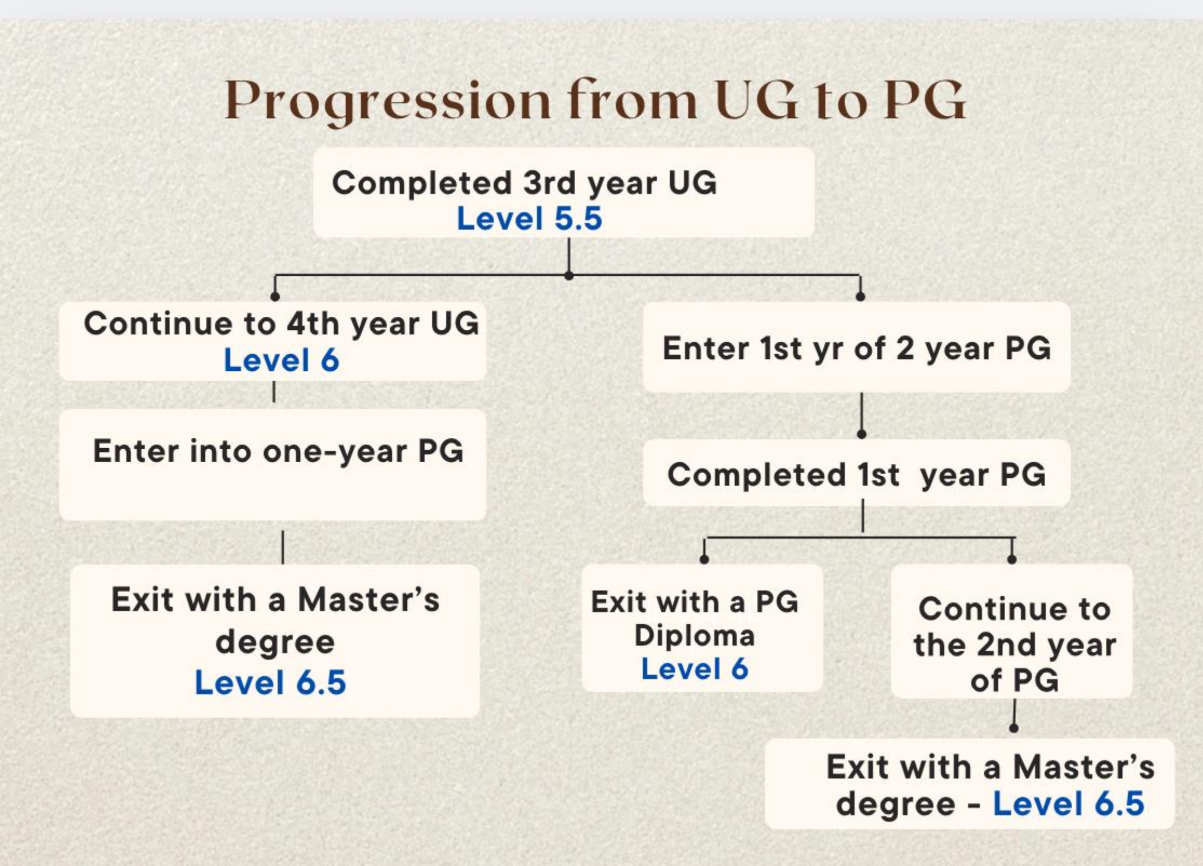
UNIVERSITY OF DELHI

MASTER OF SCIENCE/ MASTER OF ARTS
BY
THE DEPARTMENT OF ENVIRONMENTAL STUDIES

(Effective from academic Year 2025 – 2026)

Revised Syllabus as per PG Curricular Framework 2024 (PGCF-2024) based on NEP-2020 considered by Academic Council on 05 July 2025 and approved by Executive Council on xxx, 2025

PG Curricular Framework 2024 based on NEP 2020



Programme of Study and the corresponding qualification levels

First year UG programme – Level 4.5

Second Year UG Programme – Level 5

Third Year UG Programme – Level 5.5

Fourth Year UG Programme – Level 6

First year of Two Year PG Programme – Level 6

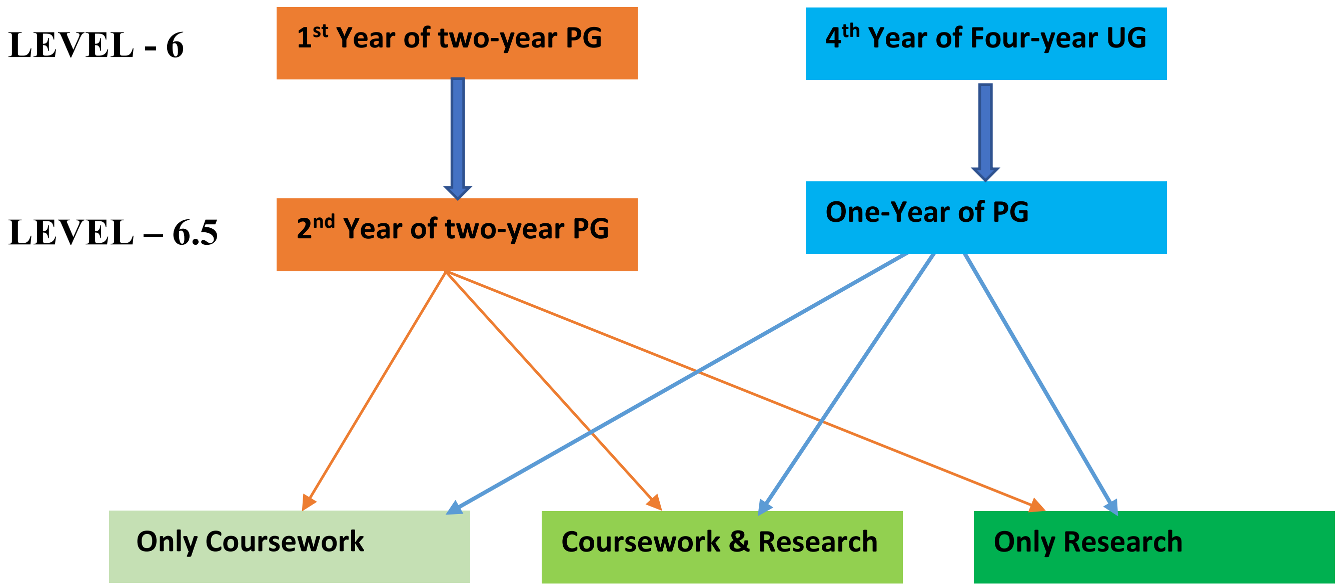
Second Year of Two Year PG Programme – Level 6.5

One year of PG Programme after 4 Year UG – Level 6.5

First year of Two Year PG Programme after 4 Year UG – Level 6.5

Second year of Two Year PG Programme after 4 Year UG – Level 7

Postgraduate Curricular Framework 2024 (based on NEP 2020)



1st Year of PG curricular structure for 2 year PG Programmes (3+2)

Semester	DSC	DSE	2 Credit course	Dissertation/ Academic Project/ Entrepreneurship	Total Credits
Semester- I	**DSC-1** **DSC -2** **DSC - 3** **(12 credits)**	**DSE - 1** **DSE – 2** OR **DSE-1 & GE-1** **(8 credits)**	Skill-based course/ workshop/ Specialised laboratory/ Hands on Learning **(2 credits)**	Nil	**22**
Semester- II	**DSC-4** **DSC -5** **DSC - 6** **(12 credits)**	**DSE- 3** **DSE – 4** OR **DSE-2 & GE-2** **(8 credits)**	Skill-based course/ workshop/ Specialised laboratory/ Hands on Learning **(2 credits)**	Nil	**22**

Details of various courses offered under PGCF for M.Sc. Environmental Science and M.A. Environmental Studies

Programme	Course	Course Code and Title
Semester I		
M.Sc./MA	Discipline-Specific Core (DSC)	**DSC-1:** Fundamentals of Environmental and Ecological Science
		DSC-2: Social, Environmental and Developmental Perspectives on Sustainability
		DSC-3: Integrated Natural Resource Governance for Sustainable Development
	Discipline-Specific Elective (DSE)	Any 2 out of Odd Semester Pool of DSE
	Skill-Based Course (SBC)	Methodologies for Environmental Studies I
Semester II		
M.Sc./MA	Discipline-Specific Core (DSC)	**DSC-4:** Environmental Pollution and Public Health
M.Sc. Environmental Science		**DSC-5:** Natural and Managed Ecosystems
		DSC-6: Ecotoxicology and Environmental Health
M.A. Environmental Studies		**DSC-5:** Global Environmental Challenges and Sustainable Solutions
		DSC-6: Environmental Law, Policy, and Governance
M.Sc./MA	Discipline-Specific Elective (DSE)	Any 2 out of Even Semester Pool of DSE
M.Sc./MA	Skill-Based Course (SBC)	Methodologies for Environmental Studies II

Pool of Discipline-Specific Elective Courses for Odd Semester (M.Sc./M.A. Programme)

Odd Semester DSE Papers (Page 15 onwards)

Pool of Discipline-Specific Elective Courses for Even Semester (M.Sc./M.A. Programme)

Even Semester DSE Papers (Page 66 onwards)

Semester I – M.Sc./M.A. Programme

M.Sc./M.A. (Environmental Studies)

DISCIPLINE-SPECIFIC CORE COURSE - (DSC-1): Fundamentals of Environmental and Ecological Science

Semester I

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title& Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Fundamentals of Environmental and Ecological Science	4	3		1	UG	-

Course Objectives

This course introduces postgraduate students to the interdisciplinary foundations of environmental and ecological sciences. It aims to:

- Provide a systems-based understanding of Earth's environmental processes
- Build foundational ecological, atmospheric, hydrological, and climate science knowledge
- Analyze the causes and consequences of contemporary environmental challenges using scientific and policy frameworks
- Equip students with core field, laboratory, and data-handling skills relevant to environmental analysis
- Cultivate critical thinking around sustainability, biodiversity, and environmental justice issues at both global and Indian scales

Learning Outcomes

By the end of this course, students will be able to:

- Explain fundamental concepts in ecology, atmosphere, hydrology, and environmental systems thinking
- Analyze the scientific basis of air, water, and land interactions using appropriate terminology and models
- Identify drivers of climate change and biodiversity loss using data and global indicators
- Evaluate the implications of environmental change using policy, legal, and sustainability lenses
- Apply basic field and lab skills to monitor and assess environmental quality
- Integrate ecological knowledge into transdisciplinary research and solution-building

Course syllabus (45 hours)

Unit 1: Earth Systems and Ecological Foundations (12 hours)

Earth as an integrated system: lithosphere, hydrosphere, atmosphere, biosphere; Energy flow and thermodynamics in ecosystems; Ecosystem structure and function: food webs, productivity, feedback mechanisms; Organismic interactions: types and ecological outcomes; Gaia hypothesis, ecosystem resilience; Biogeochemical cycles: carbon, nitrogen, phosphorus, sulfur; Global water distribution and hydrological cycle, Freshwater availability; Importance and properties of water.

Unit 2: Atmosphere, Climate, and Hydrosphere Interactions (11 hours)
Atmospheric structure and composition; Air quality standards; Greenhouse gases; Radiative forcing, climate-forcing agents, and atmospheric feedbacks; Climate sensitivity; Atmospheric chemistry–climate interactions; Evidence and indicators of global climate change (IPCC); Water resource challenges; Water use and scarcity; Water management and conservation; Types and sources of water pollution; Water quality indicators; Wastewater treatment; Regulatory frameworks.

Unit 3: Lithosphere, Soils, and Biodiversity (11 hours)
Soil formation, classification (USDA, FAO), profiles, and mineralogy; Soil degradation, erosion, desertification, and nutrient loss; Land use/land cover transitions: agriculture, industry, urbanization; Climate-soil-vegetation feedbacks; Mining impacts; Sustainable soil and land management; Levels and types of biodiversity; Biodiversity patterns, hotspots, endemism; Threats: invasive species, overexploitation, habitat fragmentation; Conservation strategies: in-situ, ex-situ, biosphere reserves, ICCAs.

Unit 4: Environmental Governance and Ecosystem Resilience (11 hours)
Natural resource use and environmental footprints; Energy transitions and circular economy; Environmental Impact Assessment, carrying capacity, environmental auditing; Overview of Indian environmental laws and institutions; Bioprospecting: types, approaches, and significance; Ecosystem services and nature-based solutions.

Suggested Practicals/Applied Exercises/Field Component (30 hours)

- Compare species diversity between two different habitats using the Simpson's diversity index.
- Assess soil health by measuring pH and conducting soil respiration test
- Determine the trophic state of a local water body
- Monitor and analyze daily fluctuations in urban air quality
- Create a thematic map of green spaces in an urban area using open-source GIS software.
- Investigate the impact of urban surfaces on rainwater runoff by comparing infiltration rates of different surface types
- Calculate and compare the carbon footprint of different transportation modes
- Analyze the urban heat island effect using temperature data collected from various points across a city
- Conduct an energy audit of a classroom/Department
- Analyze local climate trends using 30 years of temperature and precipitation data
- Based on the syllabus

Essential Readings

- Bertrand, P. and Legendre, L., 2021. Earth, Our Living Planet. Springer International Publishing.
- Cunningham, W.P. and Cunningham, M.A., 2016. Principles of Environmental Science. Inquiry & Applications, McGraw-Hill, NY.
- Cunningham, W.P. and Cunningham, M.A., 2017. Environmental Science: A Global Concern, 17th Edition. McGraw-Hill, NY
- IPCC. (2023). *AR6 Synthesis Report: Climate Change 2023*. https://www.ipcc.ch/report/ar6/syr/
- Moore, G.S. and Bell, K.A. (2018). Living with the Earth: Concepts in Environmental Health Science. CRC Press.
- Raven, P.H., Berg, L.R. and Hassenzahl, D.M. (2015). Environment. John Wiley & Sons.

Suggested Readings

- Gadgil, M., & Guha, R. (2013). *This Fissured Land: An Ecological History of India* (2nd ed.). Oxford University Press.
- Glasson, J., Therivel, R., & Chadwick, A. (2013). *Introduction to Environmental Impact Assessment* (4th ed.). Routledge.
- ISRO (2023). *Bhuvan Portal – Remote Sensing Applications*. https://bhuvan.nrsc.gov.in/
- Ministry of Jal Shakti. (2023). *India Water Resources Portal*. https://indiawris.gov.in
- MoEFCC (2023). *National Clean Air Programme (NCAP)*. https://ncap.nic.in/
- NASA Earth Observatory. (2024). *Earth's Energy Budget*. https://earthobservatory.nasa.gov

M.Sc./M.A.
Semester I

DISCIPLINE-SPECIFIC CORE COURSE - (DSC-2): Social, Environmental and Developmental Perspectives on Sustainability

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title& Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Social, Environmental and Developmental Perspectives on Sustainability	4	3		1	UG	-

Course Objectives
This course builds a critical understanding of how social, developmental, and environmental dimensions interweave in sustainability debates. It encourages analytical thinking and employability-relevant skills by:

- Exploring philosophical and theoretical foundations in environmental and development thought
- Evaluating colonial and post-colonial trajectories in resource use and governance in India and beyond
- Analyzing the modernity–risk nexus, capitalism, and emerging green critiques
- Assessing equity and justice issues in policy, participation, and sustainability
- Cultivating critical reasoning, stakeholder empathy, interdisciplinary analysis, and communicative competence

Learning Outcomes
By the end of the course, students will be able to:

- Summarize major ethical and theoretical traditions underpinning environmental thought
- Critically discuss development's impact on the environment, including colonial legacies
- Apply social science theories (capitalism, postcolonial, feminist, ecological modernization) to sustainability
- Analyze case studies of governance, activism, and participatory movements in India and globally
- Design communication strategies, policy critiques, and stakeholder assessments

Course Syllabus (45 hours)

Unit 1: Environment and Development: Theories, Critiques, and Paradigms(11 hours)
Development and progress: modernization theory, capitalist realism; Human–nature interface: deep ecology, eco-modernization; Green critiques of industrial capitalism; Postcolonial critiques and South–North environmental disparities; Anthropocene paradigms and the politics of planetary stewardship;

Redefining development: well-being, capabilities, degrowth, circular economies; Post-structural and decolonial perspectives on sustainability discourse.

Unit 2: Historical and Socio-Ecological Transformations in India (11 hours)
Pre-colonial and colonial practices: agriculture, forestry, hydrology; The colonial project: state forest regimes, canal irrigation, commercialization; Impact on communities: dispossession, uprisings, indigenous resistance; Regional comparisons: Gangetic plains, Deccan, Himalayan ecology; Valuing traditional knowledge and indigenous stewardship strategies; Sustainable development paradigms; Case studies on global and Indian strategies for sustainable equity.

Unit 3: Population, Urbanization, Technology, and Risk (12 hours)
Population–resource linkages; Malthusian debates; tragedy of the commons; Urban growth, resource consumption, environmental externalities; Technological systems: electrification, transport, energy – benefits and risks; Environmental risk and ecological modernization theory (Beck, Giddens); Governing environmental risk: frameworks, discourses, communication.

Unit 4: Environmental Governance, Justice, and Participatory Approaches (11 hours)
Environmental law & policy as governance tools; Community management: JFM, Adivasi institutions, co-governance; Principle of free, prior & informed consent; Role of social movements; Disparities and justice: caste, gender, tribal voices in environmental politics; NGO–State–Market relationships; Media and environmental literacy.

Suggested Practicals/Applied Exercises/Field Component (30 hours)

- Critically analyze and debate opposing perspectives in environmental theory by comparing modernist and deep ecologist worldviews.
- Examine the historical context of resource governance by studying colonial forest policies and evaluating their impact on postcolonial environmental movements.
- Explore institutional designs for managing common pool resources through a simulation exercise based on Ostrom's principles of collective action.
- Integrate environmental science with social critique by developing a case study on the environmental and social risks associated with technological infrastructure failures.
- Investigate equity and agency in environmental governance by creating a stakeholder power relations map for a current environmental issue.
- Critically evaluate mainstream sustainability narratives by writing a policy critique on a specific Sustainable Development Goal or national budgetary approach to environmental issues.
- Based on the syllabus

Essential Readings

- Guha, R. (2014). Environmentalism: A Global History. Penguin, UK.
- Merchant, C. (2020). The Death of Nature. HarperOne.
- Armitage, D., Charles, A. and Berkes, F., 2017. Governing the coastal commons. London: Taylor & Francis.
- Scoones, I. (2015). Sustainable Livelihoods and Rural Development. Practical Action Publishing.
- Sachs, J. (2015). The Age of Sustainable Development. Columbia University Press.

Suggested Readings

- Escobar, A., 2020. Pluriversal politics: The real and the possible. Duke University Press.
- Martinez-Alier, J. (2005). The Environmentalism of the Poor. Edward Elgar.
- Redclift, M.R. and Springett, D. (eds.) 2015. Routledge international handbook of sustainable development. London: Routledge.
- Harper, C. and Snowden, M., 2017. Environment and Society: Human perspectives on environmental issues. Routledge.

M.Sc./M.A. Semester I

DISCIPLINE-SPECIFIC CORE COURSE - (DSC-3): Integrated Natural Resource Governance for Sustainable Development

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title& Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Integrated Natural Resource Governance for Sustainable Development	4	3		1	UG	-

Course Objectives

This course provides an integrated understanding of natural resource systems, combining ecological principles with socio-political dynamics of conservation, conflict, and governance. It equips students with analytical, policy, and stakeholder engagement skills by:

- Exploring natural resource cycles and ecological foundations
- Analyzing governance structures and policy instruments for conservation
- Investigating resource-based conflicts, equity issues, and institutional responses
- Evaluating participatory and sustainable management strategies
- Applying tools for scenario analysis, stakeholder mapping, and conflict resolution

Learning Outcomes

Students will be able to:

- Explain biophysical processes and ecosystem services of key natural resources
- Evaluate conflicts over access, control, and use of natural resources
- Analyze legal, institutional, and community-based governance mechanisms
- Develop integrated conservation and management strategies
- Assess the sustainability and equity implications of resource choices

Course Syllabus (45 hours)

Unit 1: Land and Forest Resources: Conservation, Conflict, and Governance (14 hours)

Soil formation, classification, fertility and erosion dynamics; Land degradation: causes, processes and mitigation; Competing land-use demands: agriculture, infrastructure, industry, conservation; Conflicts: land grabs, mining vs. agriculture, pastoral vs. settled land use; Governance tools: land reforms, soil health cards, land use planning, commons regulation; Forest types, ecosystem services, biodiversity values; Governance regimes: state control, joint forest management, CFR (FRA 2006); Conflicts: timber extraction, protected areas vs. people, NTFP access, eco-tourism tensions; Biodiversity management: GMOs, access and benefit-sharing, wildlife corridors; Co-management models: community forestry, sacred groves, biodiversity registers.

Unit 2: Water and Aquatic Resource Governance (9 hours)
Hydrological cycle, aquifer dynamics, water quality concerns; Use conflicts: irrigation vs. drinking water, dams and displacement, transboundary river sharing; Oceans and fisheries governance: common-pool dilemmas, sovereignty disputes; Policy and institutions: river basin authorities, IWRM, groundwater legislation; Community-based water governance: watershed programs, traditional tanks, gendered access.

Unit 3: Energy, Minerals, and Environmental Justice (12 hours)
Genesis and classification of mineral/energy resources; Environmental impacts of extraction: deforestation, pollution, displacement; Mineral resource cycle; Patterns and issues in global non-renewable energy consumption; Fossil fuel resources and environmental impacts; Conflicts: mining in tribal areas, renewable energy land use; Nuclear and geothermal energy, nuclear waste politics; Regulatory frameworks: MMDR Act, CSR in extractives; Transition governance: energy justice, just transitions, fossil vs. renewable trade-offs.

Unit 4: Integrated Governance: Institutions, Innovation, and Equity (10 hours)
Principles of integrated governance: resilience, equity, subsidiarity; Conflict transformation: legal mechanisms, participatory approaches, negotiation tools; Institutions: CPCB, MoEFCC, state bodies, customary governance, green tribunals; Tools: payment for ecosystem services, sustainability assessments, conflict mapping; Case studies: Forest Rights Act, Narmada dam, REDD+, SDG implementation models.

Suggested Practicals/Applied Exercises/Field Component (30 hours)

- Analyze connections between soil management practices and land-use conflicts by mapping conflict zones and evaluating soil restoration strategies.
- Simulate complex stakeholder dynamics in forest conflicts through role-playing Joint Forest Management, tribal, conservationist, and industrial perspectives.
- Develop water sharing and fisheries conflict resolution strategies by creating mediation plans incorporating Integrated Water Resource Management and traditional practices.
- Assess the multidimensional impacts of mining activities by constructing an impact matrix for a hypothetical project, considering economic, ecological, and social factors.
- Design a cross-sectoral resource management strategy using real-world data to propose landscape-level conservation and governance approaches.

Essential Readings

- Barnes, G. and Child, B. eds., 2014. Adaptive Cross-scalar Governance of Natural Resources. New York, NY: Routledge.
- Blaikie, P. & Brookfield, H. (2015). Land Degradation and Society. Routledge.
- Evans, J. and Thomas, C., 2023. Environmental Governance. Routledge.
- Frey, U. (2020). Sustainable Governance of Natural Resources: Uncovering Success Patterns with Machine Learning. Oxford University Press.
- Valenzuela, J.R. and Eggert, 2020. Natural Resource Governance, Grievances and Conflict. Springer Fachmedien Wiesbaden.

Suggested Readings

- Beevers, M.D., 2018. Peacebuilding and Natural Resource Governance After Armed Conflict: Sierra Leone and Liberia. Springer.
- Faure, M., Mascini, P. and Liu, J., 2017. Environmental Governance and Common-Pool Resources: A Comparison of Fishery and Forestry. Routledge.
- Grant, J., Compaoré, W. and Mitchell, M. eds., 2014. New Approaches to the Governance of Natural Resources: Insights from Africa. Springer.
- Le Billon, P., 2013. Fuelling war: Natural resources and armed conflicts. Routledge

Skill-Based Course for
Semester – I (M.Sc./M.A. Programme)

M.Sc./M.A. (Environmental Studies)
Semester I

SKILL-BASED COURSE - (SBC-I): Methodologies for Environmental Studies I

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title& Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Methodologies for Environmental Studies I	2	1		1	UG	-

Course Objectives

- Equip students to formulate rigorous environmental research questions, hypotheses, and mixed-method study designs.
- Build foundational competence in descriptive and introductory inferential statistics for environmental datasets.
- Develop skill in constructing and evaluating deterministic, stochastic, and simulation models of ecological processes.

Learning Outcomes

By the end of the course, students will be able to:

- Classify data and choose appropriate measures of central tendency and dispersion.
- Apply normal and binomial distributions, t-tests, χ^2 and one-way ANOVA to real environmental data
- Interpret statistical power in the context of ecological and epidemiological studies.
- Translate conceptual system diagrams into calibrated simulation models and critically appraise model uncertainty.

Course Syllabus – Theory (15 hours)

Unit 1: Research Design and Methods (5 hours)

Environmental research questions and hypothesis formulation; Types of research: Different criteria with examples and case studies; Quantitative, qualitative and mixed-method approaches; Sampling strategies: probabilistic and non-probabilistic; Participatory rural appraisal (PRA), stakeholder mapping; Ethics in environmental research and data sovereignty

Unit 2: Environmental Statistics I (5 hours)

Types of data: nominal, ordinal, interval, ratio; Descriptive statistics and data visualization; Probability distributions: normal, binomial; Inferential statistics: Parametric tests – t-test, chi-square, ANOVA

Unit 3: Simulation and Environmental Modelling (5 hours)

Types of models: deterministic, stochastic, empirical, simulation; Conceptualizing models: systems thinking and flow diagrams; Case models: eutrophication, air pollution dispersion, climate sensitivity; Model calibration, validation, and uncertainty analysis; Introduction to participatory modelling

Suggested Practicals/Applied Exercises/Field Component (30 hours)

- Compute central tendencies, visualize data distributions of environmental variables
- Compute and visualise summary statistics (histograms, boxplots, etc.) for the environmental dataset.
- Perform *t*-tests and one-way ANOVA on environmental data and interpret post-hoc comparisons.
- Create an interview guide and perform pilot interviews
- Develop a research plan that integrates quantitative and qualitative tools, sampling strategy
- Based on the syllabus

Essential Readings

- Crawley, M.J., 2012. The R book. John Wiley & Sons.
- Gotelli, N.J. and Ellison, A.M., 2004. A primer of ecological statistics (Vol. 1, pp. 1-640). Sunderland: Sinauer Associates.
- Quinn, G.P. and Keough, M.J., 2002. Experimental design and data analysis for biologists. Cambridge university press.
- Sokal, R.R. and Rohlf, F.J., 2012. Biometry, 4th ed. Stony Brook University.
- Zar, Jerrold H. 2018. Biostatistical analysis. Pearson Education India.
- Zuur, A.F., Ieno, E.N. and Smith, G.M., 2007. Analysing ecological data (Vol. 680). New York: Springer.

Suggested Readings

- Bolker, B.M., 2008. *Ecological Models and Data in R,* Princeton University Press.
- Ellison, A.M., 2010. Repeatability and transparency in ecological research. Ecology, 91(9), pp.2536-2539.
- Mangel, M. and Hilborn, R., 2013. The Ecological Detective: Confronting Models with Data (MPB-28). Princeton University Press.
- McDonald, J.H., 2014. *Handbook of Biological Statistics*, 3rd ed., Sparky House.

Pool of Discipline-Specific Elective Courses for Even Semester (M.Sc./M.A. Programme)

Odd Semester DSE Papers

1. **DSE-1**: Biotechnology in Environmental and Public Health Applications
2. **DSE-2**: Coastal and Marine Environment
3. **DSE-3**: Culture, Environment, and Ecological Imaginaries
4. **DSE-4**: Environmental History and Contemporary Environmental Thought
5. **DSE-5**: Environmental Pollution and Epidemiology of Diseases
6. **DSE-6**: Environmental Microbiology and Microbial Ecology
7. **DSE-7**: Fundamentals of Air Pollution Science
8. **DSE-8**: Gender, Ecology, and Environmental Justice
9. **DSE-9**: Introduction to Environmental Governance
10. **DSE-10**: Remote Sensing and GIS for Environmental Applications
11. **DSE-11**: Technology, Environment, and Society
12. **DSE-12**: Traditional Indigenous Ecological Knowledge

M.Sc./M.A. Odd Semester

DISCIPLINE-SPECIFIC ELECTIVE COURSE – (DSE-1):

Biotechnology in Environmental and Public Health Applications

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title& Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
DSE-1: Biotechnology in Environmental and Public Health Applications	4	3	-	1	UG	-

Course Objectives

- Introduce students to the fundamentals of environmental biotechnology and its role in addressing environmental health issues,
- Explore the interconnections between biotechnology, ecosystem health, and public health,
- Develop understanding of microbial processes, bioremediation, and emerging biotechnologies in disease prevention and environmental restoration,
- Foster critical evaluation of biotechnological interventions in urban and rural environmental management.

Learning Outcomes

- Understand the scope and applications of environmental biotechnology in the health and environment interface.
- Analyse biotechnological solutions for waste management, water treatment, and pollutant degradation.
- Evaluate the health risks associated with environmental contaminants and the role of microbes in mitigation.
- Apply case-based learning to understand the role of biotechnology in tackling public health challenges.

Course syllabus – Theory (45 hours)

Unit I: Life Sciences in Environmental and Public Health (11 hrs)

Environment–health interactions, One Health approach: convergence of human, animal, and environmental health, Environmental determinants of health: air, water, soil, food, housing, Emerging Environmental and public health issues: AMR, pandemics, urban heat, etc, Case Study: climate change and health

Unit II: Molecular Tools in Disease Surveillance (11 hrs)

Basics of molecular biology relevant to public health, Genetic markers and biomarkers in pollution and health assessment, Environmental DNA and pathogen detection, Genomic surveillance of vector-borne and waterborne diseases, Wastewater-based epidemiology for community health monitoring, Case Study: wastewater surveillance in Indian cities

Unit III: Microbial and Ecological Applications in Environmental Health (12 hrs)

Environmental microbiology and public health: Role of microbes in transmission and prevention of infectious diseases; Microbial communities in air, water, and soil as determinants of health. Microbial applications in disease prevention and control; Use of beneficial microbes in reducing disease-causing pathogens; Role of microbiota in gut and health, Antimicrobial resistance (AMR): Emergence, transmission through environment, and health implications, Bio-toilets and rural hygiene solutions

Unit IV: Climate, Ecosystem Health, Innovation and Policy Interface (11 hrs)

Health impacts of climate change and ecosystem degradation, Traditional ecological knowledge and community-based interventions, Public health frameworks, environmental policies and SDGs, Role of life sciences in achieving One Health and sustainable development

Suggested Practicals/Applied Exercises/Field Component (30 hours)

- Microscopic observation of environmental microbial cultures
- Isolation and growth of pollutant-degrading bacteria
- Water quality testing for coliform and other health indicators
- Soil microbial diversity and pollutant exposure assay
- Survey/report on environmental determinants of health in a local community, PCR.
- Reading and discussion: Case study on bio-toilets in rural India.
- Case study on life science-based environmental health intervention (e.g., algal treatment of arsenic, probiotics in water purification, decentralised composting systems, etc).

Essential Readings

- Rittmann, B.E. & McCarty, P.L. (2001). Environmental Biotechnology: Principles and Applications.
- Vallero, D.A., 2015. Environmental biotechnology: a biosystems approach. Academic press.
- WHO Reports on Water, Sanitation and Health
- MoEFCC (India). National Environmental Health Profile Reports
- Pierik, R. & Verweij, M. (2009). Health Impact Assessment and Public Health Ethics.

Suggested Readings

- UNEP. Environmental Biotechnology for Pollution Control
- Wang, L.K., Ivanov, V., Tay, J.H. and Hung, Y.T. eds., 2010. Environmental biotechnology (Vol. 10). Springer Science & Business Media.
- IPCC Reports (Health and Vulnerability sections)
- National Health Policy 2017 – Govt. of India
- The Lancet Commission Reports on Pollution and Health

M.Sc./M.A. Odd Semester

DISCIPLINE-SPECIFIC ELECTIVE COURSE - (DSE-2) : Coastal and Marine Environment

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OFTHE COURSE

Course title& Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
DSE-2: Coastal and Marine Environment	**4**	**3**	**-**	**1**	UG	**-**

Course Objectives

The course is designed to

- Develop an advanced understanding of the physical, chemical, and biological processes governing coastal and marine environments, with a focus on their structure, function, and dynamics.
- Equip students with practical and analytical skills for the use of modern field, laboratory, and geospatial techniques such as GIS and remote sensing.
- Cultivate an understanding of the key challenges facing coastal and marine environments, including climate change, pollution, habitat degradation, biodiversity loss, and resource
- exploitation, and the capacity to propose nature-based sustainable solutions. Understand the role being played by climate change in modifying the ocean processes and the ocean-atmosphere interactions.

Learning Outcomes

At the end of the course, the students should be able to

- Demonstrate advanced understanding of the physical, chemical, and biological processes that shape coastal and marine environments, including their structure, function, and dynamics.
- Apply quantitative and qualitative research methods, including fieldwork, laboratory analysis, GIS, and remote sensing, for environmental assessment, monitoring, and spatial planning in coastal and marine contexts.
- Critically evaluate natural and anthropogenic impacts on coastal and marine systems, including pollution, habitat loss, climate change, and resource exploitation, and propose evidence-based management solutions.
- Demonstrate familiarity with global scientific concepts and research findings in the domain of climate change-driven oceanic processes.

Course syllabus - Theory (45 hours)

Unit I – Overview of Coastal and Marine Environment (14 Hours)

Bathymetry, structure, function, and classification; Opening and closing of the Ocean, Mapping Ocean floor, Active and Passive Margins, Physical andchemical properties, coastal features, zonation and ecological characteristics; ecosystem services; classification frameworks.

Unit II – Physical and Geological Processes (12 Hours)

Seafloor spreading, Patterns of Paleomagnetism, Coastal geomorphology and landforms; Classification of sediments, Sediment dynamics; Oceanic processes;Sea surface temperature, Ekman Transport, Gyres, Upwelling, Downwelling, Watermasses, Waves and Tides, Oozes, CCD, Marine geology; Paleoceanography, Coastal hazards; Karsts and carbonate systems.

Unit III – Chemical and Biological Oceanography (10 hours)

Composition, sea water Salinity and properties of seawater, Conservative and Non-conservative constituents, Ocean stratification, marine biogeochemical cycles- carbon and nitrogen, marine biodiversity, sea grasses, mangroves, habitats, salt marshes, estuaries and biogeographic zones.

Unit IV – Coastal and Marine Environmental Issues (9 Hours)

Eutrophication, harmful algal blooms, hypoxia, and Oxygen Minimum zones, Coastal erosion, sea-level rise, and climate change impacts, Marine and coastal biodiversity loss, habitat degradation, factors affecting marine communities.

Suggested Practicals/Applied Exercises/Field Component (30 hours)

- Construction and interpretation of T-S (Temperature-Salinity) diagrams.
- Seawater and marine sediment sampling techniques.
- Analysis of nutrients, dissolved oxygen, pH, and other chemical parameters associated with seawater.
- Assessment of chlorophyll content in seawater.
- Sediment sampling and grain size analysis.
- Mapping of land use/land cover, habitats, and geomorphological features in coastal zones
- Use of remote sensing data for coastal change detection and habitat assessment

Essential Readings

- Garrison Tom S. Essentials of Oceanography 5th ed. Belmont, Brooks/Cole, Cengage Learning. 2009.
- Alan P. Trujillo and Harold V Thurman. Essentials of Oceanography, Prentice Hall. 2013.
- Lalli M.C. and Parsons T.R. Biological Oceanography: An Introduction, Elsevier. 2012.
- Frank J. Millero. Chemical Oceanography, CRC Press. 2014.

Suggested Readings

- Dijkstra, H. A. (2008). Dynamical oceanography (Vol. 1, No. 4). Berlin: Springer.
- Miller, C. B. (2009). Biological oceanography. John Wiley & Sons. Abel, D. C., & McConnell, R. L. (2009). Environmental oceanography: topics and analysis. Jones & Bartlett Publishers.
- Knauss, J. A., & Garfield, N. (2016). Introduction to physical oceanography. Waveland Press. Grasshoff, K., Kremling, K., & Ehrhardt, M. (Eds.). (2009). Methods of seawater analysis. John Wiley & Sons.

M.Sc./M.A. Odd Semester

DISCIPLINE-SPECIFIC ELECTIVE COURSE- (DSE-3)
Culture, Environment, and Ecological Imaginaries

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
DSE-3: Culture, Environment, and Ecological Imaginaries	4	3		1	UG	-

Course Objectives

- Examine how diverse cultures conceptualize nature, landscape, and the human–environment relationship
- Analyze environmental transformations through the lenses of cultural adaptation, political ecology, and environmental history
- Explore the environmental implications of religious beliefs, myths, rituals, and customary practices
- Critically assess the impact of modern development, colonial legacies, and capitalism on cultural-ecological systems
- Understand how cultural narratives shape contemporary discourses on sustainability, risk, and resilience

Learning Outcomes

By the end of the course, students will be able to:

- Interpret ecological practices and landscape transformations through cultural and symbolic frameworks
- Analyze historical and contemporary modes of human adaptation across ecological regions
- Identify how cultural perceptions of environment influence conservation, land use, and development
- Reflect on the role of myth, memory, ritual, and tradition in environmental knowledge and resilience
- Engage critically with concepts such as "sacred landscapes," "ecological cosmologies," and "cultural adaptation" in policy and practice

Course Syllabus – Theory (45 hours)

Unit 1: Culture, Nature, and Environmental Knowledge Systems (13 hours)
Concept of culture, material culture, and environmental adaptation; Technology and symbolic interaction with nature; Traditional ecological knowledge (TEK) and biocultural diversity; Nature–culture dualism and its critiques; Environmental meanings in mythology, cosmology, and oral traditions; Ecological transitions: hunting-gathering, pastoralism, swidden agriculture; Spiritual landscapes; Gender, caste, and ethnicity in environmental labor and resource use.

Unit 2: Environmental Adaptation, Identity, and Governance (12 hours)
Market integration and industrial transformation; Climate adaptation in cultural context; Political ecology of land, forest, and water in colonial and post-colonial India; Customary law, community governance, and commons management; Sacred groves, shrine forests, and cultural conservation regimes; Cultural framings of scarcity, degradation, and disaster risk; Religion and ecological stewardship.

Unit 3: Development, Displacement, and Cultural Transformation (10 hours)
Development discourses and redefinition of nature; Cultural dislocation and ecological change under dams, mines, and urbanization; Environmental culture in organizations and green business ethics; Commodification of landscapes and ecological tourism; Post-development, degrowth, and regenerative movements.

Unit 4: Landscapes, Memory, and Ecological Representation (10 hours)
Landscapes as cultural texts and memory-scapes; Environmental aesthetics and ecological storytelling; Cultural change, nostalgia, and place attachment; Literary and visual representations of nature; Art, folklore, and music in environmental resistance.

Suggested Practicals/Applied Exercises/Field Component (30 hours)

- Analyze a ritual or belief system that reflects an ecological ethic
- Use narrative, symbols, or GIS to explore cultural meanings of place
- Examine a conflict between cultural practices and conservation or development policy
- Deconstruct environmental symbolism in film, photography, or media
- Assess adaptive cultural strategies across ecological zones or communities

Essential Readings

- Anderson, A. (2019). Media, Culture and the Environment. Routledge.
- Milton, K. (2003). Environmentalism: The View from Anthropology. Routledge.
- Rocheleau, D., Thomas-Slayter, B. and Wangari, E., 2013. Feminist political ecology: Global issues and local experience. Routledge.
- Sahlins, M.D., 2013. Culture and environment: The study of cultural ecology. In Theory in anthropology (pp. 367-373). Routledge.

Suggested Readings

- Dennett, D.C., 2001. The evolution of culture. The Monist, 84(3), pp.305-324.
- Krüger, F., Bankoff, G., Cannon, T., Orlowski, B. and Schipper, E.L.F. eds., 2015. Cultures and disasters: understanding cultural framings in disaster risk reduction. Routledge.
- Gold, A. G., & Gujar, B. R. (2002). In the Time of Trees and Sorrows: Nature, Power, and Memory in Rajasthan. Duke University Press.

M.Sc./M.A. Odd Semester

DISCIPLINE-SPECIFIC ELECTIVE COURSE – (DSE-4: Environmental History and Contemporary Environmental Thought

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
DSE-4: Environmental History and Contemporary Environmental Thought	4	3	-	1	UG	-

Course Objectives

- Explore major trends in environmental history from ancient to modern times
- Analyze the co-evolution of societies and ecosystems
- Understand historical roots of environmental degradation, conservation, and sustainability discourses
- Critically examine ideologies, and cultural constructs shaping environmental thinking
- Evaluate transformations in water, land, forests, disease ecology, and technology through historical processes

Learning Outcomes

By the end of the course, students will be able to:

- Analyze ecological transitions across civilizations
- Identify key environmental events that influenced develoment at global and local levels
- Examine the origins and trajectories of ecological thought and public concern about the environment
- Contextualize modern environmental challenges and movements in long-term historical patterns

Course Syllabus – Theory (45 hours)

Unit 1: Foundations of Environmental History and Ecological Thought (14 hours)

Definitions, scope, and methodologies of environmental history; Environmental thought across time: natural theology, romantic ecology, Gaia theory; Relationship with economic, social, and cultural histories; Foundational thinkers: Lynn White, Rachel Carson, Ramachandra Guha, Alfred Crosby; Human–nature relationships: from sacred landscapes to extractive frontiers; Environmental impacts of colonial expansion: forest policies, agrarian restructuring, ecological imperialism; Global movement of species, crops, pathogens, technologies.

Unit 2: Empire, Landscapes, and Ecological Transformation (11 hours)

Case studies: spice trade, tea plantations, malaria ecology, cartographic reordering; Cultural meanings of wilderness, commons, enclosures; Landscapes of control: plantations to protected areas; Industrial capitalism and ecological consequences; Urban growth: waterworks, pollution, sanitation; Changing perceptions of environmental risks; Anti-industrial resistance: Luddite and Gandhian ecological thought.

Unit 3: Environmental Movements and Contemporary Ecological Thought (10 hours)
From conservation to environmental justice; Movements for forests, water, and biodiversity: Chipko, Narmada, Bishnoi, Climate Strikes; Ecofeminism, Indigenous philosophies, deep ecology; Global green politics; Historical roots of environmental reform movements.

Unit 4: Environmental History of Inequality, Climate Futures, and the Anthropocene (10 hours)
Ecological marginality: caste, race, gender, and class; Resource access, institutional power, and governance; Historical trajectories of global environmental change; Anthropocene, planetary boundaries, and climate governance; Futures of environmental history and contemporary debates.

Suggested Practicals/Applied Exercises/Field Component (30 hours)

- Develop a cross-regional environmental chronology focusing on key socio-ecological events
- Trace the environmental history of a landscape (e.g., river, forest, wetland) using maps and reports
- Critically engage with historical environmental narratives in literature or visual media
- Curate a thematic exhibit or digital archive on historical environmental change
- Analyze contrasting approaches to nature in pre-colonial and colonial societies

Essential Readings

- Hughes, J.D., 2016. What is environmental history?. John Wiley & Sons.
- Richards, J.F., 2003. The unending frontier: an environmental history of the early modern world (Vol. 1). Univ of California Press.
- Gadgil, M. and Guha, R., 2013. Ecology and equity: The use and abuse of nature in contemporary India. Routledge.
- Guha, R., 2014. Environmentalism: A global history. Penguin UK.

Suggested Readings

- Hughes, J.D., 2009. An environmental history of the world: humankind's changing role in the community of life. Routledge.
- Merchant, C., 2007. American environmental history: An introduction. Columbia University Press.

M.Sc./M.A. Odd Semester

DISCIPLINE-SPECIFIC ELECTIVE COURSE – (DSE-5)

Environmental Pollution and Epidemiology of Diseases

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title& Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
DSE-5: Environmental Pollution and Epidemiology of Diseases	4	3	-	1	UG	-

Course Objectives

The course is aimed to:

- Introduce the scientific basis and sources of environmental pollution affecting human health,
- understand the fundamental concepts of epidemiology in the context of environmental exposure,
- explore the linkages between pollution and disease burden across populations, and
- provide exposure to environmental health data collection, analysis, and risk communication.

Learning Outcomes

After the course, students will be able to:

- Describe the types, sources, and health impacts of major pollutants,
- Examine basic epidemiological methods used in environmental health studies,
- Analyse case studies linking pollution exposure with acute and chronic diseases, and
- Conduct and interpret basic environmental health surveys and risk assessments.

Course syllabus – Theory (45 hours)

Unit I – Environmental Pollution and Human Exposure (11 hours)

Types of pollution: air, water, soil, noise, chemical, and radioactive. Pollutants of concern: PM2.5, NOx, SOx, VOCs, heavy metals, pesticides, plasticisers. Pathways of exposure: inhalation, ingestion, dermal contact. Bioaccumulation and biomagnification

Unit II – Principles of Environmental Epidemiology (10 hours)

Basic concepts: incidence, prevalence, risk factors, population-at-risk. Types of studies: cross-sectional, cohort, case-control. Exposure-response relationships and dose-response curves. Confounders and bias in environmental health studies

Unit III – Pollution-linked Diseases (12 hours)

Respiratory: asthma, bronchitis, COPD, Waterborne: cholera, typhoid, arsenicosis, fluorosis, Soil and food-related: pesticide toxicity, mycotoxicosis, heavy metal poisoning, Emerging diseases and climate-sensitive diseases (dengue, heat stroke, leptospirosis)

Unit IV – Risk Assessment and Public Health Response (12 hours)

Steps in health risk assessment: hazard identification, dose-response, exposure assessment, risk characterization, Risk management and communication, Disease surveillance systems (IDSP, NVBDCP, ICMR), Policies and regulations in environmental health (WHO, CPCB, MOHFW, SDG 3 & 6)

Suggested Practicals/Applied Exercises/Field Component (30 hours)

- Conduct an environmental health survey in a community
- Case study analysis of an epidemic linked to pollution (e.g., Minamata, Bhopal, Delhi smog)
- Data analysis of air or water quality and correlating with health indicators
- Prepare an exposure pathway diagram,
- Visit to a local PHC/UHC or environmental monitoring agency
- Design a public awareness campaign on pollution-related diseases.

Essential Readings

- Friis, R. H. (2012). Essentials of Environmental Health.
- Burt, J. E., & Barber, G. M. (1996). Elementary Statistics for Geographers.
- WHO (2006). Preventing Disease Through Healthy Environments.
- Kondo, M. C. et al. (2018). Health impact of urban environmental exposures: A systematic review.
- CPCB/ICMR Reports on Environmental Health and Pollution

Suggested Readings

- Balakrishnan, K. et al. (2020). Air Pollution and Health in India: A Review.
- ICMR-NIREH. (2021). Environmental Health Risk Assessment Manual.
- Baird, C., & Cann, M. (2012). Environmental Chemistry (Chapters on pollutants).
- Kjellstrom, T. et al. (2007). Comparative Quantification of Health Risks: Global and Regional Burden of Disease Attributable to Selected Major Risk Factors.
- Indian Ministry of Health Reports and NDMA Guidelines on pollution-linked emergencies

M.Sc./M.A. Odd Semester

DISCIPLINE-SPECIFIC ELECTIVE COURSE - (DSE-6): Environmental Micobiology and Microbial Ecology

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title& Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
DSE-6: Environmental Micobiology and Microbial Ecology	4	3	-	1	UG	-

Course Objectives

- Understand microbial diversity and ecological roles in natural and managed ecosystems
- Gain proficiency in classical and molecular techniques for microbial identification and analysis
- Examine microbial functions in biogeochemical cycles, plant-microbe interactions, and ecosystem processes
- Explore microbial adaptations and their applications in bioremediation and environmental sustainability.
- Analyze policy, ethical, and legal frameworks related to microbial resources and biosafety.

Learning Outcomes

At the end of the course, the students should be able to

- Understand interactions of microorganisms with abiotic and biotic environment
- Microorganisms and biogeochemical cycles
- Microorganisms in terrestrial, aquatic and extreme environments
- Culture-based characterization of microbial communities
- Molecular characterization: PCR, real-time PCR, molecular fingerprints
- Statistical methods in microbial ecology

Course Syllabus – Theory (45 hours)

Unit I – Microbial Function in Ecosystems (12 Hours)

Microbial diversity and ubiquity in ecosystems: roles of microorganisms in biogeochemical cycles (nitrogen fixation, methane metabolism, phosphate mobilization, sulfur cycling); photosynthesis in microorganisms and diversity of pigments; microbial ecological niches and metabolic specialization: functional roles in ecosystems including production, decomposition, and nutrient mobilization; symbiotic and mutualistic relationships; microbial applications in biodegradation and bioremediation.

Unit II – Interactions of Microorganisms with Abiotic and Biotic Environment (14 Hours)

Microbial networks and ecological interactions; plant-microbe interactions including mycorrhizal associations. PGPR and rhizosphere dynamics; microbial interactions with animals and humans; microbe-microbe interactions including competition and quorum sensing; microbial decomposition and nutrient recycling; effects of abiotic factors such as temperature, pH, and moisture on microbial activity; extremophiles and microbial adaptations to extreme environments.

Unit III – Methods in Microbial Ecology (10 Hours)

Traditional microbial isolation techniques; characterization of microbial species using morphological and biochemical tests; aseptic techniques and culture maintenance; molecular tools for studying microbial diversity (PCR, 16S and 18S rRNA sequencing, metagenomics); functional gene analysis and metatranscriptomics; use of bioinformatics in microbial ecology; environmental sampling and experimental design; statistical approaches in microbial ecological studies.

Unit IV – Intellectual Property Rights and Microorganisms (9 Hours)

TRIPS agreement and microbial patentability; Convention on Biological Diversity (CBD) and benefit-sharing frameworks; legal and ethical considerations in microbial resource utilization; case studies on biopiracy and access-benefit sharing; emerging doctrines such as the rights of nature; global inequities in microbial biotechnology and environmental justice.

Suggested Practicals/Applied Exercises/Field Component (30 hours)

Environmental sampling: collection of samples from soil, water, air and niche habitats__

- Aseptic media preparation, isolation and characterization of microbes on prepared media
- DNA extraction from tissue and environmental samples
- Metagenomics: understanding microbial diversity and function by analyzing all DNA sequences in a sample
- Metatranscriptomics: understanding microbial gene expression and functional potential through analyses of RNA sequencing from microbial communities
- Bioinformatics: handling, assembling and annotating large datasets.

Essential Reading

- Environmental Microbiology and Microbial Ecology. Barton, L.L., McLean, R.J.C. (2019). Wiley-Blackwell
- Soil Biology and Ecology: The Basics. Popoviciu, D.R., Bentham Science (2024)
- Metagenomics: methods and protocols. Streit, W.R., Daniel, R., Springer Nature (2023)
- Are ecological processes that select beneficial traits in agricultural microbes nature's intellectual property rights? Kothamasi, D., Vemeylen, S., Deepika, S. Nature Biotechnology (2023) 41:1381 – 1384
- Journal Research articles related to lectures delivered in the classroom

Suggested Readings

- Microbial Ecology, Larry L. Barton, Diana E. Northup, Wily-Blackwell (Publisher)
- Microbial Ecology: Fundamentals and Applications, Ronald M Atlas and Richard Bartha
- Intellectual Property and Biotechnology, Biological Inventions, Mathew Rimmer. Edward Elgar (Publisher)
- Rau, N. et al., 2009. Evaluation of functional diversity in rhizobacterial taxa of a wild grass (*Saccharum ravennae*) colonizing abandoned fly ash dumps in Delhi urban ecosystem. Soil Biology and Biochemistry, 41(4), pp.813-821.

M.Sc./M.A. Odd Semester

DISCIPLINE-SPECIFIC ELECTIVE COURSE - (DSE-7): Fundamentals of air pollution science

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title& Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
DSE-7: Fundamentals of Air Pollution Science	4	3	-	1	UG	-

Course Objectives
The course is designed to

- Understand the environmental effects of air pollution
- Understand the dispersion of air pollutants
- Learn about air pollution monitoring methods and control technologies

Learning Outcomes
At the end of the course, the students should be able to

- Evaluate the emergent issues of air pollution in India and worldwide
- Evaluate the impact of air pollution on the atmospheric environment
- Measure air pollutants and select the appropriate control technologies for the target pollutants

Course syllabus – Theory (45 hours)

Unit 1- Basics of Air Pollution (11 hours)
Types and sources of air pollution; Air pollution hot spots; Criteria pollutants, and NAAQs; Air pollution monitoring methods; Objectives of the air pollution monitoring programme; Government initiatives to tackle air pollution; Indoor air pollution.

Unit II - Air pollution meteorology (11 hours)
Meteorological parameters; Temperature profile of the atmosphere; Lapse rate; Atmospheric stability; Plume behaviour; Dispersion of air pollutants; Gaussian plume model; Meteorological data acquisition and use in air quality forecasting

Unit III - Air pollution control technologies (11 hours)
Technologies for controlling the gaseous and particulate pollution; Vehicle emission control technologies; Urban planning and traffic interventions for air quality; Pollution control in thermal power plants, cement and other industries; Role of green infrastructure and urban vegetation; Case studies.

Unit IV- Impacts of air pollution on the environment and health (12 hours)
Inter-relation of air pollution and climate change; Air pollution impacts on human health; Impacts on atmospheric chemistry and radiative forcing; Air pollution and mortality/morbidity statistics; Agricultural and ecological effects; Transboundary air pollution and regional agreements; Policy responses: WHO air quality guidelines, UNEP reports; Case studies

Suggested Practicals/Applied Exercises/Field Component (30 hours)

- To study the meteorological parameters
- To study mixing height and atmospheric stability
- To study the concentration of particulates in the ambient air
- Monitoring air pollutants using low-cost sensors
- Study and interpret the data from the continuous ambient air quality monitoring system
- Air quality Index- calculation and interpretation
- Based on the syllabus

Essential Readings

- Seinfeld, J.H., Pandis, S.N., (2016). Atmospheric Chemistry and Physics: From Air Pollution to Climate Change. Wiley publication.
- Vallero, D. A., (2014). Fundamentals of air pollution. 5th edition. Academic Press, USA.
- Tiwari, A., Williams, I., (2018). Air Pollution: Measurements, Modelling and Mitigation. 4th Edition. CRC Press.
- De N.N., (2000). Air Pollution Control Engineering. McGraw-Hill.

Suggested Readings

- Jeremy, C., Tiwary, A., Colls, J. (2009). Air pollution: measurement, modeling and mitigation, 3rd Edition, USA: CRC Press.
- Guidelines for Ambient Air Quality Monitoring. CPCB India.
- Lutgens, F.K., Tarbuck, E.J., Tasa, D., (2013). The Atmosphere: An Introduction to Meteorology. Pearson.

M.Sc./M.A. Odd Semester

DISCIPLINE-SPECIFIC ELECTIVE COURSE – (DSE-8)

Gender, Ecology, and Environmental Justice

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
DSE-8: Gender, Ecology, and Environmental Justice	**4**	**3**	**-**	**1**	**UG**	**-**

Course Objectives
- Develop a globally relevant understanding of gender–environment relationships
- Critically examine how ecological degradation, climate crises, and environmental governance intersect with gender, class, race, and coloniality
- Explore global and local feminist ecological knowledge systems, policy frameworks, and justice-based movements
- Investigate the role of women in environmental conservation, and activism

Learning Outcomes
By the end of the course, students will be able to:
- Analyze the interlocking systems of gender, race, class, and environment using critical and intersectional theories
- Apply feminist and decolonial ecological frameworks to case studies of climate, conservation, and development
- Critique dominant environmental discourses and policies through gender-justice and equity lenses
- Assess contributions of feminist movements, and eco-justice actors in global environmental governance
- Design and communicate gender-responsive, socially inclusive environmental policies

Course Syllabus – Theory (45 hours)

Unit 1: Theorizing Gender, Ecology, and Environmental Thought (14 hours)
Genealogies of gender, race, and environmental thought; Ecofeminism: radical, spiritual, materialist, and posthuman approaches; Feminist political ecology: access, control, knowledge, and everyday struggles; Queer ecologies and intersectional environmentalism; Decolonial and Indigenous feminist critiques of development and conservation. Women's knowledge in agriculture, forest management, and water governance; Gendered labour and care work in ecological transitions.

Unit 2: Gendered Knowledge, Resource Politics, and Justice (11 hours)
Land tenure, land grabs, and feminization of land struggles; Indigenous women and ecological stewardship; Global political economy of extraction and environmental harm; Gendered dimensions of climate vulnerability and resilience; Migration, conflict, urbanization, and displacement; UNFCCC Gender Action Plan.

Unit 3: Environmental Movements, Activism, and Climate Justice (11 hours)
Women-led environmental movements: Chipko, Narmada, Standing Rock; Feminist campaigns against mining, nuclear projects, and toxics; Gender and corporate accountability; Feminist storytelling in climate justice and environmental resistance; Just transitions: renewable energy, carbon markets, reparative frameworks.

Unit 4: Governance, Policy, and the Future of Environmental Justice (9 hours)
Gender mainstreaming in environmental governance; Gender-responsive budgets and institutional reforms; International instruments: CEDAW, IUCN Gender & Environment Hub; Ethics of care; Future directions for gendered environmental justice and global sustainability.

Suggested Practicals/Applied Exercises/Field Component (30 hours)

- Visualize gender-climate vulnerability for a community or region
- Critically assess a national environmental policy (e.g., climate plan, forest rights) for gender equity
- Analyze representations of gender and environment in documentaries or social campaigns
- Propose an initiative that integrates gender equity and environmental sustainability in a specific sector
- Write or deconstruct eco-feminist stories from oral traditions, Indigenous epistemologies, or digital media
- Based on the syllabus

Essential Readings

- Alston, M. and Whittenbury, K. eds., 2012. Research, action and policy: Addressing the gendered impacts of climate change. Springer Science & Business Media.
- Buckingham, S., 2020. Gender and environment. Routledge.
- Cuomo, C., 2002. Feminism and ecological communities. Routledge.
- MacGregor, S. ed., 2017. Routledge handbook of gender and environment. Taylor & Francis.

Suggested Readings

- Gaard, G., 2017. Critical ecofeminism. Lexington Books.
- Haraway, D.J., 2016. Staying with the trouble: Making kin in the Chthulucene. In Staying with the Trouble. Duke University Press.
- Sachs, C.E., 2018. Gendered fields: Rural women, agriculture, and environment. Routledge.

M.Sc./M.A. Odd Semester

DISCIPLINE-SPECIFIC ELECTIVE COURSE – (DSE-9)

Introduction to Environmental Governance

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title& Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
DSE-9: Introduction to Environmental Governance	4	3	-	1	UG	-

Course Objectives

- Introduce the evolution, principles, and frameworks of environmental governance at multiple levels,
- Explain the roles of institutions, policies, stakeholders, and legal mechanisms in governing natural resources and ecosystems,
- Foster critical understanding of participatory, Decentralised, and inclusive models of governance,
- Equip students with analytical tools to evaluate governance structures in the context of environmental justice, equity, and sustainability.

Learning Outcomes

At the end of the course, students will be able to:

- Understand key concepts, actors, and mechanisms involved in environmental governance.
- Examine how power, institutions, and norms influence environmental decision-making.
- Evaluate national and global governance systems through real-world case studies.
- Recommend policy or governance interventions for sustainable and equitable outcomes.

Course syllabus – theory (45 hours)

Unit I – Concepts and Frameworks of Environmental Governance (12 hours)
Definition and significance of environmental governance, Core principles: transparency, accountability, participation, equity, rule of law, Governance vs. government: new institutionalism, decentralisation, Environmental governance and sustainable development, Theories of governance: adaptive, polycentric, collaborative governance

Unit II – Governance Actors and Institutions (11 hours)
Key actors: state, judiciary, civil society, indigenous communities, media, corporations, Role of Panchayati Raj Institutions and Urban Local Bodies, Public-Private Partnerships (PPP) in environmental governance, Environmental Tribunals, especially National Green Tribunal (NGT), Policy instruments: command-and-control regulations, market-based incentives, voluntary codes, certifications

Unit III – Environmental Governance in India (12 hours)
Constitutional and legislative provisions: Art. 48A, 51A(g); EPA 1986; FRA 2006, Institutional framework: MoEFCC, CPCB, SPCBs, Forest Departments, Implementation challenges: gaps, coordination issues, political economy, corruption Case studies: Forest Rights Act implementation, Coastal Regulation Zone norms, Environmental Impact Assessment Notification 2006

Unit IV – Global Environmental Governance (10 hours)
Global commons and transboundary environmental challenges, Global institutions: UNEP, IPCC, WTO, World Bank, GEF, Major Multilateral Environmental Agreements (MEAs): UNFCCC and the Paris Agreement, CBD, Basel Convention, Minamata Convention, Governance of climate change, biodiversity, pollution control, Emerging issues: climate justice, environmental diplomacy, geoengineering governance

Suggested Practicals/Applied Exercises/Field Component (30 hours)

- Institutional Mapping: Local/state environmental governance bodies,
- Case Study Analysis: Governance success/failure (e.g., Aravalli Hills restoration, Delhi CNG policy)
- Stakeholder Analysis: Contested environmental issues (e.g., mining project, dam construction),
- Governance Audit: Preparation of a report on a local environmental issue (e.g., water pollution, waste management),
- Policy Drafting Exercise: Alternative policy framework for local waste or water governance,
- Legal Brief: Landmark NGT judgment or PIL (e.g., Sterlite, Vizag gas leak) ,
- Document Review: Content and critique of a State Action Plan on Climate Change (SAPCC

Essential Readings

- Lemos, M. C. & Agrawal, A. (2006). Environmental Governance. Annual Review of Environment and Resources.
- Evans, J. and Thomas, C., 2023. Environmental governance. Routledge.
- Ostrom, E. (1990). Governing the Commons.
- Government of India. (2006). National Environment Policy.
- Baviskar, A. (2004). In the Belly of the River.

Suggested Readings

- UNDP. Environmental Governance for Sustainable Development
- World Bank. (2003). World Development Report: Sustainable Development in a Dynamic World
- IPCC Sixth Assessment Report (Summary for Policymakers)
- NGT Compendium of Landmark Judgments (MoEFCC)

M.Sc./M.A. Odd Semester

DISCIPLINE-SPECIFIC ELECTIVE COURSE - (DSE10): Remote Sensing and GIS for Environmental Applications

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
DSE-10: Remote Sensing and GIS for Environmental Applications	4	3	-	1	UG	-

Course Objectives

- Provide foundational and applied knowledge of geospatial technologies for environmental analysis
- Develop competence in remote sensing data acquisition, image processing, and spatial analysis
- Equip students with hands-on GIS tools for solving real-world environmental problems
- Explore global satellite missions, sensors, and cloud-based platforms for environmental monitoring
- Apply geospatial techniques in sustainable resource management, climate assessment, and biodiversity conservation

Learning Outcomes

By the end of this course, students will be able to:

- Explain the principles of remote sensing and geographic information systems
- Analyze spatial and spectral data from satellite and airborne sources
- Apply GIS for spatial modeling and visualization of environmental patterns and processes
- Utilize tools like QGIS, ArcGIS, and Google Earth Engine for environmental decision-making
- Integrate RS-GIS into climate change, land use, biodiversity, and pollution studies

Course Syllabus – Theory (45 hours)

Unit 1: Principles of Remote Sensing and Data Acquisition (11 hours)
Electromagnetic spectrum: interactions with atmosphere and surface; Remote sensing platforms and sensors: Landsat, Sentinel, MODIS, IRS, LiDAR; Resolution types: spatial, spectral, radiometric, temporal; Image acquisition and pre-processing: radiometric and geometric corrections; Global data sources: USGS Earth Explorer, Bhuvan, Copernicus, NOAA.

Unit 2: GIS Fundamentals, Spatial Analysis, and Data Management (11 hours)
GIS concepts: raster and vector models; Spatial reference systems and projections; Data input, digitization, attribute tables, georeferencing; Spatial analysis: buffering, overlay, spatial interpolation; Database creation, metadata, and spatial data quality.

Unit 3: Image Processing, Classification, and Cloud-Based Analytics (11 hours)
Digital image enhancement and classification: supervised, unsupervised; Vegetation indices: NDVI, SAVI; Change detection and temporal analysis; Accuracy assessment and ground truthing; Visual and digital interpretation; Introduction to Google Earth Engine and cloud-based geospatial platforms.

Unit 4: Environmental Applications, Modeling, and Decision Support (12 hours)
Land use/land cover change and urban sprawl; Forest degradation, biodiversity, and conservation planning; Wetland and watershed mapping; Pollution zoning: air and water; Natural hazard monitoring: drought, floods, fires; GIS-based environmental modeling: erosion, runoff, climate vulnerability; Drone and GPS integration; EIA, carrying capacity analysis; Ethics and limitations in geospatial data use.

Suggested Practicals/Applied Exercises/Field Component (30 hours)

- Land cover classification using Sentinel or Landsat data – Detect and classify vegetation and built-up areas
- Watershed delineation using DEM data – Apply GIS hydrological tools
- Change detection analysis of urban growth – Monitor land use transitions over time
- Pollution mapping using spatial interpolation – Visualize pollutant spread from sampling data
- GIS-based suitability analysis for conservation sites – Perform multi-criteria decision analysis
- Based on the syllabus

Essential Readings

- Burrough, P. A., McDonnell, R. A., & Lloyd, C. D. (2015). Principles of geographical information systems (3rd ed.). Oxford University Press.
- Jensen, J. R. (2013). Remote sensing of the environment: An earth resource perspective (2nd ed.). Pearson.
- Lillesand, T. M., Kiefer, R. W., & Chipman, J. W. (2015). Remote sensing and image interpretation (7th ed.). Wiley.
- Longley, P. A., Goodchild, M. F., Maguire, D. J., & Rhind, D. W. (2015). Geographic information systems and science (4th ed.). Wiley.

Suggested Readings

- Bolstad, P. (2016). GIS fundamentals: A first text on geographic information systems (5th ed.). XanEdu Publishing.
- Campbell, J. B., & Wynne, R. H. (2011). Introduction to remote sensing (5th ed.). Guilford Press.
- Google Earth Engine Tutorials. https://developers.google.com/earth-engine
- QGIS Documentation Team. (2023). QGIS User Guide. https://docs.qgis.org

M.Sc./M.A. Odd Semester

DISCIPLINE-SPECIFIC CORE COURSE - (DSC-11): Technology, Environmental and Society

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title& Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
DSE-11: Technology, Environmental and Society	4	3	-	1	UG	-

Course Objectives

- Analyze the historical and contemporary relationships between technological advancement, society, and the environment
- Critically assess the social and ecological consequences of technology adoption across sectors
- Examine the role of innovation in driving sustainability transitions and addressing environmental challenges
- Explore environmental policy frameworks and their interaction with technological choices
- Understand the contribution of social and environmental movements to responsible and equitable technology development

Learning Outcomes

By the end of the course, students will be able to:

- Articulate the reciprocal influences of technology, environmental change, and social systems
- Distinguish between types and scales of technologies and their implications for ecological sustainability
- Evaluate technological innovations in key environmental domains (e.g., energy, transport, water)
- Interpret policy frameworks and assess how they shape technology transitions
- Critically reflect on environmental movements and community-led alternatives to dominant technological paradigms

Course Syllabus – Theory (45 hours)

Unit 1: Technology, Society, and Environmental Change (14 hours)

Historical human–technology–nature interactions; Industrial revolutions and environmental transformations; Technology as an agent of ecological risk and adaptation; Comparative tech trajectories: Global North vs Global South; Technological dualism and environmental justice critiques; Cultural and ecological dimensions of technological change. Typologies of technology: green, disruptive, appropriate, soft and hard; Lifecycle assessment and design-for-environment; Technology adoption barriers; Environmental externalities of legacy and lock-in technologies.

Unit 2: Technological Systems, Innovation, and Sustainability (11 hours)

Case studies: decentralized solar, bio-digesters, electric mobility; Material flow and end-of-life challenges in tech systems; Sectoral innovations: agriculture, water, mobility, waste; Bioeconomy and circular technologies; Green technologies for pollution control and resource efficiency; Emerging tech: AI, IoT, climate-tech, risk modeling; Frugal innovation and climate-smart adaptation technologies.

Unit 3: Governance, Policy, and Socio-Technical Transitions (10 hours)
Policy instruments: regulatory, fiscal, voluntary; Socio-technical transitions and Multi-Level Perspective (MLP); Environmental costs: mining, digital waste, rebound effects; Governance of emerging technologies: uncertainty, ethics, risk; Innovation systems for low-carbon pathways; Policy–technology integration for just transitions.

Unit 4: Technology Movements, Justice, and Corporate Responsibility (10 hours)
Media and civil society in shaping tech narratives; Environmental justice movements and technology critiques; Corporate shifts: CSR to ESG to Steward Leadership; Appropriate technology revival: ethics, scale, purpose; Community-led innovation and decentralized systems; Role of academia and media; Global critiques of greenwashing and techno-solutionism.

Practicals/Tutorials/Activities/Applied Exercises/Field Component (30 hours)

- Analyze the lifecycle and environmental footprint of a chosen technology
- Map the governance landscape for EV adoption in India or any region
- Assess technology deployment in a contested landscape (e.g., hydropower, waste incineration)
- Case study analysis of community resistance to a large infrastructure project; stakeholder assessment
- Draft an "appropriate technology" proposal addressing water, waste, or mobility
- Based on the syllabus

Essential Readings

- Atkinson, J. and Crowe, M. eds., 2006. Interdisciplinary research: Diverse approaches in science, technology, health and society. John Wiley & Sons.
- Dove, M. and Kammen, D., 2015. Science, society and the environment: Applying anthropology and physics to sustainability. Routledge.
- Golden, J.M., 2016. Dawn of the metal age: Technology and society during the Levantine Chalcolithic. Routledge.
- Gross, M. and Mautz, R., 2014. Renewable energies. Routledge.
- Harper, C. and Snowden, M., 2017. Environment and society: Human perspectives on environmental issues. Routledge.
- Perkins, J.H., 2017. Changing energy: the transition to a sustainable future. Univ of California Press.

Suggested Readings

- Brownsword, R., 2019. Law, technology and society: reimagining the regulatory environment. Routledge.
- Jasanoff, S. (2004). States of Knowledge: The Co-Production of Science and the Social Order. Routledge.
- Narayanan, A., Sharma, R.S. and Mishra, V., 2025. Unmasking the Masks of Profits: Analyzing Corporate Social Responsibility Through an Environmental Justice Framework. In Integrating Environmental Sustainability and Corporate Social Responsibility: A Move Beyond Profit: Corporate Social Responsibility for Environmental Sustainability (pp. 65-94). Cham: Springer Nature Switzerland.
- Odum, H.T., 2007. Environment, power, and society for the twenty-first century: the hierarchy of energy. Columbia University Press.
- Smil, V., 2007. Energy in nature and society: general energetics of complex systems. MIT Press.

M.Sc./M.A. Odd Semester

DISCIPLINE-SPECIFIC ELECTIVE COURSE – (DSE-12)

Traditional Indigenous Ecological Knowledge

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
DSE-12: Traditional Indigenous Ecological Knowledge	**4**	**3**	**-**	**1**	**UG**	**-**

Preamble

A "traditional environment knowledge" cover key topics definition and principles of Traditional Ecological Knowledge (TEK), its application in different ecosystems, indigenous knowledge systems related to plants, animals, weather patterns, land management practices, cultural beliefs tied to the environment. Methods for documenting and preserving TEK, and ethical considerations for studying and applying indigenous knowledge, often focusing on the interconnectedness between humans and their environment. The course is designed to deliver a foundational framework and overall understanding of Traditional Ecological Knowledge (TEK) in sustainability science and in the larger sustainability context and conservation movements. The course will make an effort to amalgamate theory and practical hands on experience techniques for alleviating and preserving indigenous knowledge in the scenario of socio-cultural transitions between knowledge systems. The students will focus on narratives of environmental knowledge, and how it can be integrated with social beliefs and subsequently to cater environmental management. Traditional versus scientific knowledge will also be explored.

Course Objectives

- Know the meaning of "traditional environment knowledge" and its significance in the contemporary world.
- Aware of the concept of "traditional environment knowledge" in sync with cultural beliefs and ecosystem interconnectedness to ecosystem services.
- Will be acquainted about the traditional indigenous knowledge of the elements of earth.

Learning Outcomes

- Understand the significance of our indigenous environmental knowledge system.
- In the scenario of globalization- how indigenous environmental knowledge will play a key role to conserve natural resources.
- Enhanced ability to communicate and understand the tacit balance between nature, culture, and biological diversity
- Comprehensively aware about the socio-cultural heritage and how TEK can augment and sensitize the youth in sync to government programs.

Course Syllabus – Theory (45 hours)

Unit- 1: (12 hours)

Introduction: Concept, Meaning and Definition, Approaches of Traditional Ecological Knowledge, Identification, Documentation, and Validation of Traditional Ecological Knowledge, Significance of Indigenous Traditional Ecological Knowledge. Sacred groves as living repositories of Traditional Ecological Knowledge – their ecological, and cultural significance in maintaining biodiversity, microclimate regulation, and ecosystem services. Sacred groves in traditional forest and land stewardship. Sacred groves as community-conserved areas and potential for ecotourism and environmental education.

Unit- 2: (9 hours)

Indigenous Traditional Ecological Knowledge (I-TEK) its linkages to Ecosystem Services, sustainability and Nature based Solutions (NbSs). Case study- Crop cultivation, and community based environment friendly practices.

Unit- 3: (12 hours)

Traditional Knowledge System and Practice: Studies related to agro-ecosystem, Land use and soil fertility, water conservation, and Forest products. Case Study related to traditional Indian water management and irrigation methods- aquifers, traditional baoli and various irrigation types. Historical practices of metallurgy and Indian metal carvings. Historical architectural influences in terms of energy efficiency. Traditional textile technology in terms of fiber, fabric, colour (use of natural colours) and weaving.

Unit- 4: (12 hours)

Traditional Knowledge System Community rights: Socio-cultural Heritage, Role of organizations/institutions, transitions of Intellectual Property Rights (IPRs). Policy Implications and way Forward- recognizing the importance of Traditional Ecological Knowledge, Integrating Inter-generational transitions of Traditional Ecological Knowledge, Policy framework and initiatives taken uplift Traditional Ecological Knowledge with respect to India. Addressing the challenges of Indigenous Traditional Ecological Knowledge (I- TEK) through SWOT- (Strength, Weakness, Opportunities and Threats) analysis.

Suggested Practicals/Applied Exercises/Field Component (30 hours)

- Conduct biodiversity assessments (flora/fauna checklists), and measure environmental parameters like soil moisture and canopy cover etc.
- Simulate a community meeting to resolve resource-sharing rights using traditional frameworks.
- Conduct a SWOT analysis of a selected traditional ecological practice (e.g., shifting cultivation, pastoralism etc.).
- Developing a fact sheet of documenting observations, interviews, photos, and reflections on traditional ecological knowledge of any selected area.
- Write a short policy brief recommending measures to integrate TEK into environmental planning and role of IPR in protecting indigenous knowledge: benefits versus exploitation scenario.

Essential Readings

- Basham A.L. (ed.). A Cultural History of India. OUP, 1997.
- Berkes, F. (2012). Sacred ecology (3rd ed.). New York, NY: Routledge.
- Ramakrishnan, P. S. (1998). Conserving the sacred: From species to landscapes. New Delhi: UNESCO & Oxford & IBH Publishing.
- Melissa N. and Shilling D. (2018). Traditional Ecological Knowledge: Learning from Indigenous Environmental Sustainability. Cambridge University Press.
- Sen, G. (Ed.). (1997). India: A National Culture? New Delhi: Sage Publications.

- Sillitoe, P. (2007). Local science vs global science: Approaches to indigenous knowledge in international development. New York, NY: Berghahn Books.
- Raygorodetsky, Gleb (2011). *Why Traditional Knowledge Holds the Key to Climate Change.* UN University.
- Gadgil, M., Berkes, F., and Folke, C. (1993). Indigenous knowledge for biodiversity conservation. Ambio, 22, 151–156.
- Hughes, JD and Chandran, MDS (1998). Sacred groves around the Earth: An overview. In: PS Ramakrishnan, KG Saxena, and UM Chandrashekara (Eds.), Conserving the sacred: For biodiversity management (pp. 69–86). New Delhi: Oxford and IBH Publishing.
- Millennium Ecosystem Assessment (MEA). (2005). Ecosystems and human well-being: Synthesis. Washington, DC: Island Press.

Suggestive Readings

- Agarwal, A., and Narain, S. (1997). Dying wisdom: Rise, fall and potential of India's traditional water harvesting systems. New Delhi: Centre for Science and Environment.
- Kumar B B (2001). Indigenous knowledge and sustainable development. New Delhi: Concept Publishing Company.
- Brush, S. B. (1996). *Indigenous Knowledge of Biological Resources and Intellectual Property Rights: The Role of Anthropology.* American Anthropologist, 98(3), 653–686.
- UNESCO. (2009). Learning and knowing in indigenous societies today. Paris: UNESCO.
- Ministry of Environment, Forest and Climate Change (MoEFCC). (2014). National biodiversity action plan: Addendum 2014 to NBAP 2008. Government of India.

Semester – II

Details of various courses offered under PGCF for M.Sc. Environmental Science and M.A. Environmental Studies

Programme	Course	Course Code and Title
Semester I		
M.Sc./MA	Discipline-Specific Core (DSC)	**DSC-1:** Fundamentals of Environmental and Ecological Science
		DSC-2: Social, Environmental and Developmental Perspectives on Sustainability
		DSC-3: Integrated Natural Resource Governance for Sustainable Development
	Discipline-Specific Elective (DSE)	Any 2 out of Odd Semester Pool of DSE
	Skill-Based Course (SBC)	Methodologies for Environmental Studies I
Semester II		
M.Sc./MA	Discipline-Specific Core (DSC)	**DSC-4:** Environmental Pollution and Public Health
M.Sc. Environmental Science		**DSC-5:** Natural and Managed Ecosystems
		DSC-6: Ecotoxicology and Environmental Health
M.A. Environmental Studies		**DSC-5:** Global Environmental Challenges and Sustainable Solutions
		DSC-6: Environmental Law, Policy, and Governance
M.Sc./MA	Discipline-Specific Elective (DSE)	Any 2 out of Even Semester Pool of DSE
M.Sc./MA	Skill-Based Course (SBC)	Methodologies for Environmental Studies II

Pool of Discipline-Specific Elective Courses for Even Semester (M.Sc./M.A. Programme)

Even Semester DSE Papers (Page 66 onwards)

Semester II – M.Sc./M.A. Programme

M.Sc./M.A. (Environmental Studies)
Semester II

DISCIPLINE-SPECIFIC CORE COURSE - (DSC-4):
Environmental Pollution and Public Health

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title& Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
DSC-4: Environmental Pollution and Public Health	**4**	**3**		**1**	**UG**	**-**

Course Objectives

- Examine contemporary environmental pollution and exposure pathways affecting human health
- Build interdisciplinary knowledge spanning environmental chemistry, toxicology, epidemiology, and public health
- Analyze environmental health risks using global standards and data-driven approaches
- Train students in emerging methods of environmental health surveillance, modelling, and policy response

Learning Outcomes

By the end of the course, students will be able to:

- Evaluate environmental pollutants in relation to their health effects across exposure routes and life stages
- Use global and Indian monitoring standards to interpret pollutant data from air, water, soil, and food systems
- Analyze exposure-disease relationships including both communicable and non-communicable outcomes
- Apply tools for environmental epidemiology, pollution risk mapping, and vulnerable population profiling

Course Syllabus – Theory (45 hours)

Unit 1: Pollution Types, Exposure Pathways, and Health Risk Fundamentals (12 hours)
Types of pollutants: physical, chemical, biological, and emerging contaminants (e.g., microplastics, PFAS); Exposure routes; Dose-response concepts, exposure burden, DALYs, vulnerable populations; Basics of toxicokinetics and environmental toxicology; Vector ecology: mosquitoes, rodents, ticks – disease ecology and seasonality; Climate change and vector expansion; Zoonotic diseases: Nipah, COVID-19, leptospirosis, One Health frameworks; Mental health effects of pollution and ecological stress.

Unit 2: Air, Water, Soil, and Food Pollution and Related Health Impacts (12 hours)
Air pollutant composition (inorganic and organic) and sources; Respiratory and cardiovascular impacts; Air quality monitoring and standards (national/international); Health thresholds, AQI, meteorological monitoring and biological effects; Drinking water quality (WHO, BIS standards), contaminants, and treatment; Waterborne pathogens and diseases; Soil and heavy metal exposure: arsenic, lead, mercury, cadmium; mycotoxins.

Unit 3: Radiation, Noise, Indoor, and Occupational Environmental Health Risks (11 hours)
Types of radiation: UV, X-rays, ionizing and non-ionizing; Health impacts from nuclear disasters, EMF, mobile towers; Noise pollution and auditory/other health effects; Indoor air pollution: biomass fuels, household chemicals, building-related illness; Ventilation: standards and health impacts; Occupational exposure and workplace health (ILO guidelines); Urban health: slums, waste, sanitation; Public health challenges in cities and climate-sensitive disease patterns.

Unit 4: Environmental Health Governance, Surveillance, and Risk Communication (10 hours)
Indian regulatory framework: Air Act, Water Act, EP Act, Biomedical Waste Rules; E-waste and hazardous waste rules; National/international frameworks: EPA, CPCB, WHO; Community health assessments and Environmental Health Indicators (EHIs); Climate-resilient health systems, disaster preparedness, environmental surveillance; Role of digital tools, citizen science, and health communication in environmental health.

Suggested Practicals/Applied Exercises/Field Component (30 hours)

- Analyze global and national case studies on various pollutants and their health effects
- Examine the success and challenges of various national/international policies in combating pollution and improving health.
- Develop profile exposure hotspots of targeted pollutants using open-source data (e.g., AQI, CPCB)
- Evaluate physical, chemical, and microbial parameters of drinking water quality
- Survey and map noise levels in different urban zones
- Assess indoor air quality, evaluate risk factors, and develop household improvement plans
- Prepare documentaries on pollution and health issues of the selected site
- Based on the syllabus

Essential Readings

- Goodsite, M.E., Johnson, M.S. and Hertel, O. eds., 2021. Air pollution sources, statistics and health effects. New York, NY: Springer.
- McGranahan, G. and Murray, F. eds., 2012. Air pollution and health in rapidly developing countries. Routledge.
- Moreira, D. and Vilhena, M. eds., 2009. Air pollution and turbulence: modeling and applications. CRC Press.
- Pope III, C.A. and Dockery, D.W., 2025. Particles of Truth: A Story of Discovery, Controversy, and the Fight for Healthy Air. MIT Press.
- Taylor, D., 2014. Toxic communities: Environmental racism, industrial pollution, and residential mobility. In Toxic communities. New York University Press.

Suggested Readings

- Fuller, R., Landrigan, P.J., Balakrishnan, K., Bathan, G., Bose-O'Reilly, S., Brauer, M., Caravanos, J., Chiles, T., Cohen, A., Corra, L. and Cropper, M., 2022. Pollution and health: a progress update. The Lancet Planetary Health, 6(6), pp.e535-e547.
- Garg, S., Kumar, P., Mishra, V., Guijt, R., Singh, P., Dumée, L.F. and Sharma, R.S., 2020. A review on the sources, occurrence and health risks of per-/poly-fluoroalkyl substances (PFAS) arising from the manufacture and disposal of electric and electronic products. Journal of Water Process Engineering, 38, p.101683.
- Landrigan, P.J., Fuller, R., Acosta, N.J., Adeyi, O., Arnold, R., Baldé, A.B., Bertollini, R., Bose-O'Reilly, S., Boufford, J.I., Breysse, P.N. and Chiles, T., 2018. The Lancet Commission on pollution and health. The lancet, 391(10119), pp.462-512.
- Prüss-Üstün, A., Wolf, J., Corvalán, C., Bos, R. and Neira, M., 2016. Preventing disease through healthy environments: a global assessment of the burden of disease from environmental risks. World Health Organization.

Semester II – M.Sc. Environmental Science

M.Sc. (Environmental Science)
Semester II

DISCIPLINE-SPECIFIC CORE COURSE - (DSC-5): Natural and Managed Ecosystesms

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Natural and Managed Ecosystems	**4**	**2**		**2**	**UG**	**-**

Course Objectives

This course explores how ecosystems are structured, function, and respond to natural and anthropogenic changes. It emphasizes ecological theories, mechanisms of community assembly, and the functioning of terrestrial and aquatic ecosystems. Through conceptual frameworks and hands-on practice, students will:

- Develop foundational knowledge in systems ecology and plant community dynamics
- Understand biotic interactions (competition, facilitation, invasion, allelopathy, defense) shaping ecosystems and causes of biodiversity loss
- Examine the role of biodiversity in ecosystem processes and resilience
- Explore ecological perspectives on human-modified ecosystems
- Acquire field and laboratory skills in vegetation and soil ecological assessment

Learning Outcomes

By the end of this course, students will be able to:

- Explain the organization and dynamics of ecosystems and ecological communities
- Analyze the processes driving competition, facilitation, and community structure
- Apply theoretical frameworks (e.g., niche theory, assembly rules, ecosystem energetics)
- Assess human-mediated impacts on ecosystem patterns and biogeochemistry
- Conduct ecosystem-level field investigations with robust ecological design

Course Syllabus – Thoery (30 hours)

Unit 1: Ecosystem Foundations and Community Dynamics (8 hours)
Concepts of ecosystems: components, boundaries, scales; Ecosystem energetics: energy capture, productivity, trophic levels; Nutrient cycles: N, P, S cycles, inputs, transformations, and loss; Food chains, food webs, trophic cascades; Functional responses and efficiencies in energy and matter flow; Community structure: niche, dominance, stratification, species diversity; Development and dynamics: succession, r/K strategies.

Unit 2: Plant Strategies, Interactions, and Community Assembly (8 hours)
Plant strategies: CSR framework (Grime), Tilman's R* theory; Plant competition: resource limitation, light, water, nutrients; Plant facilitation: Stress gradient hypothesis, context dependency; Community assembly rules and coexistence theory; Plant defense theories: optimal defense, carbon:nutrient balance, induced vs. constitutive defense; Allelopathy: chemical interactions, roles in community assembly.

Unit 3: Invasion Ecology, Ecosystem Types, and Disturbance Regimes (7 hours)
Invasive species: linkages with ecosystem processes; Ecological consequences of invasion; Case studies: Lantana, Prosopis juliflora, Wattles; Ecosystem types: forests, grasslands, wetlands, deserts, rivers, lakes, oceans; Managed ecosystems: agri-ecosystems, plantations, aquaculture, urban systems; Disturbance regimes: fire, grazing, drought, flooding; Biodiversity–function relationships: stability, productivity, redundancy.

Unit 4: Ecosystem Services, Human Influence, and Restoration (7 hours)
Biodiversity and ecosystem services: provisioning, regulating, supporting, cultural; Ecosystem fragmentation and connectivity; Human-mediated plant community transformation (agriculture, plantations, invasive species); Managed ecosystems: agroecosystems, aquaculture, community forests, urban greens; Ecosystem restoration and nature-based ecological management.

Suggested Practicals/Applied Exercises/Field Component (60 hours)

- To analyze vegetation community structure using quadrat and transect methods, calculating density, frequency, abundance, and basal area.
- To assess key soil properties influencing plant growth by measuring pH, texture, moisture, organic carbon, and major nutrients (nitrate, phosphate, sulfate).
- To estimate primary productivity and biomass using non-destructive techniques, including leaf area index (LAI) measurement and above-ground to below-ground biomass correlations.
- To investigate plant-plant interactions by designing and conducting basic experiments on resource competition or facilitation under varying plant densities.
- To explore species-area relationships and biodiversity patterns by constructing species-area curves and calculating Shannon and Simpson diversity indices.
- To examine the link between plant functional traits and community structure by observing and documenting key traits (e.g., height, specific leaf area, dispersal mode, defense mechanisms) and relating them to species abundance.
- Based on the syllabus

Essential Readings

- Singh JS, Singh SP, and Gupta SR (2017) Ecology, Environmental Science and Conservation. S. Chand Publishing.
- Rockwood, L.L. (2015). Introduction to population ecology. John Wiley & Sons.
- Grime, J. P. (2001). Plant Strategies, Vegetation Processes, and Ecosystem Properties. Wiley.
- Gurevitch, J., Scheiner, S. M., & Fox, G. A. (2020). The Ecology of Plants (3rd ed.). Sinauer.
- Inderjit. 2005. Invasive plants: Ecological and Agricultural Aspects. Birkhäuser Verlag AG, Switzerland.
- Weil RR and Brady NC. 2017. The nature and properties of soils. 15^{TH} ed. Pearson.

Suggested Readings

- Loreau, M. (2014). From Populations to Ecosystems: Theoretical Foundations for a New Ecological Synthesis. Princeton.
- Reid, W. V. et al. (2005). Millennium Ecosystem Assessment: Synthesis. Island Press.
- IPBES (2022). Global Biodiversity and Ecosystem Services Report. https://ipbes.net
- Allen, S. E. (1989). Chemical Analysis of Ecological Materials. Blackwell.
- Inderjit, Simberloff D, Kaur H, Kalisz S and Bezemer TM. 2021. Novel chemicals engender myriad invasion mechanisms. New Phytologist (Tansley Review), 232: 1184-1200.
- Inderjit, Wardle DA, Karban R and Callaway RM. 2011. The ecosystem and evolutionary contexts of allelopathy. Trends in Ecology & Evolution, 26: 655-662.

M.Sc. (Environmental Studies)
Semester II

DISCIPLINE-SPECIFIC CORE COURSES - (DSC-6):
Ecotoxicology and Environmental Health

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title& Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Ecotoxicology and Environmental Health	4	2		2	UG	-

Course Objectives

- Develop an integrated understanding of toxic substances, their pathways, and their ecological and human health impacts
- Equip students with advanced tools for toxicity testing, biomonitoring, and health risk assessment
- Build knowledge of international conventions and policy instruments governing toxic exposure and environmental health
- Promote critical thinking about exposure justice, chemical safety, and sustainable remediation technologies

Learning Outcomes

By the end of this course, students will be able to:

- Identify and analyze major classes of environmental toxicants and their fate in ecosystems
- Evaluate toxicant impacts at biochemical, molecular, and ecosystem levels
- Conduct environmental health assessments using epidemiological and toxicological data
- Interpret and apply global treaties and safety standards (WHO, IARC, Stockholm, Minamata)
- Design field-based toxicity and health risk assessments using bioassays and exposure indicators

Course syllabus (30 hours)
PART A: ECOTOXICOLOGY

Course Syllabus – Theory (30 hours)

Part A: Ecotoxicology
Unit 1: Foundations and Fate of Environmental Toxicants (6 hours)
Scope and principles of ecotoxicology; Major pollutant classes: heavy metals, organics, endocrine disruptors, nanomaterials; Environmental entry routes (soil, water, air), bioavailability, transport; Environmental fate: bioaccumulation, biomagnification, biotransformation; Global movement: grasshopper effect, long-range transport.

Unit 2: Toxic Effects and Ecotoxicological Responses (9 hours)
Molecular and biochemical responses: oxidative stress, detoxification enzymes (CYP450, GST); Genetic toxicity: DNA damage, epigenetics, mutation assays; Sub-lethal and chronic effects in organisms; Ecotoxicity at population, community, and ecosystem levels; Tools: Adverse Outcome Pathways (AOP), omics approaches; Bioassays (LC_{50}, NOEC, EC_{50}), test organisms and endpoints; Biomarkers, bioindicators, eDNA, biosensors; Field biomonitoring and data quality.

Part B: Environmental Health
Unit 3: Foundations of Environmental Health and Hazard Pathways (8 hours)
Environmental health and toxicology: key concepts and risk assessment; Occupational and community exposures; Classification of toxicants: carcinogens, mutagens, teratogens, neurotoxins; Environmental stressors: chemical, physical, biological, psychosocial; Sources and exposure pathways: solid/hazardous waste, industrial emissions, pesticides, sewage, air pollution.

Unit 4: Environmental Disease Burden and Public Health Interventions (7 hours)
Major disease types: waterborne (cholera, hepatitis), airborne (asthma, COPD), vector-borne (malaria, dengue), foodborne (toxins, parasites); Effects of radioactive exposures; Climate-related health risks: heat, cold, altitude; Preventive strategies: surveillance, sanitation, public awareness, ecological interventions, resilience building.

Suggested Practicals/Applied Exercises/Field Component (60 hours)
- Estimate heavy metals in water/soil using AAS
- Measure oxidative enzyme activity in exposed plants/animals
- Assess physiological responses to environmental contaminants in plants and microbes
- Conduct ecotoxicity assays using a model organism
- Determine enzyme polymorphism in response to eotoxicants
- Analyse eDNA from polluted habitats and compare with pristine habitats
- Assess air quality and risk of associated diseases
- Determine the water quality of potable water
- Assess the density of selected microbes prevalent in air, soil and water
- Determine the lung capacity of the selected population exposed to different air quality
- Bsaed on the syllabus

Essential Readings

- Bradley, N., Harrison, H., Hodgson, G., Kamanyire, R., Kibble, A. and Murray, V. eds., 2014. Essentials of Environmental Public Health Science: A Handbook for Field Professionals. Oxford University Press (UK).
- Landrigan, P. J., & Etzel, R. A. (Eds.). (2013). Textbook of children's environmental health (2nd ed.). Oxford University Press.
- Newman, M. C. (2019). Fundamentals of ecotoxicology: The science of pollution (5th ed.). CRC Press.
- Sparling, D. W. (2017). Basics of Ecotoxicology. CRC Press.
- Walker, C. H., Sibly, R. M., Hopkin, S. P., & Peakall, D. B. (2016). Principles of Ecotoxicology (4th ed.). CRC Press.

Suggested Readings

- Hauser-Davis, R. A., & Parente, T. E. (Eds.). (2018). Ecotoxicology: Perspectives on key issues. CRC Press.
- Warner, L.M. and Schwarzer, R., 2024 Handbook of Concepts in Health, Health Behavior and Environmental Health. Singapore: Springer Nature Singapore.
- Moore, G.S. and Bell, K.A., 2018. Living with the Earth: Concepts in environmental health science (4th ed.). CRC Press.
- Rawat, D., Mishra, V. and Sharma, R.S., 2016. Detoxification of azo dyes in the context of environmental processes. Chemosphere, 155, pp.591-605.
- Suter, G. W. (2016). Ecological Risk Assessment (2nd ed.). CRC Press.
- Van Gestel, C.A., Jonker, M., Kammenga, J.E., Laskowski, R. and Svendsen, C. (eds.) (2016). Mixture Toxicity: Linking Approaches from Ecological and Human Toxicology. CRC Press.

Semester II – M.A. Environmental Studies

M.A. (Environmental Studies)
Semester II

DISCIPLINE-SPECIFIC CORE COURSE - (DSC-5): Global Environmental Challenges & Sustaianable Solutions

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title& Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Global Environmental Challenges & Sustainable Solutions	4	3		1	UG	-

Course Objectives

- Understand complex global environmental challenges within scientific, economic, legal, and geopolitical frameworks
- Examine international treaties, institutions, and governance mechanisms shaping global responses
- Evaluate sustainable technological and policy innovations across sectors
- Explore ethics, equity, and environmental justice in global decision-making
- Cultivate critical thinking and applied skills through simulations, debates, and real-world case studies

Learning Outcomes

Upon completion, students will be able to:

- Analyze major global environmental problems and their interlinkages
- Critically interpret international environmental law, treaties, and negotiations
- Evaluate the role of global institutions in promoting sustainability
- Recommend integrated policy solutions based on ethics and equity
- Apply frameworks and tools to simulate environmental governance scenarios

Course Syllabus – Theory (45 hours)
Unit 1: Climate Change, Governance Mechanisms, and Environmental Security (12 hours)

Scientific and policy dimensions of climate change; Carbon markets, REDD+, methane regulation; Food vs Fuel debate, NDCs, climate finance, carbon trading; Emerging debates: loss & damage, adaptation vs. mitigation, climate migration; Ecological impacts of war and terrorism; Case studies: Ukraine, Vietnam, Iraq; Nuclear winter, chemical/biological warfare; ENMOD, Geneva Conventions; UNEP post-conflict assessments; Resource security, water diplomacy, energy conflicts.

Unit 2: Global Waste, Hazardous Trade, and Environmental Justice (11 hours)
Global waste flows and environmental injustice; Basel, Bamako, Stockholm, Rotterdam Conventions; Governance of e-waste, plastics, mercury, POPs; Key institutions: UNEP, GEF, Interpol, WTO; Circular economy, Extended Producer Responsibility (EPR), green tariffs; Global campaigns, trade–environment disputes, and case-based perspectives on toxic waste governance.

Unit 3: Biodiversity Conservation, Genetic Resources, and Ethical Governance (11 hours)
CBD, CITES; Biopiracy, GMOs, IPRs, access and benefit-sharing (ABS); Regulatory bodies: IUCN, WIPO, TRIPS, FAO; Synthetic biology, CRISPR, biosafety and ethics; Indigenous knowledge, seed sovereignty, and public trust in biodiversity governance.

Unit 4: Energy Transitions, Corporate Sustainability, and Global Pathways (11 hours)
Global energy transitions: renewables, nuclear safety, and sustainability; Case studies: EU Green Deal, India Solar Mission, Brazil biofuels; Life Cycle Assessment (LCA) and decarbonization strategies; Corporate environmental frameworks: CSR, ESG, CDP, GRI, ISO 14001; Global partnerships: UNGC, IEA, IRENA, WBCSD; Net-zero pledges, green recovery, circular business models.

Suggested Practicals/Applied Exercises/Field Component (30 hours)

- Negotiation simulation on global climate finance allocation
- Policy critique of e-waste regulation in an emerging economy
- Case study analysis of a transboundary toxic-waste dispute
- Biodiversity and biopiracy debate featuring stakeholder perspectives
- Techno-economic assessment of solar vs. nuclear energy in India
- Corporate ESG report design for a real or hypothetical company
- Based on the syllabus

Essential Readings

- Brauch, H.G., Behera, N.C., Chourou, B., Dunay, P., Grin, J., Kameri-Mbote, P., Liotta, P.H., Mesjasz, C. and Spring, Ú.O. eds., 2008. Globalization and environmental challenges: reconceptualizing security in the 21st century (Vol. 3). Berlin: Springer.
- Harris, F. ed., 2012. Global environmental issues. John Wiley & Sons.
- Hite, K.A. and Seitz, J.L., 2021. Global issues: an introduction. John Wiley & Sons.
- Klein, N. (2014). This Changes Everything: Capitalism vs. the Climate. Simon & Schuster.
- Middleton, N., 2024. The global casino: an introduction to environmental issues. Routledge.
- Spaargaren, G., Mol, A.P. and Buttel, F.H. eds., 2006. Governing environmental flows: global challenges to social theory. MIT Press.

Suggested Readings

- Chasek, P. S. (2018). Global Environmental Politics. Routledge.
- Harwell, M.A., 2012. Nuclear winter: the human and environmental consequences of nuclear war. Springer Science & Business Media.
- Kareiva, P. M., et al. (2015). Improving Global Environmental Management with Standard Corporate Reporting. PNAS, 112(23), 7375–7382.
- Kaur, H., Rawat, D., Poria, P., Sharma, U., Gibert, Y., Ethayathulla, A.S., Dumée, L.F., Sharma, R.S. and Mishra, V., 2022. Ecotoxic effects of microplastics and contaminated microplastics–Emerging evidence and perspective. Science of the Total Environment, 841, p.156593.
- Russo, M. V. (2008). Environmental Management: Readings and Cases. Houghton Mifflin.
- Welford, R. (2016). Corporate Environmental Management 3: Towards Sustainable Development. Earthscan.

M.A. (Environmental Studies)
Semester II

DISCIPLINE-SPECIFIC CORE COURSE - (DSC-6): Environmental Law, Policy, and Governance

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Environmental Law, Policy, and Governance	4	3		1	UG	-

Course Objectives

This course provides an interdisciplinary and critical foundation in environmental law, policy instruments, and governance frameworks. It addresses formal legal systems and the evolving landscape of environmental governance across scales, with emphasis on participatory processes, justice, and institutional accountability.

Students will:

- Understand foundational legal concepts and statutory mechanisms for environmental protection
- Analyze institutions and tools of environmental governance from local to global levels
- Examine environmental movements, power structures, and stakeholder roles in shaping outcomes
- Engage with real-world legal cases, treaties, and governance innovations
- Develop competencies in legal reasoning, policy critique, and institutional assessment

Learning Outcomes

Upon successful completion, students will be able to:

- Describe the evolution of environmental law and the principles guiding regulation
- Analyze Indian constitutional, legislative, and institutional frameworks for environmental protection
- Interpret international environmental agreements and India's role in global governance
- Evaluate the effectiveness and equity of environmental governance mechanisms
- Apply legal and governance insights to assess contemporary environmental issues

Course Syllabus (45 hours)

Unit 1: Foundations of Environmental Law and Regulation (12 hours)

Definitions and scope of environmental law; Legal bases: constitutional, statutory, judicial, customary; Core principles: sustainable development, polluter pays, precautionary principle, public trust, equity; Regulatory tools: command-and-control, incentive-based, liability laws, ESG compliance; Role of EIA and environmental audit in regulatory frameworks; Constitutional foundations: Articles 14, 19(1)(g), 21, 32, 48A, 51A(g); PILs and judicial activism.

Unit 2: Legislative and Institutional Frameworks in India (11 hours)

Environmental statutes: Water Act (1974), Air Act (1981), Environment Protection Act (1986), Forest laws (1927, 1980), Wildlife Protection Act (1972), Biodiversity Act (2002); Waste management rules: hazardous, biomedical, e-waste, plastic; Environmental institutions: CPCB, SPCBs, NGT, NEAA; Innovations in environmental law: legal personhood for nature, ecocide legislation; National Environmental Policy (2006), NAPCC and SAPCCs; Centre–state roles in environmental governance.

Unit 3: Global Environmental Law and Multilateral Governance (11 hours)

Milestones: Stockholm (1972), Rio (1992), Johannesburg (2002), Paris (2015), Glasgow (2021); Major MEAs: CBD, UNFCCC, Kyoto, Montreal, Basel, CITES, Nagoya Protocol; CBDR; Institutions: UNEP, UNFCCC, IPCC, WTO; Environmental trade disputes and climate litigation; Carbon markets, loss and damage mechanisms; Rights of nature and their position in Indian and global frameworks.

Unit 4: Environmental Governance, Justice, and Political Ecology (11 hours)

Regulatory effectiveness: monitoring, enforcement, compliance challenges; Community-based natural resource governance: JFM, FRA; Decentralized and participatory models: Panchayati Raj, urban local bodies, river basin authorities; Role of civil society, media, green tribunals, and corporate governance. Environmental justice: caste, class, livelihood, procedural equity; Grassroots movements: Chipko, Narmada, Bhopal, Silent Valley; Indigenous and gendered perspectives; Political ecology: development conflicts, access, and governance failures.

Suggested Practicals/Applied Exercises/Field Component (30 hours)

- To analyze a landmark environmental case by identifying key legal principles and assessing their impact on current environmental governance.
- To draft a simplified Public Interest Litigation (PIL) addressing a local environmental issue, focusing on relevant constitutional and statutory provisions.
- To evaluate the effectiveness of a specific environmental policy by analyzing its implementation challenges and proposing evidence-based improvements.
- To compare two major multilateral environmental agreements, examining their objectives, mechanisms, and India's commitments under each.
- To conduct a structured debate on a current environmental controversy, critically examining the balance between development needs and environmental protection.
- Based on the syllabus

Essential Readings

- Divan, S., & Rosencranz, A. (2022). Environmental Law and Policy in India (3rd ed.). Oxford University Press.
- Singh, G. (2024). Environmental Law (3rd ed.). Eastern Book Company
- Cullet, P., 2017. Differential Treatment in International Environmental Law. Routledge.
- Bodansky, D., Brunnée, J., & Rajamani, L. (2017). International Climate Change Law. Oxford University Press.
- McInerney-Lankford, S., Darrow, M., & Rajamani, L. (2010). Human Rights and Climate Change. World Bank.

Suggested Readings

- Bell, S., McGillivray, D., Pedersen, O.W., Lees, E. and Stokes, E. (2017). Environmental Law. Oxford University Press.
- Lazarus, R.J. (2023). The Making of Environmental Law. University of Chicago Press.
- Elliott, L. and Schaedla, W.H. (eds.) (2016). Handbook of Transnational Environmental Crime. Edward Elgar Publishing.
- Chasek, P. and Downie, D.L. (2020). Global Environmental Politics. Routledge.

Skill-Based Course for
Semester II (M.Sc./M.A. Programme)

M.Sc./M.A. (Environmental Studies)
Semester II

SKILL-BASED COURSE - (SBC-II): Methodologies for Environmental Studies II

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title& Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Methodologies for Environmental Studies II	2	1		1	UG	-

Course Objectives

- Advance student proficiency in correlation, regression, non-parametric and time-series techniques for environmental analytics.
- Integrate spatial data (RS/GIS/GPS) with statistical outputs to address land-use change, hazard mapping, and conservation problems.
- Cultivate critical competence in digital image processing and thematic map creation for decision support.

Learning Outcomes

By the end of the semester, students will be able to:

- Choose and justify Pearson/Spearman correlations, simple–multiple linear regression, or logistic regression, for diverse datasets.
- Execute non-parametric tests (Mann-Whitney U, Kruskal-Wallis, Wilcoxon)
- Acquire, preprocess, and classify multispectral imagery; calculate NDVI and change-detection maps in QGIS/ArcGIS.
- Integrate GPS ground truth with raster and vector layers to validate land-cover and hazard maps.

Course syllabus – Theory (15 hours)

Unit 1: Environmental Statistics II (5 hours)

Correlation and Regression: Types and applications; Non-parametric tests: Mann-Whitney U, Kruskal-Wallis, Wilcoxon signed-rank; Comparison of parametric and non-parametric methods; Time series analysis in environmental datasets

Unit 2: Remote Sensing Principles & Digital Image Processing (5 hours)
Remote Sensing: definition, principles, satellites and sensors; Aerial photography to satellite remote sensing; Digital image processing and image interpretation; Applications of Remote Sensing for Environmental Studies

Unit 3: GIS, GPS and Environmental Applications (5 hours)
GPS principles and applications; Geographic Information System: concepts, database generation and analysis; Case studies: (a) Land-use/land-cover change, Forest degradation, Urban sprawling; (b) Mining Hazards/Impacts; (c) Forest Fire/Coal Fire Monitoring

Suggested Practicals/Tutorials/Applied Exercises/Field Component (30 hours)

- Investigate relationships between environmental variables
- Compare linear vs. logistic models using environmental data.
- Analyse abundance of target species across disturbance gradients with Mann-Whitney U and Kruskal-Wallis tests.
- Perform supervised classification (maximum-likelihood) of Landsat 8 imagery and assess accuracy with ROC curves.
- GIS mapping of invasive species distributions
- Based on the syllabus

Essential Readings

- Borcard, D., Gillet, F. and Legendre, P., 2011. Numerical ecology with R (Vol. 2, p. 688). New York: Springer.
- Burrough, P.A., McDonnell, R.A. and Lloyd, C.D., 2015. Principles of geographical information systems. Oxford University Press.
- Coops, N.C. and Tooke, T.R., 2017. Introduction to remote sensing. Learning Landscape Ecology: A Practical Guide to Concepts and Techniques, pp.3-19.
- Jensen, J.R., 2015. Remote sensing of the environment: An earth resource perspective 2/e. Pearson India.
- Zar, Jerrold H. 2018. Biostatistical analysis. Pearson Education India.

Suggested Readings

- Dale, M.R. and Fortin, M.J., 2014. Spatial analysis: a guide for ecologists. Cambridge University Press.
- Lillesand, T., Kiefer, R.W. and Chipman, J., 2015. Remote sensing and image interpretation. John Wiley & Sons.
- O’Sullivan, D. & Unwin, D. 2010. Geographic Information Analysis, 2nd ed. John Wiley & Sons.
- Wickham, H. and Grolemund, G., 2017. R for data science (Vol. 2). Sebastopol, CA: O'Reilly.

Pool of Discipline-Specific Elective Courses for Even Semester (M.Sc./M.A. Programme)

Even Semester DSE Papers (Page 66 onwards)

M.Sc./M.A. Even Semester

DISCIPLINE SPECIFIC ELECTIVE COURSE - (DSE-13)

Atmospheric Aerosols

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
DSE-13: Atmospheric Aerosols	4	3	-	1	UG	-

Course Objectives
The course is designed to

- Understand the sources and chemical composition of aerosols
- Learn about aerosol measurement methods
- Understand their role in atmospheric phenomena

Learning Outcomes
At the end of the course, the students should be able to

- Evaluate the importance of aerosols in the atmosphere
- Understand the aerosol measurement methods
- Evaluate the environmental and climatic effects of aerosols

Course syllabus – Theory (45 hours)

Unit 1- Introduction to atmospheric aerosols (12 Hours)
Climate and aerosols; Sources and aerosol types; Production rates and budget; Characteristics of ambient aerosols; Physical properties of aerosols; Optical and chemical characteristics of aerosols; Thermodynamics of aerosols; Impact of meteorology on aerosol characteristics: Atmospheric boundary layer, temperature, wind, relative humidity; Formation and sinks of aerosols.

Unit II - Measurements of Aerosols (11 Hours)
Mass concentration, number concentration, and size distribution; Scattering, absorption, and extinction coefficients; Methods for determination of particulate matter bound carbonaceous aerosols, ionic species, and metals; Optical properties: Aerosol optical depth (AOD), Single scattering albedo (SSA), and asymmetry parameter (g); Fine mode fraction; Remote sensing of aerosols.

Unit III - Aerosol radiative forcing and aerosol-cloud interactions (11 Hours)
Radiation; Radiative transfer: Equation, Beer-Lambert law, effect of surface albedo in radiative transfer, definition of radiative forcing; Aerosol radiative forcing: Estimation, sensitivity to AOD, SSA and g, role of surface reflectance, short wave vs long wave, comparison; Clouds; Uncertainty in aerosol-cloud interactions and precipitation.

Unit IV- Aerosol impacts on climate and air quality (11 Hours)
Direct radiative forcing: Tropospheric aerosols, black carbon aerosol, aerosol vertical profile and aerosol radiative forcing, aerosol impact on surface temperature, stratospheric aerosols; Indirect radiative forcing: Cloud albedo effect, semi-direct effects; Aerosols and Indian summer monsoon; Aerosol impacts on air quality and aquatic systems; Case studies.

Suggested Practicals/Applied Exercises/Field Component (30 hours)

- Study the $PM_{2.5}$ mass concentration in the ambient air
- Analyse the size distribution of aerosols
- Examine the optical properties of aerosols
- Study the $PM_{2.5}$-bound inorganic ions
- Study the ambient carbonaceous aerosols
- Based on the syllabus

Essential Reading

- Seinfeld, J.H., Pandis, S.N., (2016). Atmospheric Chemistry and Physics: From Air Pollution to Climate Change. Wiley publication.
- Ramachandran, S., (2018). Atmospheric Aerosols: Characteristics and Radiative Effects. CRC press.
- Gelencser, A., (2004). Carbonaceous Aerosols. Springer.

Suggested Reading

- Lutgens, F.K., Tarbuck, E.J., Tasa, D., (2013). The Atmosphere: An Introduction to Meteorology. Pearson.

M.Sc./M.A. Even Semester

DISCIPLINE-SPECIFIC ELECTIVE COURSE - (DSE-14): Bioremediation and Rhizosphere Engineering for Sustainable Development

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
DSE-14: Bioremediation and Rhizosphere Engineering for Sustainable Development	4	3	-	1	UG	-

Course Objectives

- Develop a foundational understanding of bioremediation processes and rhizosphere ecology
- Examine microbial and plant-based technologies for detoxifying pollutants and restoring contaminated soil and water
- Equip students with knowledge of rhizospheric interactions and microbiome engineering for sustainability
- Strengthen skills in ecological risk assessment, and nature-compatible remediation

Learning Outcomes

By the end of this course, students will be able to:

- Describe the principles and applications of bioremediation and rhizosphere engineering
- Analyze microbial and plant-assisted strategies for removing environmental pollutants
- Evaluate the effectiveness of bioremediation techniques in different environmental settings
- Design rhizosphere-based interventions to enhance soil health, and carbon sequestration
- Integrate biotechnological tools in sustainable development

Course Syllabus – Theory (45 hours)

Unit 1: Principles and Strategies of Bioremediation (10 hours)

Definition and scope of bioremediation; Microbial degradation pathways: aerobic, anaerobic, co-metabolism; Biostimulation, bioaugmentation, intrinsic bioremediation; In situ vs. ex situ approaches: landfarming, biopiles, bioventing, biosparging; Biosurfactants and genetically engineered microorganisms (GEMs)

Unit 2: Phytoremediation and Plant-Based Strategies (10 hours)

Phytoremediation mechanisms: phytoextraction, phytostabilization, phytodegradation; Hyperaccumulator species and transgenic plants; Role of endophytic microbes in enhancing phytoremediation; Monitoring tools and ecological safety concerns

Unit 3: Rhizosphere Microbiome and Soil Health Engineering (12 hours)
Structure and dynamics of the rhizosphere; Microbial interactions: PGPR, mycorrhizae, nitrogen fixers, quorum sensing; Rhizoengineering for nutrient cycling, pollutant breakdown, and stress tolerance; Rhizosphere-mediated carbon sequestration and climate resilience; Innovations in microbial consortia and biofertilizers

Unit 4: Integrated Applications and Sustainable Development Goals (13 hours)
Role of bioremediation in water treatment and sanitation; Land reclamation and brownfield restoration; Green wastewater treatment systems (constructed wetlands, root zone tech); Bioremediation in circular economy: resource recovery from waste; Biomarker assays and gene expression in contaminated systems; Monitoring efficacy: bioindicators, microbial community profiling (NGS, qPCR).

Suggested Practicals/Applied Exercises/Field Component (30 hours)
- Isolation and purification of heavy metal-tolerant microbes
- Characterization of heavy metal-tolerant microbes
- Identification and selection of ecotoxicant tolerant plant species through field surveys
- Examination of key characteristics of plants with high phytoremediation potential
- Evaluation of phytoremediation efficiency of selected plant species
- Assess rhizosphere microbial density and diversity of selected plant species from contaminated habitats
- Understand and design in situ microbial treatment processes
- Enhancement plant growth and stress tolerance using PGPR
- Detection of pollutant-degrading genes using PCR-based tests
- Based on the syllabus

Essential Readings

- Hlihor, R.M., Apostol, L.C. and Gavrilescu, M., 2017. Environmental bioremediation by biosorption and bioaccumulation: principles and applications. Enhancing Cleanup of Environmental Pollutants: Volume 1: Biological Approaches, pp.289-315.
- King, R.B., Sheldon, J.K. and Long, G.M., 2023. Practical Environmental Bioremediation: The Field Guide. CRC Press.
- Mackova, M., Dowling, D. and Macek, T. eds., 2006. Phytoremediation and Rhizoremediation (Vol. 9). Springer Science & Business Media.
- Russell, D.L., 2024. Remediation Manual for Contaminated Sites. CRC Press.

Suggested Readings

- Atlas, R.M. and Philp, J., 2005. Bioremediation. Applied microbial solutions for real-world environmental cleanup (pp. xi+-366).
- Cole, G.M., 2018. Assessment and Remediation of Petroleum Contaminated Sites. CRC Press.
- Glick, B.R. and Patten, C.L., 2022. Molecular biotechnology: principles and applications of recombinant DNA. John Wiley & Sons.
- Mishra et al., 2025. Innovative sustainable solutions for detoxifying textile industry effluents using advanced oxidation and biological methods. Journal of Environmental Management, 380, p.124804.
- Sharma et al., 2011. Functionally diverse rhizobacteria of *Saccharum munja* (a native wild grass) colonizing abandoned morrum mine in Aravalli hills (Delhi). Plant and soil, 341, pp.447-459.
- Willey, N. (ed.) 2008. Phytoremediation: Methods and Reviews (Vol. 23). Springer Science & Business Media.

M.Sc./M.A. Even Semester

DISCIPLINE-SPECIFIC ELECTIVE COURSE - (DSE-15): Design Thinking for Nature-Positive Development

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
DSE-15: Design Thinking for Nature-Positive Development	4	3	-	1	UG	-

Course Objectives

- Introduce design thinking as a human-centered and systems-based approach to solving environmental challenges
- Foster creativity, empathy, and iterative thinking in building nature-positive solutions
- Apply principles of regenerative and circular design for sustainable innovation
- Enable students to ideate, prototype, and test interventions that benefit both people and the planet

Learning Outcomes

By the end of this course, students will be able to:

- Understand the principles and stages of design thinking in an environmental context
- Apply co-creation and ideation tools to generate innovative, ecologically sound solutions
- Prototype, test, and iterate sustainable interventions using feedback loops
- Evaluate solutions based on ecological performance, equity, and social adoption potential

Course Syllabus – Theory (45 hours)

Unit 1: Foundations of Design Thinking and Nature-Positive Development (11 hours)

What is design thinking? Origins and evolution; Nature-positive and regenerative development: concepts and principles; The five stages: Empathize, Define, Ideate, Prototype, Test; Environmental design ethics and the precautionary principle; Design for equity, circularity, and net-positive outcomes

Unit 2: Empathizing with Stakeholders and Systems Thinking (10 hours)

Ecosystem mapping and stakeholder analysis; Systems thinking tools: causal loops, feedback, leverage points; Community-driven innovation and social learning; Working across cultures and knowledge systems (indigenous, informal, expert)

Unit 3: Defining Challenges and Ideating Solutions (12 hours)

Problem framing techniques: HMW (How Might We) questions; Ecological constraints and opportunity spaces; Ideation methods: brainstorming, SCAMPER, blue ocean, 10x thinking; Co-creation sessions with users and experts; Tools: idea canvases, SWOT, design briefs

Unit 4: Prototyping and Testing Nature-Based Interventions (12 hours)
Nature-based solutions and biomimicry in prototyping; Feedback collection, iteration, and scenario testing; Rapid prototyping labs: green walls, waste-to-product ideas, urban cooling; Metrics: ecological footprint, biodiversity impact, social acceptance; Pitching nature-positive solutions and developing a Theory of Change.

Suggested Practicals/Applied Exercises/Field Component (30 hours)
Empathy Mapping with local stakeholders – Identify user needs and values

- Design Challenge Framing using systems maps – Define complex eco-social problems
- Nature-Based Prototyping Sprint – Build and test small-scale green infrastructure solutions
- Storytelling and Pitch Workshop – Communicate design vision and ecological impact
- Design Audit of an Urban/Natural Space – Redesign a space for regenerative performance
- Based on the syllabus.

Essential Readings

- Birkeland, J., 2020. Net-positive design and sustainable urban development. Routledge.
- Boy, G.A. ed., 2017. The handbook of human-machine interaction: a human-centered design approach. CRC Press.
- Kanaani, M. ed., 2022. The Routledge Companion to Ecological Design Thinking: Healthful Ecotopian Visions for Architecture and Urbanism. Taylor & Francis.
- Lee, H., 2013. Creating cultural events: the role of design within culture-led regeneration strategies. Lancaster University (United Kingdom).
- Manzini, E., 2015. Design, when everybody designs: An introduction to design for social innovation. MIT Press.
- Primrose, S.B., 2020. Biomimetics: nature-inspired design and innovation. John Wiley & Sons.

Suggested Readings

- Brown, T. (2009). Change by design: How design thinking creates new alternatives for business and society. Harper Business.
- Cross, N., 2023. Design thinking: Understanding how designers think and work. Bloomsbury Publishing.
- Raworth, K. (2018). Doughnut economics: Seven ways to think like a 21st-century economist. Chelsea Green.
- Walsh, E.A. and Moore, S.A., 2014. Regenerative Design. Architecture Beyond Criticism: Expert Judgment and Performance Evaluation, p.252.

M.Sc./M.A. Even Semester

DISCIPLINE-SPECIFIC ELECTIVE COURSE - (DSE-16): Ecological Genomics: Genes, Ecosystems, and Environmental Change

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
DSE-16: Ecological Genomics: Genes, Ecosystems, and Environmental Change	**4**	**3**	**-**	**1**	**UG**	**-**

Course Objectives

- Integrate genomics into the study of ecosystem structure and functions
- Explore how gene(s) shape patterns and processes in biodiversity
- Analyze relationships between genomes and organisms' roles in nutrient cycling, and primary production
- Examine how environmental changes influence functional genes, symbiotic networks, and ecosystem services
- Equip students with cutting-edge tools of environmental metagenomics, transcriptomics, and genomics

Learning Outcomes

By the end of the course, students will be able to:

- Apply ecological genomics to study environmental responses and ecosystem functioning
- Analyze gene–environment interactions across different scales of biological organization
- Evaluate roles of genes and genomes in ecosystems resilience using molecular tools
- Interpret high-throughput datasets using bioinformatics platforms to derive ecological inferences
- Design genomics-based frameworks for biodiversity monitoring, restoration, and climate adaptation

Course Syllabus – Theory (45 hours)

Unit 1: Foundations and Tools in Ecological Genomics (14 hours)

Scope and principles of ecological genomics; Genotype × environment interactions; Evolutionary and functional genomics; Tools and technologies: NGS, transcriptomics, eDNA, functional annotation; Linking genomics with ecological theory; eDNA metabarcoding for biodiversity monitoring; Molecular indicators of pollution and disturbance; Policy and ethical considerations in environmental genomics.

Unit 2: Genomic Insights into Ecosystem Structure and Function (12 hours)

Genetic diversity and ecosystem multifunctionality; Genomic basis of plant-microbe-soil interactions; Molecular underpinnings of productivity, herbivory, symbiosis, and decomposition; Genomics of resilience, redundancy, and stability; Ecological genomics in selecting resilient genotypes.

Unit 3: Genomics of Biogeochemical and Ecological Processes (11 hours)
Microbial genomics in carbon, nitrogen, sulfur, and phosphorus cycling; Metagenomic profiling of soils, sediments, and extreme and polluted environments; Functional gene markers; Genomic gradients across latitudes, elevations, and urban-rural interfaces; Landscape genomics and host-microbiome co-evolution.

Unit 4: Environment, Epigenetics, and Mental Health in a Changing Ecological Landscape (8 hours)
Epigenetics and environmental regulation; Gene–environment interactions and mental health; Green space, biodiversity, and epigenetic health; Genomic signals of environmental shifts; Transgenerational epigenetic effects and trauma ecology; Ecological justice and epigenomic vulnerability

Suggested Practicals/Applied Exercises/Field Component (30 hours)

- DNA/RNA Extraction and Metagenomics Setup – Extract nucleic acids from soil/water and prepare for sequencing
- Functional Gene Analysis – Identify nitrogen cycling genes using PCR and sequence data
- Landscape Genomics Mapping – Analyze gene–environment associations using GIS layers and SNP datasets
- Microbial Community Profiling – Use QIIME or MG-RAST to analyze environmental microbiomes
- Case Simulation – Interpret ecosystem functioning from a metagenomics dataset (e.g., rhizosphere or estuarine)
- Comparative genomics of selected microbial species from two ecologically distinct habitats
- Based on the syllabus

Essential Readings

- Allendorf, F. W., Funk, W. C., Aitken, S. N., Byrne, M., Luikart, G., & Antunes, A. (2022). *Conservation and the genomics of populations* (3rd ed.). Oxford University Press.
- Ussery, D.W., Wassenaar, T.M. and Borini, S., 2009. Computing for comparative microbial genomics: bioinformatics for microbiologists (Vol. 8). Springer Science & Business Media.
- Van Straalen, N.M. and Roelofs, D., 2012. An introduction to ecological genomics. OUP Oxford.
- Weissensteiner, M.H., Suh, A. and Kraus, R.H.S., 2019. Avian genomics in ecology and evolution: From the lab into the wild. Springer

Suggested Readings

- Cox, C.B., Moore, P.D. and Ladle, R.J., 2016. Biogeography: an ecological and evolutionary approach. John Wiley & Sons.
- Freeland, J.R., 2020. Molecular ecology. John Wiley & Sons.
- Gregory, T.R. ed., 2011. The evolution of the genome. Elsevier.
- Martin, F. (2013). The Ecological Genomics of Fungi. Wiley.

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M.Sc./M.A. (Semester I/II)

DISCIPLINE-SPECIFIC ELECTIVE COURSE - (DSE-17)

Energy and Environment

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
DSE-17: Energy and Environment	4	3	-	1	UG	-

Course Objectives

The course is designed to

- Examine advanced relationships between energy systems and environmental sustainability.
- Analyze technological, ecological, and policy aspects of renewable energy with a focus on bioenergy systems
- Provide a comparative understanding of renewable and non-renewable energy systems.
- Explore the scientific, technological, environmental, and policy dimensions of bioenergy.
- Develop critical thinking about sustainable energy transitions in India and globally.

Learning Outcomes

At the end of the course, the students should be able to

- Identify and classify various energy sources and explain their roles in development.
- Analyze the environmental implications of fossil-based and renewable energy systems.
- Evaluate bioenergy technologies and their integration in circular economy models.
- Interpret and critique national/international energy policies and SDG linkages.

Course Syllabus – Theory (45 hours)

Unit 1: Fundamentals of Energy Systems and Non-Renewable Resources (12 hours)
Core energy concepts and forms; Solar radiation principles; Energy-development interlinkages (GDP, HDI, energy poverty); Global and Indian energy consumption trends; Fossil fuel classification and extraction technologies; Unconventional reserves (shale, gas hydrates); Environmental costs and mitigation (pollution, GHGs); Energy policies and missions (India and global); Renewable and nuclear governance; Carbon markets, SDGs, and international frameworks.

Unit 2: Renewable and Nuclear Energy Systems (10 hours)
Principles and systems: solar, wind, hydro, geothermal, tidal, OTEC; Intermittency, economics, and grid integration; Nuclear energy: fission/fusion, reactor types, waste risks; Global case studies: Chernobyl, Fukushima; Emerging clean energy technologies.

Unit 3: Bioenergy Systems and Biomass Conversion Technologies (12 hours)
Biomass sources: residues, MSW, algae, energy crops; Biofuel generations (1st to 4th); Conversion pathways—thermochemical (gasification, pyrolysis), biochemical (AD, fermentation), bioelectrochemical (MFCs, MECs); Products: biogas, bioethanol, biodiesel, biohydrogen; Sustainability considerations, nutrient recovery, and CCUS.

Unit 4: Circular Economy, Industrial Sustainability, and Societal Dimensions (11 hours)
Waste-to-energy and biochar applications; Circular economy in energy systems; Eco-design and material efficiency; Industrial sustainability: clean technologies, symbiosis, GHG benchmarks; EPR and product stewardship; Access, equity, and gender in decentralized energy; Behavioral change, community participation, and justice-based energy transitions.

Suggested Practicals/Applied Exercises/Field Component (30 hours)

- Set up and operate a waste-to-bioenergy reactor.
- Determine the moisture content of a biomass sample using the oven-drying method.
- Estimate the total solids in biomass. How does this differ from moisture content determination?
- Calculate the volatile solids in biomass. What do they indicate about the biodegradability of biomass?
- Determine the Chemical Oxygen Demand (COD) of biomass slurry. Why is this important for assessing potential biogas yield?
- Determine the Biological Oxygen Demand (BOD) in biomass samples. What is its relevance to bioenergy systems?
- Quantify cellulose in biomass. Why is this parameter crucial for biofuel production?
- Measure hemicellulose content in lignocellulosic biomass. What is its role in bioenergy conversion?
- Estimate lignin content in biomass. How does lignin affect biomass digestibility?
- Determine the ash content in biomass. What implications does it have for thermochemical conversion?
- Field visits

Essential Readings

- Abraham, A.R., Susanto, H., Haghi, A.K. and Asli, K.H. eds., 2024. Sustainability in Energy and Environment: Engineered Materials and Smart Computational Techniques. CRC Press.
- Ahamed, M.I., Boddula, R. and Rezakazemi, M. eds., 2021. Biofuel cells: materials and challenges. John Wiley & Sons.
- André, M. and Samaras, Z. eds., 2016. Energy and Environment. John Wiley & Sons.
- Ngô, C. and Natowitz, J., 2016. Our energy future: resources, alternatives and the environment. John Wiley & Sons.
- Ristinen, R.A., Kraushaar, J.J. and Brack, J.T., 2022. Energy and the Environment. John Wiley & Sons.
- Twidell, J., & Weir, T. (2021). *Renewable Energy Resources.* Taylor & Francis

Suggested Readings

- Baker, N. and Steemers, K., 2003. Energy and environment in architecture: a technical design guide. Taylor & Francis.
- Chhachhiya, N., Tiwari, A., Sharma, R.S., Rai, P.K., Anand, S. and Mishra, V., 2025. Transformative potential of optimized microbial fuel cell designs and materials for eco-friendly management of hazardous chemical waste. Journal of Water Process Engineering, 69, p.106647.
- Kalogirou, S.A., 2023. Solar energy engineering: processes and systems. Elsevier.
- Meyer, B., 2013. Sulfur, energy, and environment. Elsevier.
- Tan, Z. and Li, Q. eds., 2019. Micro/Nano Materials for Clean Energy and Environment. MDPI.
- Yadav, A., Kumar, P., Rawat, D., Garg, S., Mukherjee, P., Farooqi, F., Roy, A., Sundaram, S., Sharma, R.S. and Mishra, V., 2022. Microbial fuel cells for mineralization and decolorization of azo dyes: Recent advances in design and materials. Science of The Total Environment, 826, p.154038.

M.Sc./M.A. (Semester I/II)

DISCIPLINE-SPECIFIC ELECTIVE COURSE - (DSE-18): Environmental Behaviour and Psychology

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
DSE-18: Environmental Behaviour and Psychology	**4**	**3**	**-**	**1**	**UG**	**-**

Course Objectives

- Examine environmental perception and behavior and their associated psychological theories and cognitive processes
- Analyze sociocultural and contextual factors shaping pro-environmental behavior
- Understand individual and collective responses to environmental risks, and ecological identity
- Apply behavior-change models and interventions for sustainability and environmental justice and in policy, education, communication

Learning Outcomes

Upon completion, students will be able to:

- Analyze the drivers and barriers of individual and group-based environmental actions
- Explain key psychology theories and cognitive processes of pro-environmental behavior
- Evaluate interventions for promoting sustainability and reducing ecological harm
- Apply psychological insights to environmental campaigns, nudges, and policy instruments

Course Syllabus – Theory (45 hours)

Unit 1: Foundations of Environmental Psychology and Human-Nature Relationships (12 hours)

Evolution and scope of environmental psychology; Theories of place attachment, biophilia, and ecological identity; Environmental attitudes and values; Cognitive dissonance and environmental concern; Nature connectedness, eco-spirituality, and well-being; Environmental risk perception, affective heuristics; Spatial cognition and landscape perception; Information processing, value–action gap.

Unit 2: Perception, Cognition, and Decision-Making in Environmental Contexts (12 hours)

Framing, heuristics, and mental models in climate risk; Eco-anxiety, denial, and psychological distance; Theories of planned behavior, norm activation, and behavioral economics; Barriers to sustainable behavior: habits, norms, structural constraints; Emotions, empathy, identity in motivation; Behaviorally-informed communication strategies and participatory engagement.

Unit 3: Social and Cultural Dimensions of Environmental Behaviour (11 hours)

Role of gender, class, and culture in shaping behavior; Cultural cognition and belief systems; Collective action and community norms; Group identity, intergroup dynamics, and sustainability movements; Social learning and public engagement in climate action; Environmental education and experiential learning.

Unit 4: Institutional Applications and Behavioral Interventions for Sustainability (10 hours)
Urban design and behavior; Workplace and institutional sustainability; Behavioral audit and intervention design; Case studies: recycling, energy use, dietary change, mobility transitions; Integrating behavioral science into sustainability policy and planning.

Suggested Practicals/Applied Exercises/Field Component (30 hours)

- Environmental Value Survey and behavior mapping – Identify underlying values and behavior gaps
- Perception Mapping of green spaces – Understand landscape perception and comfort design
- Climate Risk Communication Analysis – Evaluate message framing and emotional response
- Design a Behavioral Intervention (e.g., nudge for waste segregation) – Apply behavior change tools
- Environmental Identity and Reflection Journal – Explore personal relationship with nature and pro-social behavior
- Based on the syllabus

Essential Readings

- Gifford, R. (2007). Environmental psychology: Principles and practice (5th ed.). Optimal Books.
- Steg, L., van den Berg, A. E., & de Groot, J. I. M. (Eds.). (2019). Environmental psychology: An introduction (2nd ed.). Wiley.
- Di Fabio, A. and Cooper, C.L. eds., 2024. Psychology of sustainability and sustainable development in organizations. Routledge.
- Kals, E., Strubel, I.T. and Hellbrück, J., 2025. Environmental Psychology. Berlin, Heidelberg: Springer Berlin Heidelberg.
- Clayton, S.D. ed., 2012. The Oxford handbook of environmental and conservation psychology. Oxford University Press.

Suggested Readings

- Fleury-Bahi, G., Pol, E. and Navarro, O. eds., 2017. Handbook of environmental psychology and quality of life research (pp. 329-344). Cham, Switzerland: Springer International Publishing.
- Gifford, R., 2016. Research methods for environmental psychology. John Wiley & Sons.
- van Valkengoed, A. and Steg, L., 2019. The psychology of climate change adaptation. Cambridge University Press.
- Koger, S.M., 2011. The psychology of environmental problems: Psychology for sustainability. Psychology press.

M.Sc./M.A. Even Semester
M.Sc. (Semester I/II)

DISCIPLINE-SPECIFIC ELECTIVE COURSE - (DSE-19): Restoration Ecology and Nature-Based Engineering

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
DSE-19: Restoration Ecology and Nature-Based Engineering	4	3	-	1	UG	-

Course Objectives
- Build foundational understanding of ecological degradation and ecosystem recovery processes
- Introduce ecological principles, techniques, and design approaches for restoring natural systems
- Equip students with tools to design, assess, and monitor ecological restoration projects
- Explore emerging nature-based engineering solutions for climate resilience, urban planning, and biodiversity conservation
- Integrate sustainability science, indigenous knowledge, and systems thinking in landscape restoration

Learning Outcomes
By the end of this course, students will be able to:
- Understand key drivers of ecosystem degradation and resilience
- Apply ecological principles to restore and rehabilitate degraded ecosystems
- Design site-specific nature-based solutions for soil, water, and biodiversity restoration
- Evaluate effectiveness of restoration interventions through monitoring and adaptive management
- Integrate socio-ecological perspectives in large-scale restoration projects and policy frameworks

Course Syllabus – Theory (45 hours)
Unit 1: Foundations and Principles of Ecological Restoration (12 hours)
Concepts: restoration, rehabilitation, rewilding, reclamation; Historical ecology and reference systems; Causes of ecosystem degradation: land-use change, pollution, overexploitation; Ecological succession and resilience theory; Principles and ethics of ecological restoration (SER guidelines); Definition and principles of Nature-Based Solutions (NbS); Bioengineering techniques: vetiver systems, living walls, green roofs; Natural water retention and flood control systems.

Unit 2: Ecosystem Restoration Across Landscapes (12 hours)
Forest ecosystems: afforestation, enrichment planting, assisted regeneration; Wetlands and rivers: wetland hydrology, riparian buffers, rechanneling; Grasslands and deserts: seed banks, grazing management, dune stabilization; Urban and peri-urban ecosystems: green belts, bioswales, ecological corridors; Coastal and marine ecosystems: mangrove restoration, coral nurseries; Climate-resilient infrastructure: sponge cities, regenerative agriculture; Ecosystem-based adaptation (EbA) and disaster risk reduction.

Unit 3: Planning and Implementing Restoration Projects (11 hours)
Site assessment: soil, hydrology, biota, disturbance history; Restoration goals, reference models, and success indicators; Stakeholder participation and co-design approaches; Planning tools: GIS, spatial modeling, suitability mapping; Project management, timelines, and costing frameworks.

Unit 4: Monitoring, Governance, and Global Restoration Initiatives (10 hours)
Monitoring frameworks: ecological indicators, adaptive management; Use of remote sensing in monitoring; National and global restoration policies: UN Decade on Ecosystem Restoration, Bonn Challenge, Community-based restoration and indigenous stewardship; Legal, institutional, and funding mechanisms for large-scale restoration.

Suggested Practicals/Applied Exercises/Field Component (30 hours)

- Site Assessment and Baseline Survey – Evaluate biophysical and socio-ecological parameters
- Design a Nature-Based Solution for urban flood control – Apply eco-engineering for resilience
- Vegetation Recovery Monitoring using quadrats and diversity indices – Track post-restoration trends
- Soil Quality Assessment in degraded vs. restored plots – Understand soil function restoration
- Case Study Analysis: Mangrove restoration or forest landscape restoration – Evaluate strategy effectiveness and community involvement
- Based on the syllabus

Essential Readings

- Clewell, A. F., & Aronson, J. (2012). Ecological restoration: Principles, values, and structure of an emerging profession (2nd ed.). Island Press.
- Greipsson, S., 2011. Restoration ecology. Jones & Bartlett Learning.
- Hartmann, T., Slavíková, L. and McCarthy, S., 2019. Nature-based flood risk management on private land: Disciplinary perspectives on a multidisciplinary challenge (p. 228). Springer Nature.
- Howell, E.A., Harrington, J.A. and Glass, S.B., 2012. Introduction to restoration ecology. Washington, DC: Island Press.
- Sharky, B., 2024. Nature-Based Design in Landscape Architecture. Taylor & Francis.
- van Andel, J., & Aronson, J. (2012). Restoration ecology: The new frontier (2nd ed.). Wiley-Blackwell.

Suggested Readings

- Chazdon, R. L. (2014). Second growth: The promise of tropical forest regeneration in an age of deforestation. University of Chicago Press.
- IUCN. (2020). Nature-based solutions for climate change adaptation and disaster risk reduction. IUCN Publications.
- Sang, N. ed., 2020. Modelling Nature-Based Solutions: Integrating Computational and Participatory Scenario Modelling for Environmental Management and Planning. Cambridge University Press.
- Temperton, V.M., Hobbs, R.J., Nuttle, T. and Halle, S. eds., 2013. Assembly rules and restoration ecology: bridging the gap between theory and practice (Vol. 5). Island Press.
- Toft, J.D., 2017. Living Shorelines: The Science and Management of Nature-Based Coastal Protection. CRC Press.
- Sharma, R.S., Karmakar, S., Kumar, P. and Mishra, V., 2019. Application of filamentous phages in environment: A tectonic shift in the science and practice of ecorestoration. Ecology and Evolution, 9(4), pp.2263-2304.

M.Sc./M.A. Even Semester

DISCIPLINE-SPECIFIC ELECTIVE COURSE - (DSE-20): Environmental Geosciences

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OFTHE COURSE

Course title& Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
DSE-20: Environmental Geosciences	**4**	**3**	**-**	**1**	UG	**-**

Course Objectives

The course is designed to

- Provide a comprehensive understanding of the fundamental geological principles as they relate toenvironmental processes, hazards, and resources.
- Equip students with the ability to analyze, assess, and address environmental issuesusing geological methods and knowledge.
- Develop proficiency in identifying, evaluating, and managing geological hazards, such as landslides, earthquakes, floods, and contamination, with an emphasis on risk mitigation andsustainable solutions.
- Foster skills in the exploration, sustainable utilization, and management of earth resources(water, minerals, energy) while considering environmental and societal impacts.

Learning Outcomes

At the end of the course, the students should be able to

- Understand and apply geological principles to evaluate environmental problems and proposesustainable nature-based solutions.
- Identify, interpret, and manage geological hazards and contaminated sites.
- Use advanced field and laboratory techniques for environmental assessment and monitoring.
- Integrate geological knowledge with environmental policy and management strategies.

Course syllabus – theory (45 hours)

Unit 1 – The Earth System (12 hours)

Exploring Earth's Interior, Layered structure of the Earth, Plate Tectonics, Rates and History of Plate Motions, Evolution of Continents, The Grand Reconstruction, Interactions Between Plate Tectonics and Climate Systems; Mantle convection and its role in surface processes, Earth system cycles; Earth's magnetic field; Lithosphere–asthenosphere interactions.

Unit II – Geologic Processes (12 hours)

Igneous, magmatic differentiation and intrusions; Sedimentary, Classification, Burial and Diagenesis; Metamorphism, Causes, types and Grades; Deformation, types, structures andunravelling geologic history; Minerals and Rock-forming Processes, Physical properties of minerals,Minerals as valuable resources; Structural geology; Plate boundaries; Tectonometamorphic terrains.

Unit III – Geologic Records (14 hours)

Geological Time Scale-Relative and absolute age, Principles of Stratigraphy, Reconstructing Geologic History from the Stratigraphic Record, Measuring Absolute Time with Radioactive Clocks, Geobiological Events in Earth's History; Evolution of life and major extinction events; Unconformities and their geological significance, Isotopic dating methods

Unit IV – Internal and Surficial Geosystems (9 hours)

Volcanoes, Eruptive style and landforms; Earthquakes, Patterns of Faulting, Exploring interior with seismic waves; Stream and Glacial Transport, Drainage networkand Landscapes; Mass movement; Coastal processes, Aeolian processes, Tectonics and surface processes

Suggested Practicals/Applied Exercises/Field Component (30 hours)

1. To undertake Particle size analysis
2. To evaluate the Bulk density of the soil
3. To undertake Loss-on-ignition analysis
4. To undertake major minerals identification
5. To identify major rock types
6. To undertake satellite images interpretation
7. To undertake digitization- point, line, polygon data
8. To understand data conversion-vector to raster, raster to vector
9. To prepare land use/land cover maps using visual and digital interpretation
10. A visit to the Geology Museum

Essential Reading

- Bennett, M.R. and Doyle, P. Environmental geology: Geology and the Human Environment.John Wiley and Sons. 1997.
- Jensen, J.R., Remote Sensing of the Environment – An Earth Resources Perspective, Pearson Education, Inc. (Singapore) Pvt. Ltd., Indian edition, Delhi, 2000.
- Jenson, J.R. Introductory Digital Image Processing: Prentice Hall Series, 2018.

- Keller, E.A. (2008). Introduction to Environmental Geology. Prentice Hall, Upper SaddleRiver, New Jersey.
- Montgomery, C. W. (2006). Environmental geology (p. 540). New York: McGraw-Hill.

Suggested Readings

- Kehew, A. E. (2021). Geology for engineers and environmental scientists. Waveland
- Knödel, K., Lange, G., & Voigt, H. J. (2007). Environmental geology: handbook of field methods and case studies. Springer Science & Business Media.
- Merritts, D., De Wet, A., & Menking, K. (1998). Environmental geology: an earth system science approach. Macmillan.
- Valdiya, K. S. (2004). Geology, Environment, and Society. Universities Press.

M.Sc./M.A. Even Semester

DISCIPLINE-SPECIFIC ELECTIVE COURSE – DSE(-21)

Fundamentals of Environmental Politics

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
DSE-21: Fundamentals of Environmental Politics	**4**	**3**	**-**	**1**	**UG**	**-**

Course Objectives

- Introduce foundational concepts and frameworks in environmental policy and political ecology.
- Explore how environmental policies are shaped by socio-political, economic, and institutional contexts.
- Understand global and national environmental governance systems.
- Enable students to critically evaluate contemporary environmental challenges through a policy and political lens.

Learning Outcomes

After the course, students will be able to:

- Describe the key concepts and actors involved in environmental policy-making.,
- Analyse the role of political ideologies and power structures in shaping environmental outcomes
- Understand the evolution and structure of environmental policies in India and globally,
- Evaluate contemporary environmental issues and governance mechanisms with policy relevance.

Course Syllabus – Theory (45 hours)

Unit I – Understanding Environmental Politics (12 hours)
Definition, scope, and significance of environmental politics, Key stakeholders: state, civil society, corporations, indigenous communities, Political ideologies: Ecocentrism **vs** Anthropocentrism**,** Environmental Justice**,** Ecofeminism**,** Power, equity, and representation in environmental decision-making, Introduction to Political Ecology: concepts and key thinkers, Environmental citizenship.

Unit II – Environmental Policy: Concepts and Processes (11 hours)
Definition and importance of public policy, The policy cycle: Agenda setting, policy formulation, adoption, implementation, evaluation, Policy instruments: Command-and-control Market-based (e.g., carbon pricing), Voluntary instruments (e.g., eco-labels) Role of institutions and stakeholders: State, NGOs, corporations, media, judiciary, Right to Information and public participation in policy processes, Role of science and traditional knowledge in policymaking

Unit III – Introduction to Environmental Politics in India (12 hours)
Historical context of post-independence environmental governance, Growing tension between development and ecological sustainability; Role of the state, judiciary, and institutions. Environmental movements (Chipko Movement, Narmada Bachao Andolan, and anti-mining struggles) and contributions of marginalised communities (women and tribals) in resisting ecological degradation; Role of civil society, NGOs, media, and judicial activism in shaping public discourse and environmental decision-making. Politics of development

Unit IV – Introduction to Global Environmental Politics (10 hours)
Politics and evolution of global environmental discourse: Stockholm (1972) to Paris (2015) Multilateral Environmental Agreements (MEAs): Environmental diplomacy and negotiations.

Suggested Practicals/Applied Exercises/Field Component (30 hours)

- Policy Analysis: Critical review and presentation on a major Indian environmental policy/law (e.g., Forest Rights Act, Draft EIA 2020),
- Comparative Review: Indian vs international treaty (e.g., CRZ vs Ramsar Convention; EPA 1986 vs UNFCCC),
- Media Content Analysis: Tracking trends and biases in environmental coverage
- Policy Brief Writing: Drafting short policy documents on current environmental issues (e.g., air pollution, water security, waste),
- Institutional Visit: Visit to a local body like municipal council, CPCB/SPCB,
- Mini-Project: "Policy solutions for a local environmental problem" (to be presented)

Essential Readings

- Rosenbaum, W. A. (2013). Environmental Politics and Policy.
- Rangarajan, M. (Ed.) (2007). Environmental Issues in India: A Reader.
- Baviskar, A. (2004). In the Belly of the River: Tribal Conflicts Over Development.
- Guha, R. & Martinez-Alier, J. (1997). Varieties of Environmentalism.
- Government of India. National Environmental Policy (2006) and Draft NEP (2020).

Suggested Readings

- Hajer, M. A. (1995). The Politics of Environmental Discourse.
- Jasanoff, S. (2004). States of Knowledge: The Co-production of Science and Social Order.
- UN Environment Programme: Global Environmental Outlook
- CSE: State of India's Environment (latest)
- IPCC Summary for Policymakers (latest report)

M.Sc./M.A. Even Semester

DISCIPLINE-SPECIFIC ELECTIVE COURSE – (DSE-22): Invasion Biology

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
DSE-22: Invasion Biology	**4**	**3**	**-**	**1**	**UG**	**-**

Invasion Biology

Preamble:

Biological invasions represent a critical dimension of global change, threatening biodiversity, altering ecosystems, and posing significant socio-economic challenges. Understanding the mechanisms, impacts, and management of invasive species is essential for developing resilient ecological frameworks and informed conservation strategies.

Learning Objective:

The course aims to equip students with a comprehensive understanding of invasion biology by exploring the historical development, ecological theories, invasion processes, and the multifaceted impacts of invasive species. It also emphasizes analytical skills for assessing risks and implementing effective management strategies.

Learning Outcome:

- Students will be able to explain the historical context and key concepts underlying invasion biology.
- Analyze mechanisms of species invasiveness and community invasibility.
- Evaluate the ecological and economic consequences of biological invasions.
- Apply predictive tools and risk assessment methods to real-world invasion scenarios.
- Critically assess and propose context-appropriate management and policy interventions for invasive species control.

Course syllabus – Theory (45 hours)

Unit I (11 hours)

Introduction: Terminology- definition and concepts of invasion biology, Invasion biology in the 21st century. Framing biological invasions, issues of specialization and dissociation and re-association, Invasion research priorities, Critique of invasion Biology (SPRED ecology – SPecies REDistribution), EICAT an IUCN standard for the classification of impacts of alien taxa on the environment.

Process of invasion: Introduction (intentional and accidental)- Pathways and vectors, Establishment and Naturalization- Residence time, Biotic resistance, Propagule pressure, Tens rule, Hybridization, Species traits, Rapid evolution and Spread and subsequent invasion meltdown. Various frameworks proposed time to time for invasive species spread. Invasive species databases e.g. GISD and ILORA

Unit II (11 hours)

Species and Community invasibility: Species traits and invasibility, small-scale, large- scale and non- experimental studies, Enemy release hypothesis (ER), Evolution of Increased Competitive Ability (EICA), Allopathic advantage against resident species (AARS), allelopathy and competition, density dependent fitness in invasive populations, Allee effects, Darwin's naturalization hypothesis etc., Empty niche hypothesis, Intermediate disturbance hypothesis. Fluctuating resource hypothesis, Diversity–invasibility hypothesis, facilitation, mutualism and predator relationships. Hybridization, Epigenetics and evolutionary diversification.

Impacts of global environmental change on invasion process- atmospheric CO_2 concentration, change in temperature, change in nutrients- habitat heterogeneity, nitrogen deposition etc, disturbance regimes, and habitat fragmentation- canopy openings as windows of species invasions. Case studies related to plant and animal invasions.

Unit III (11 hours)

Ecological and economic consequences: Loss of species diversity through biotic homogenization; disruption of native community composition and food web dynamics; alterations in nutrient cycling, water flow patterns, and fire frequency; long-term ecological liabilities ('invasion debt'); and shifts in the overall economic valuation of biodiversity. EICAT an IUCN standard for the classification of impacts of alien taxa on the environment.

Unit IV (12 hours)

Forecasting and evaluating invasion risks: Anticipating the spread of invasive species using Weed Risk Assessment tools and species distribution models such as GARP and MaxEnt; implementing biosecurity protocols and quarantine strategies to prevent introduction and establishment.

Management of invasive species: prevent introductions, detect nascent invasions, identify susceptible environments, rapid management response. Management strategies- Physical removal, Chemical treatments and Bio-controls, advantages and disadvantages of strategies. Capacity building through biological invasion managers, and Citizen Science. Vulnerabilities and contribution of emerging technologies.

Suggested Practicals/Applied Exercises/Field Component (30 hours)

- To identify and document the presence and abundance of invasive plant species in a selected study area.
- To assess how an invasive species affects the growth and survival of native plants through competition.
- To compare germination success and seedling growth between invasive and native species.
- To test whether invasive plants release chemicals that inhibit the growth of native species.
- Ecological Niche Modelling (ENM) techniques to predict the potential distribution of invasive plant species based on environmental variables and habitat suitability.
- Based on the syllabus

Essential Readings

- Elton, C (1958). The Ecology of Invasions by Animals and Plants. Methuen Publishing.
- Richardson, DM (Ed.). (2011). *Fifty years of invasion ecology: The legacy of Charles Elton*. Wiley-Blackwell.
- Ramakrishnan, PS (1991). *Ecology of biological invasion in the tropics*. New Delhi: International Scientific Publications.
- Lockwood, JL, Hoopes, MF, and Marchetti, MP (2013). *Invasion ecology* (2nd ed.). Wiley-Blackwell.
- Davis M (2009) Introduction Invasion biology. Oxford University Press.
- Pyšek, P., Richardson, DM, and Rejmánek, M (Eds.). (2020). Encyclopedia of Biological Invasions. University of California Press.
- Simberloff, D (2013). Invasive species: What everyone needs to know. Oxford University Press.

Suggestive Readings

- Blackburn, TM, Pyšek, P., Bacher, S., Carlton, JT, Duncan, RP, Jarošík, V. and Richardson, DM (2011). A proposed unified framework for biological invasions. *Trends in Ecology & Evolution, 26*(7), 333–339.
- Seebens, H., et al. (2017). No saturation in the accumulation of alien species worldwide. *Nature Communications, 8*(1), 14435.
- Catford, JA, Jansson, R, and Nilsson, C (2009). Reducing redundancy in invasion ecology by integrating hypotheses into a single theoretical framework. *Diversity and Distributions, 15*(1), 22–40.
- Blossey, B., and Notzold, R. (1995). Evolution of increased competitive ability in invasive nonindigenous plants: A hypothesis. *Journal of Ecology, 83*(5), 887–889.
- Inderjit, Wardle DA, Karban R and Callaway RM. (2011) The ecosystem and evolutionary contexts of allelopathy. Trends in Ecology & Evolution, 26: 655-662.
- Sharma, GP, Singh, JS, & Raghubanshi, AS (2005). Plant invasions: Emerging trends and future implications. Current Science, 88(5), 726–734.
- Callaway, RM, and Ridenour, WM (2004). Novel weapons: Invasive success and the evolution of increased competitive ability. *Frontiers in Ecology and the Environment, 2*(8), 436–443.
- Vilà, M., Espinar, JL, Hejda, M., Hulme, PE, Jarošík, V., Maron, JL and Pyšek, P. (2011). Ecological impacts of invasive alien plants: A meta-analysis of their effects on species, communities and ecosystems. *Ecology Letters, 14*(7), 702–708.
- Pejchar L., and Mooney H. A. (2009). Invasive species, ecosystem services and human well-being. *Trends in Ecology & Evolution, 24*(9), 497–504.

M.Sc./M.A. Even Semester

DISCIPLINE-SPECIFIC ELECTIVE COURSE - (DSE-23): Sustainable Finance and ESG Reporting

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
DSE-23: Sustainable Finance and ESG Reporting	**4**	**3**	**-**	**1**	**UG**	**-**

Course Objectives

- Develop a robust understanding of sustainability-linked financial instruments
- Explore principles and practices of Environmental, Social, and Governance (ESG) reporting and ratings
- Analyze global frameworks, standards, and regulatory mechanisms for green and ethical finance
- Equip students with applied skills in ESG disclosure, materiality analysis, and impact investing

Learning Outcomes

By the end of the course, students will be able to:

- Explain core concepts in sustainable finance, ESG investing, and climate-risk disclosure
- Analyze ESG metrics, KPIs, and frameworks for sustainability assessment and reporting
- Evaluate ESG performance and sustainability strategies of corporations and institutions
- Apply ESG data for scenario analysis, stakeholder communication, and regulatory compliance

Course Syllabus – Theory (45 hours)

Unit 1: Foundations of Sustainable Finance and Global Instruments (12 hours)

Definitions and trends in sustainable finance; Evolution of responsible investing and ESG integration; Green, blue, social, and SDG-linked bonds; Principles of climate finance; Role of development banks and private equity in sustainability transitions; ESG pillars—environmental risk, social equity, corporate governance; Global ESG standards: GRI, SASB, TCFD, ISSB, CDP.

Unit 2: ESG Frameworks, Standards, and Regulatory Landscapes (12 hours)

ESG data providers: MSCI, Sustainalytics, Bloomberg, LSEG; Double materiality, climate risk disclosure, EU Taxonomy; Regulatory ecosystems: SEBI (India), SEC (US), EU SFDR; Integrating ESG into business models; Materiality mapping, stakeholder engagement, sustainability KPIs; ESG reporting practices and corporate case studies.

Unit 3: Climate Risk, Carbon Finance, and ESG Ethics (11 hours)

Climate-related financial risks; Internal carbon pricing, offsets, carbon credits, and trading schemes; Paris-aligned finance and net-zero strategies; Science-Based Targets (SBTi); Role of financial institutions in climate mitigation; Assurance, auditing, benchmarking ESG performance; Greenwashing, controversies, and ethical considerations in ESG.

Unit 4: ESG Analytics, Decision Tools, and Emerging Markets (10 hours)
ESG score construction and integration challenges; Quantitative and qualitative ESG metrics and dashboards; SDG alignment and materiality tools; ESG performance in emerging and frontier economies; Role of AI, blockchain, and big data in ESG reporting and decision-making.

Suggested Practicals/Applied Exercises/Field Component (30 hours)
1. Materiality Matrix Design for a listed company – Identify ESG priorities for strategic disclosure
2. ESG Scorecard Analysis using Bloomberg/Refinitiv sample data – Evaluate corporate ESG performance
3. Green Bond Case Study Review – Assess environmental impact and compliance
4. Carbon Risk Scenario Analysis – Estimate exposure to climate transition risks
5. Develop a Mini ESG Report for an SME or startup – Synthesize ESG metrics and stakeholder narrative

Essential Readings

- Adams, C., 2017. Understanding integrated reporting: the concise guide to integrated thinking and the future of corporate reporting. Routledge.
- Bednárová, M. and Soratana, K., 2025. Environmental, Social, and Governance (ESG) Investment and Reporting. Springer.
- Bini, L. and Bellucci, M., 2020. Integrated sustainability reporting. Integrated Sustainability Reporting. Springer
- Boustead, R., 2025. ESG Reporting Manual: 500+ Legal Tips and Tricks to Improve Your ESG Reporting. CRC Press.
- Hill, J., 2020. Environmental, Social, and Governance (ESG) investing: A balanced analysis of the theory and practice of a sustainable portfolio. Academic Press.

Suggested Readings

- Clark, G. L., Feiner, A., & Viehs, M. (2015). From the stockholder to the stakeholder: How sustainability can drive financial outperformance. University of Oxford.
- GRI. (2021). Universal Standards 2021. Global Reporting Initiative.
- Haar, G., 2024. Rethink Economics and Business Models for Sustainability. Springer Nature Switzerland.
- Netterstrom, R., 2014. Sustainability Reporting and Communications. Business Expert Press.
- TCFD. (2023). Recommendations of the Task Force on Climate-related Financial Disclosures. https://www.fsb-tcfd.org
- Trites, G., 2024. Beyond Sustainability Reporting: The Pathway to Corporate Social Responsibility. Business Expert Press.
- Wachtel, P., Ferri, G. and Miklaszewska, E. eds., 2023. Creating value and improving financial performance: inclusive finance and the ESG premium. Springer Nature.

M.Sc./M.A. Even Semester

DISCIPLINE SPECIFIC ELECTIVE COURSE - (DSE-24)

Tropical Field Ecology

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
DSE-24: Tropical Field Ecology	**4**	**3**	**-**	**1**	**UG**	**-**

Course Objectives

- To prepare students with interests in Ecology and Evolution to the diverse field approaches used to address ecological questions..
- To gain experience with field techniques used in ecological research, including habitat evaluation, sampling, and identifying wildlife populations, using case based approach
- To present the natural history and ecology of tropical forests through practical exercises, lectures, field visits, tutorials, and small group project work.
- To impart fieldwork skills and experience relevant to tropical forest ecology and biodiversity.

Learning Outcomes

At the end of the course, the students should be able to

- prepare students with the scientific methods needed for field ecology and conduct ecological surveys of flora and fauna in forests.
- learn to work effectively in teams and contribute to research project design, execution, analysis, and interpretation of ecological data sets through small-group research projects.
- understand bioacoustics principles and their practical applications with a focus on conservation and applied ecological research.
- prepare students for entry-level jobs in environmental monitoring, rare-plant surveys, undergraduate and high school teaching, project management for nonprofit organizations, and park management

Course Syllabus – Theory (45 hours)

Unit 1- (11 hours)

Paleoecology: historical ecological patterns; Structure, function, and diversity of tropical forests; the ecological, evolutionary and biogeographic processes leading to high diversity in tropical forests; importance of natural history and taxonomy in the study of biodiversity of tropical forests; drivers of change in tropical forests and examples of solutions; major threats to tropical forests, as well as examples of tropical forest recovery following disturbance.

Unit II (12 hours)

Principles of Field-Based Research: Sampling strategies, field data collection methods, biases in data collection; Biodiversity field surveys for vertebrates (Transects/Line transect surveys camera trapping, pugmarks, scat surveys), invertebrates (butterflies, dung beetles, dragonflies), plants (families with high economic, ecological, or ethnobotanical importance), and assessments of ecosystem functioning (seed predation, herbivore predation); examples of large-scale experiments in tropical forests and their importance in tropical forest ecology and conservation.

Unit III (11 hours)

Soil and vegetation assessment in a range of habitats (from coastal sand dunes to rainforests), distribution and dynamics of vegetation; field methods to reconstruct fire history (tree rings analyses) and assess past fire history through forest stand structure. Use of QGIS for species distributions and habitat associations through spatial data in forest and fire ecology; Field ornithology: morphology, ecology, and behavior, taxonomy, field identification of local birds by sight and sound, and field methods (e.g., point counts, mist netting, bird banding).

Unit IV (11 hours)

Introduction to bioacoustics, and the functions of sound in biology; Techniques for Wildlife Recording: Essentials of equipment use, and field recording skills. Bioacoustics applications in real-world conservation: Eco acoustics, passive acoustic monitoring, and machine learning applications for conservation efforts, focused on real-world data analysis and species classification.

Suggested Practicals/Applied Exercises/Field Component (30 hours)

- Field Skills in Ecology: Survey and identify local plants, insects, amphibians, reptiles, birds, and mammals
- Collect ecological data using pitfall traps, mist nets, visual counts, sweep nets, Pollard's walk for butterfly sampling, aural, point counts and transects for bird sampling
- Field monitoring techniques, including radio telemetry, camera traps, acoustic monitoring, and electrofishing
- Orientation: GPS and campus navigation, map and field bearings
- Use of citizen science platforms such as GBIF, iNaturalist, eBird and other global biodiversity databases for species occurrence data
- Bioacoustics: familiarization with wildlife recording equipment and field recording techniques; focal species recordings in the field; Visualizing soundscapes and analyzing sound data

Essential Reading

- *Krebs, C.J. (2013) Ecology* The Experimental Analysis of Distribution and Abundance. New International Edition, 6E, New York
- Molles, M. C. (2016). Ecology: *concepts and applications*. Seventh edition. McGraw-Hill Education.
- Wheater, C. P., Bell, J. R., & Cook, P. A. (2020). *Practical field ecology: a project guide*. 2E. John Wiley & Sons.
- Fryxell, J. M., Sinclair, A. R., & Caughley, G. (2014). *Wildlife ecology, conservation, and management*. John Wiley & Sons.
- Smith, R. L., & Smith, T. M. (2001). Ecology and field biology: hands-on field package. Benjamin Cummings

Suggested Textbooks:

- Real, L. A., & Brown, J. H. (Eds.). (2012). Foundations of Ecology:\Classic Papers with Commentaries. University of Chicago Press.
- Smith, R. L. (2001). Ecology and field biology. 5E. Pearson
- Begon, M., Howarth, R. W., & Townsend, C. R. (2014). Essentials of ecology. John Wiley & Sons.
- Bradbury, J. W., & Vehrencamp, S. L. (2011). Principles of animal communication.2E Oxford University Press