, bioswales, rain gardens, permeable surfaces, blue-green infrastructure
    - Coastal and marine NBS: mangrove restoration, salt marsh restoration, coral reef conservation, dune stabilisation
    - Agricultural and rural NBS: agroforestry, conservation agriculture, riparian buffer strips, farm ponds, soil-carbon enhancement
    - River and watershed-based solutions: river restoration, floodplain reconnection, catchment treatment, spring-shed management
- Global frameworks and initiatives supporting NBS: IPBES, IUCN, UNCCD, UNEP and SDG linkages
- Case examples: constructed wetlands for wastewater treatment, mangrove restoration for cyclone protection, urban green infrastructure for heat-island reduction, and watershed restoration for water security

Module V: Linking ESG with Nature-Based Solutions

- ESG integration in conservation, restoration and NBS projects
- Corporate sustainability and NBS investments
- Nature-positive business strategies and biodiversity risk management
- Social and governance aspects in NBS projects: stakeholder participation, community ownership, equity, benefit-sharing and safeguards
- Incentives, subsidies and financial mechanisms for NBS: CSR, green finance, blended finance, carbon credits, biodiversity credits and payment for ecosystem services
- ESG-linked documentation of NBS projects: baseline, indicators, impact assessment and reporting
- Case studies on policy-driven and corporate-led NBS adoption
- Indian case studies: constructed wetlands for wastewater polishing, East Kolkata Wetlands as a nature-based waste-recycling system, mangrove restoration in the Sundarbans, urban lake restoration, and campus-level biodiversity/green-cover enhancement projects

Module VI: Hands on training

- Identification and documentation of local Nature-Based Solutions in a campus, urban, wetland, riverine or rural setting

- Preparation of a simple ESG–NBS assessment checklist covering environmental, social and governance indicators
- Case-study analysis of a constructed wetland for wastewater treatment, including treatment objective, plant species used, pollutant removal mechanism, maintenance requirement and ESG relevance
- Mapping of ecosystem services delivered by a selected NBS intervention, such as flood regulation, carbon sequestration, biodiversity support, water purification or heat reduction
- Preparation of a mini-project report on a local NBS intervention with baseline condition, stakeholders, expected benefits, monitoring indicators and sustainability challenges
- Preparation of a simple monitoring and reporting framework for an NBS project, including indicators, data sources, frequency of monitoring and reporting format

Textbooks and Reference Books/ Other Resources:

1. Cohen-Shacham, E., Walters, G., Janzen, C., & Maginnis, S. (Eds.). (2016). *Nature-Based Solutions to Address Global Societal Challenges*. IUCN.
2. Eccles, R. G., Ioannou, I., & Serafeim, G. (2014). The Impact of Corporate Sustainability on Organizational Processes and Performance. *Management Science*, 60(11), 2835-2857. https://doi.org/10.1287/mnsc.2014.1984
3. Seddon, N., Chausson, A., Berry, P., Girardin, C. A. J., Smith, A., & Turner, B. (2020). Understanding the value and limits of nature-based solutions to climate change and other global challenges. *Philosophical Transactions of the Royal Society B*, 375(1794), 20190120. https://doi.org/10.1098/rstb.2019.0120
4. United Nations Environment Programme. (2021). *Nature-based Solutions for Climate Change Mitigation*. UNEP.
5. Friess, D. A., & Webb, E. L. (2014). *Mangrove forests as socio-ecological systems: Understanding and managing ecosystem services*. Springer.
6. World Economic Forum. (2020). *Nature Risk Rising: Why the Crisis Engulfing Nature Matters for Business and the Economy*.

Course Title: Industrial Pollution Prevention and Clean Technologies
Programme: M.Sc. Environmental Science and Sustainability
Semester: IV
Course Code: EVS511
Course Type: Discipline-Specific Elective (DSE)
L-T-P-C: 4-0-0-4

Course Objectives

- To analyse pollution types, sources, and risks associated with the metal, mining, chemical, and paper industries.
- To evaluate cleaner production and pollution prevention strategies specific to high-pollution sectors.

- To explore technological innovations and process modifications for waste minimisation and emission control.
- To study integrated waste and emission treatment approaches relevant to industrial ecology.
- To critically assess legal, policy, and best-practice frameworks applicable to industrial pollution mitigation.

Course Outcomes

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

CO1: Identify and categorise industrial pollutants and process emissions specific to selected sectors.

CO2: Apply cleaner production and energy-efficiency principles in metal, mining, chemical, and paper industries.

CO3: Evaluate technological and material interventions for waste minimisation and source-level prevention.

CO4: Recommend appropriate physical, chemical, or biological treatment options for industry-specific wastes.

CO5: Design integrated pollution control and cleaner production frameworks for selected industries.

CO6: Interpret environmental policies and evaluate national and global case studies of clean technology adoption.

Module I: Industrial Pollution Profiles and Environmental Impacts

- Overview of industrial pollution: air emissions, wastewater, solid waste and hazardous waste
- Major pollution-generating industrial sectors:
    - Metal and electroplating industries
    - Mining and mineral-based industries
    - Chemical, fertiliser and pesticide industries
    - Pulp and paper industries
    - Textile and dyeing industries
    - Leather/tannery industries
    - Cement and thermal power sectors
- Common industrial pollutants: particulate matter, SOx, NOx, VOCs, heavy metals, acids/alkalis, dyes, chromium, cyanide, high BOD/COD wastewater, sludge, fly ash and process residues
- Environmental and health impacts of industrial pollution
- Concept of industrial pollution load and source identification

Module II: Cleaner Production and Pollution Prevention

- Pollution prevention hierarchy: avoid, reduce, reuse, recycle, recover and treat
- Cleaner production principles and resource efficiency
- Process optimisation, input substitution and waste minimisation
- Energy and material efficiency in selected industries

- Water conservation, water audit and industrial water reuse
- Good housekeeping, preventive maintenance and environmental management practices
- Case examples of cleaner production in metal, textile, paper, chemical and food-processing industries

Module III: Industrial Water and Wastewater Treatment

- Sources and characteristics of industrial wastewater
- Industrial water requirement, water balance and water audit
- Concept of Water Footprint, Product Water Footprint, Business Water Footprint
- Segregation of wastewater streams at source
- Advanced treatment: filtration, adsorption, ion exchange, membrane processes, disinfection and advanced oxidation processes
- Treatment of sector-specific wastewater: textile dyeing, tannery, electroplating, pulp and paper, chemical and food-processing industries
- Zero Liquid Discharge, wastewater recycling and treated effluent reuse
- Sludge handling, dewatering and safe disposal
- Case study: industrial ETP/CETP and ZLD system

Module IV: Clean Technology Applications and Pollution Control Systems

- Clean technology applications in selected industries
- Air pollution control systems: cyclones, bag filters, electrostatic precipitators, scrubbers and flue-gas desulphurisation
- Dust suppression and fugitive emission control in mining and material-handling units
- Solid and hazardous waste management: stabilisation, solidification, secure landfill, co-processing and resource recovery
- Waste-to-resource approaches: fly ash utilisation, slag reuse, solvent recovery and by-product recovery
- Role of automation, sensors, AI/IoT and online monitoring in industrial compliance
- Case studies of clean technology adoption in Indian industries

Module V: Policy, Compliance and Industrial Case Studies

- Overview of industrial environmental regulations in India
- Role of CPCB/SPCB, Consent to Establish and Consent to Operate
- Industry-specific environmental standards and effluent/emission norms
- EIA, EMP, environmental audit and ISO 14001
- ESG audit parameters for industrial pollution prevention
- Charter on Corporate Responsibility for Environmental Protection
- Best-practice case studies from selected industries
- International models of pollution prevention and cleaner productio

Module VI: Hands on training

- Visit to an industrial unit, ETP, CETP, STP, ZLD facility or industrial wastewater treatment plant

- Preparation of a simple industrial water balance or water-audit sheet
- Analysis of selected industrial wastewater parameters such as pH, EC, TDS, turbidity, hardness, chloride, BOD, COD, oil and grease, nitrate, phosphate or heavy metals, depending on available facilities
- Demonstration of jar test/coagulation-flocculation for wastewater treatment
- Sludge observation, documentation and discussion on sludge handling practices
- Case-study analysis of industrial ETP/CETP design and treatment sequence
- Visit to a laboratory of eminence or centre of excellence engaged in industrial pollution monitoring, wastewater analysis, instrumental analysis or clean technology research
- Preparation of visit report/technical report on industrial pollution prevention and treatment practices

Textbooks and Reference Books/ Other Resources:

1. Rao, C. S. (2018). *Environmental Pollution Control Engineering* (3rd ed.). New Age International Publishers.
2. Worrell, E., & Reuter, M. (2014). *Handbook of Industrial Ecology and Cleaner Production*. Springer.
3. Fels, M., & Gornik, E. (2016). *Pollution Prevention and Cleaner Production*. CRC Press.
4. Tchobanoglous, G., & Kreith, F. (2002). *Handbook of Solid Waste Management* (2nd ed.). McGraw-Hill.
5. UNEP. (2019). *Cleaner Production and Sustainable Industrial Development*. United Nations Environment Programme.
6. CPCB. (2010-2022). *CREP Guidelines, ZLD Protocols, and Industry-Specific Environmental Standards*. Central Pollution Control Board, India.
7. Singh, A., & Poonia, M. P. (2021). *Industrial Waste Management: Policies and Practices in India*. NITTTR & AICTE.
8. Buekens, A., & Cen, K. (2013). *Waste Incineration: The Environmental Impact and Remedies*. Springer.

Course Title: Health, Safety and Environment
Programme: M.Sc. Environmental Science and Sustainability
Semester: IV
Course Code: EVS512
Course Type: Discipline-Specific Elective (DSE)
L-T-P-C: 4-0-0-4

Course Objectives:

- To understand the fundamental concepts of occupational health, safety, and environmental management.
- To identify common workplace hazards and assess risks related to health, safety, and environment.

- To learn about regulatory frameworks and standards governing occupational health and safety (OHS).
- To explore techniques and tools for accident prevention and emergency preparedness.
- To integrate environmental considerations with health and safety practices for sustainable industrial operations.

Course Outcomes:

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

CO1: Describe the principles and scope of occupational health, safety, and environmental management.

CO2: Identify and evaluate workplace hazards and associated health risks.

CO3: Apply risk assessment methods and control measures to mitigate hazards.

CO4: Explain the legal and regulatory framework related to health, safety, and environment.

CO5: Develop strategies for accident prevention, emergency response, and disaster management.

CO6: Integrate health, safety, and environmental management systems for organizational sustainability.

Module I: Fundamentals of Health, Safety, and Environment (HSE)

- Introduction to occupational health and safety
- Concepts of industrial hygiene and workplace hazards
- Role and responsibilities of HSE professionals

Module II: Identification and Assessment of Workplace Hazards

- Types of hazards: physical, chemical, biological, ergonomic, and psychosocial
- Hazard identification techniques
- Health risk factors and exposure limits
- Risk assessment methodologies: qualitative and quantitative

Module III: Health and Safety Management Systems and Regulations

- Overview of OHS management systems (e.g., OHSAS 18001, ISO 45001)
- National and international health and safety legislation
- Environmental regulations related to industrial health and safety
- Compliance, audits, and inspections

Module IV: Accident Prevention and Emergency Preparedness

- Causes and consequences of industrial accidents
- Accident investigation and reporting
- Safety culture and behaviour-based safety
- Emergency planning, fire safety, and disaster management

Module V: Integration of HSE with Environmental Sustainability

- Environmental impact of occupational activities
- Sustainable workplace design and green initiatives
- Corporate social responsibility (CSR) and HSE

Textbooks and Reference Books/ Other Resources:

1. Goetsch, D. L. (2019). *Occupational Safety and Health for Technologists, Engineers, and Managers* (9th ed.). Pearson.
2. HSE. (2014). *Managing Health and Safety in the Workplace: The Basics*. Health and Safety Executive, UK.
3. Bhattacharya, B. (2014). *Occupational Health and Safety Management*. PHI Learning.
4. Khan, F. I., & Abbasi, S. A. (2017). *Environmental and Occupational Health Hazards: Risk Assessment and Control*. CRC Press.
5. Merry, J. (2016). *Environmental Safety and Health Management*. Routledge.
6. Dhillon, B. S. (2015). *Engineering Principles of Occupational Safety and Health*. CRC Press.

Course Title: Entrepreneurship
Programme: M.Sc. Environmental Science and Sustainability
Semester: IV
Course Code: EVS513
Course Type: Entrepreneurship
L-T-P-C: 0-2-0-2

Course Objectives

- To introduce the fundamentals of entrepreneurship and entrepreneurial mindset.
- To familiarise students with the legal, financial, and regulatory frameworks for starting and managing businesses in India.
- To provide knowledge on taxation systems, GST compliance, and business registration processes.
- To highlight national and state-level policies supporting entrepreneurship and start-ups.
- To promote entrepreneurship focused on environmental sustainability and green innovation.

Course Outcomes

Upon successful completion of this course, students will be able to:
CO1: Explain the key concepts, characteristics, and types of entrepreneurships.
CO2: Describe the institutional and policy frameworks governing entrepreneurship in India.
CO3: Apply knowledge of taxation, GST, and business compliance requirements.
CO4: Evaluate the procedures for registering and managing start-ups or MSMEs.
CO5: Formulate entrepreneurial ideas with a focus on environmental sustainability and social impact.
CO6: Prepare a business model canvas and pitch for a green or sustainability-related start-up.

Module I: Introduction to Entrepreneurship

- Definition, scope, and types of entrepreneurships
- Entrepreneurial characteristics and competencies
- Women entrepreneurs, social entrepreneurs, and intrapreneurship

- Entrepreneurial mindset and creativity
- Idea generation and opportunity identification

Module II: Institutional and Legal Framework

- Overview of central and state entrepreneurship policies (Startup India, Atal Innovation Mission, state-specific schemes)
- Role of MSME Ministry, SIDBI, NSIC, NABARD, and District Industries Centres (DICs)
- Types of business ownership structures (sole proprietorship, partnership, LLP, Pvt. Ltd., etc.)
- Company registration and UDYAM registration
- Basics of contracts, IPR, and regulatory compliances

Module III: Financial Literacy and Taxation

- Basics of accounting and bookkeeping for entrepreneurs
- Direct and indirect taxes relevant to businesses
- Introduction to GST: structure, rates, registration, invoicing, return filing
- Business financing: Bootstrapping, bank loans, venture capital, angel funding
- Financial institutions and credit guarantee schemes

Module IV: Environmental and Sustainable Entrepreneurship

- Concepts of eco-preneurship, green business models, sustainable eco-tourism, circular economy
- Environmental regulations and compliances for green start-ups
- Market opportunities in renewable energy, waste management, clean tech, sustainable agriculture
- Eco-labelling, life cycle thinking, and green certifications
- Successful Indian examples of sustainable enterprises

Module V: Entrepreneurial Project and Business Plan

- Business Model Canvas (BMC) and Lean Canvas
- SWOT analysis and feasibility studies
- Preparing a business pitch and elevator speech
- Writing a business plan for a sustainability-related start-up
- Pitch deck presentations and peer evaluation

Suggested Readings:

1. Hisrich, R. D., Peters, M. P., & Shepherd, D. A. (2017). *Entrepreneurship* (10th ed.). McGraw-Hill Education.
2. Taneja, S. (2022). *Entrepreneurship Development* (2nd ed.). Pearson India.
3. Ministry of Finance, Government of India. (2021). *GST Law and Practice: A Guide to Goods and Services Tax in India*.
4. Kumar, S. (2019). *Small Business and Entrepreneurship in India*. Routledge.
5. UNEP. (2017). *Green Entrepreneurship: Promoting Sustainable Business*. United Nations Environment Programme.
6. Rao, P. K. (2020). *Environmental Management and Entrepreneurship*. PHI Learning.

Course Title: Dissertation-II

Programme: M.Sc. Environmental Science and Sustainability
Semester: IV
Course Code: EVS514
Course Type: Research
L-T-P-C: 0-0-12-12

Course Objectives

- To enable students to carry out advanced, independent research on an environmental or sustainability-related topic.
- To facilitate the application of research methodologies developed during Dissertation-I to real-world or experimental data.
- To enhance students' abilities in data analysis, critical thinking, and scientific writing.
- To provide training in the preparation of high-quality research reports, dissertations, or publications.
- To promote academic and professional presentation of research findings through oral defence or viva-voce.

Course Outcomes

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

CO1: Conduct in-depth data collection, experimentation, or field research as per the approved research plan.

CO2: Apply appropriate statistical, qualitative, or computational tools for data analysis and interpretation.

CO3: Critically evaluate findings in relation to the research objectives and existing scientific knowledge.

CO4: Prepare a comprehensive and structured dissertation report adhering to academic standards.

CO5: Communicate research outcomes effectively through scientific writing, visualisation, and referencing.

CO6: Defend their research work confidently in front of an expert panel during the final presentation or viva-voce.

Course Details

Dissertation-II is the final phase of the two-part research project initiated in Semester III. In this phase, students are expected to execute their full-scale research plan developed during Dissertation-I. Key expectations include:

- Completion of fieldwork, experimentation, or primary/secondary data collection as per approved methodology.
- Application of analytical tools and techniques to process, analyse, and interpret data.
- Critical discussion of results in light of the research objectives and existing literature.
- Preparation of a structured dissertation following academic and ethical standards, including referencing and plagiarism check.
- Submission of the final dissertation followed by a viva-voce or oral defence before a departmental evaluation committee.

Assessment Components

- Final Dissertation Report (50%)
- Viva-Voce / Oral Defence (30%)
- Presentation of Findings (20%)

Total Credits after 2 years M.Sc. Environmental Science and Sustainability = 97