SYLLABUS

For

M.Sc. Environmental Studies

As per NEP2020

(w.e.f. 2025-26)

School of Environmental Studies

MAA SHAKUMBHARI UNIVERSITY

Punwarka, Saharanpur, Uttar Pradesh 247120

1. The syllabus for **M.Sc. Environmental Studies (2025–2027 batch)** was revised and unanimously approved by the Board of Studies.
2. The course will consist of four semesters, including theory papers, practical courses, fieldwork, seminars, and research projects.
3. It was resolved to implement the approved syllabus from the **academic session 2025–26**, subject to final approval by the Academic Council.
4. It was further resolved that periodic syllabus reviews shall be conducted to maintain relevance with academic advancements and environmental policy frameworks.

Signatures of Members

S. No.	Name	Designation	Signature
1.	Prof. Garima Jain	Dean, Faculty of Science, DAV College, MZN	
2.	Prof. Sanjeev Kumar	Coordinator (Botany), DAV College, MZN	
3.	Prof. Sandhya Jain	Coordinator (Zoology), DAV College, MZN	
4.	Mr. Satendra Kumar	Member (Zoology), DAV College, MZN	
5.	Prof. Omkar Singh	External Expert, NIH, Roorkee	Online
6.	Dr. Vinay Kumar Sethi	External Expert, US University, Haridwar	16/6/25
7.	Dr. Vinod Kumar	External Expert, GK(DU), Haridwar	16/6/25

MAA SHAKUMBHARI UNIVERSITY, SAHARANPUR

SCHOOL OF ENVIRONMENTAL STUDIES

VISION OF THE SCHOOL

To nurture professionals equipped with ethical values, scientific acumen, and global competence capable of addressing contemporary environmental challenges. The School aims to cultivate a dynamic ecosystem of innovation and knowledge generation, nurturing an interdisciplinary learning environment for achieving academic and research excellence in Environmental Studies.

MISSION OF THE SCHOOL

To establish itself among the leading institutions of environmental education in India within the next decade by promoting sustainable development, interdisciplinary research, and community-oriented practices. The School will implement adaptive academic and administrative mechanisms to maximize the utilization of resources and contribute to the conservation and management of ecological systems and biodiversity across varied habitats.

ABOUT THE SCHOOL OF ENVIRONMENTAL STUDIES

The School of Environmental Studies was instituted with the objective of advancing postgraduate education and interdisciplinary research in Environmental Science. Recognizing the urgency and importance of addressing environmental concerns in the 21st century, the University introduced the M.Sc. Environmental Studies programme from the academic session 2023–24. The programme aligns with the goals of the National Education Policy (NEP) 2020, aiming to provide holistic, flexible, and multidisciplinary education.

Environmental Studies integrates physical, chemical, biological, and social sciences to understand and solve environmental problems. This transdisciplinary field is central to addressing global concerns such as climate change, pollution, biodiversity loss, and sustainable resource management. The School seeks to prepare students with both theoretical knowledge and practical skills to become professionals, researchers, and policymakers in environmental sectors at national and international levels.

VISION

- To offer quality education and develop competencies for national-level competitive examinations and research careers, including those in organizations such as MoEFCC, CPCB, SPCBs, IIFM, WII, TERI, NEERI, NTA-UGC, DBT, DST, ICAR, and international agencies.
- To enable students to engage with national and global environmental challenges through rigorous academic and field-based learning.

Smv Shalini Bhasin on-line. Vinay Bethi 16/6/25 MP 16/6/25

- To foster the development of future leaders in environmental science, policy, and sustainable development.

MISSION

- To promote excellence in environmental education, applied research, and outreach through innovative curricula and transdisciplinary approaches.
- To equip students with critical thinking, problem-solving abilities, and analytical tools essential for assessing and managing environmental systems.
- To create a globally competitive academic environment rooted in sustainability, environmental ethics, and climate resilience.
- To impart knowledge of environmental regulations, impact assessment, environmental biotechnology, remote sensing, and climate modeling.
- To instill skills and values necessary for careers in academia, environmental consultancy, regulatory bodies, civil services, and non-governmental organizations engaged in environmental conservation and management.

M.SC. ENVIRONMENTAL STUDIES PROGRAMME PREREQUISITES

To pursue this programme, a student must have studied in a relevant science discipline, such as Environmental Science/Studies, Biology, Chemistry, Physics, Botany, Zoology, Mathematics, or any allied discipline at the undergraduate level.

PROGRAMME OUTCOMES (POS)

- **PO1**: Apply fundamental and advanced knowledge of environmental science to assess, analyze, and address local and global environmental problems.
- **PO2**: Develop practical competencies and innovative solutions for sustainable development, adaptation of climate change, pollution control, and ecosystem management.
- **PO3**: Demonstrate professional growth through career opportunities in teaching, research, governmental and non-governmental organizations, environmental consultancies, and corporate sectors.
- **PO4**: Integrate interdisciplinary approaches from natural sciences, social sciences, and policy studies for comprehensive environmental problem-solving.
- **PO5**: Analyze complex environmental issues, identify resource-use conflicts, and formulate action-based strategies informed by scientific, legal, and socio-economic considerations.
- **PO6**: Design, evaluate, and implement sustainable technologies and strategies for environmental conservation and natural resource management.
- **PO7**: Acquire and apply technical skills, tools, and methodologies in areas such as remote sensing, GIS, environmental impact assessment (EIA), and ecological monitoring.
- **PO8**: Inculcate ethical values, environmental responsibility, and a commitment to sustainability in both academic and professional spheres.
- **PO9**: Demonstrate effective oral and written communication skills, including the ability to present technical information clearly to a range of stakeholders.
- **PO10**: Engage in lifelong learning through awareness of contemporary environmental challenges, scientific advancements, and policy changes.

PROGRAMME SPECIFIC OUTCOMES (PSOS)

- **PSO1**: Apply environmental science principles and methodologies to real-world contexts such as biodiversity conservation, waste management, water quality monitoring, and environmental health.
- **PSO2**: Formulate, analyze, and evaluate environmental policies and regulatory frameworks in light of ecological, social, and economic objectives.
- **PSO3**: Demonstrate advanced laboratory and field-based skills in environmental sampling, data analysis, and scientific reporting.
- **PSO4**: Design and implement projects related to environmental education, community awareness, and sustainability practices.
- **PSO5**: Employ digital tools including GIS, statistical software (e.g., SPSS, R), and modeling platforms for environmental data analysis and interpretation.
- **PSO6**: Qualify for competitive examinations such as UGC-NET (Environmental Science), GATE, IFS, and recruitment drives by MoEFCC, CPCB, ICAR, DBT, and CSIR-affiliated institutes.
- **PSO7**: Exhibit competencies required for employment in sectors such as environmental consultancy, government agencies, research institutions, developmental organizations, and industry.
- **PSO8**: Cultivate personal and professional skills such as leadership, project management, critical thinking, and adaptability in multidisciplinary work environments.
- **PSO9**: Integrate environmental ethics and biosafety principles into research and professional practices.
- **PSO10**: Contribute to the formulation of science-based solutions for environmental sustainability through academic research and policy engagement.

MS UNIVERSITY, SAHARANPUR			NEW CODE LIST 2025		CAMPUS COURSE CODE LIST			UNIVERSITY CAMPUS		
SCIENCE FACULTY (FACULTY CODE: B = 2)										
18 M.Sc. Environmental Studies (215)										
S. N.	Course Name	Subject	Sem	Paper Code	Core/ Elective/ Value Added	Title of paper	Theory/ Practical/ project	Credit	Internal	External	Total
(PG I Sem / NEP2020)											
1	M.Sc.	Environmental Studies	1	2150701	Core Compulsory	Fundamentals of Environment and Geosciences	Theory	4	25	75	100
2	M.Sc.	Environmental Studies	1	2150702	Core Compulsory	Ecological Principles	Theory	4	25	75	100
3	M.Sc.	Environmental Studies	1	2150703	Core Compulsory	Biodiversity and Conservation	Theory	4	25	75	100
4	M.Sc.	Environmental Studies	1	2150704	Core Compulsory	Environmental Pollution	Theory	4	25	75	100
5	M.Sc.	Environmental Studies	1	2150780	Core Compulsory	Practical - I	Practical	4	-	100	100
(PG II Sem / NEP2020)											
1	M.Sc.	Environmental Studies	2	2150801	Core Compulsory	Environmental Policy, Ethics, and Climate Governance	Theory	4	25	75	100
2	M.Sc.	Environmental Studies	2	2150802	Core Compulsory	Solid Waste Management and Techniques	Theory	4	25	75	100
3	M.Sc.	Environmental Studies	2	2150803	Core Compulsory	Natural Resources, Disasters, and Energy Management	Theory	4	25	75	100
4	M.Sc.	Environmental Studies	2	2150804	Core Compulsory	Environmental Awareness, Impact Assessment, and Auditing	Theory	4	25	75	100
5	M.Sc.	Environmental Studies	2	2150880	Core Compulsory	Practical - II	Practical	4	-	100	100
(PG III Sem / NEP2020)											
1	M.Sc.	Environmental Studies	3	2150901	Core Compulsory	Environmental Analysis Techniques and Instrumentation	Theory	4	25	75	100
2	M.Sc.	Environmental Studies	3	2150902	Core Compulsory	Environmental Chemistry and Toxicology	Theory	4	25	75	100
3	M.Sc.	Environmental Studies	3	2150903	Elective	Remote Sensing and GIS in Environmental Studies	Theory	4	25	75	100
4	M.Sc.	Environmental Studies	3	2150904	Elective	Industrial and Biomedical Waste Management	Theory	4	25	75	100

Sir Sifani bkum on-line. 16/6/25 16/6/25

5	M.Sc.	Environmental Studies	3	2150965	Core Compulsory	Research Project - I	Project	4	25 (Publication)	75	100
6	M.Sc.	Environmental Studies	3	2150980	Core Compulsory	Practical - III	Practical	4	-	100	100
(PG IV Sem / NEP2020)											
1	M.Sc.	Environmental Studies	4	2151001	Core Compulsory	Statistical Applications and Research Methodology	Theory	4	25	75	100
2	M.Sc.	Environmental Studies	4	2151002	Core Compulsory	Environmental Biotechnology	Theory	4	25	75	100
3	M.Sc.	Environmental Studies	4	2150903	Core Compulsory	Environmental Control Systems and Treatment Technologies	Theory	4	25	75	100
5	M.Sc.	Environmental Studies	4	2151065	Core Compulsory	Research Project -II	Project	4	25 (Publication)	75	100
6	M.Sc.	Environmental Studies	4	2151080	Core Compulsory	Practical - IV	Practical	4	-	100	100

Sm Shri bkum on-line. Vinayakthi 16/6/25 MP 16/6/25

INSTRUCTIONS FOR EXAMINATION PATTERN

Internal Examination (Total: 25 Marks | Duration: 1 Hour)

1. Written Test – 15 Marks
    - 5 Marks: Quiz/Multiple Choice Questions (MCQs)
    - 5 Marks: Short Answer Questions
    - 5 Marks: Long Answer Questions
2. Class Attendance – 5 Marks
3. Assignment and Presentation – 5 Marks

External Examination (Total: 75 Marks | Duration: 3 Hours)

- Semester 1 and Semester 3:
    - Written (theoretical) examination
- Semester 2 and Semester 4:
    - Multiple Choice Question (MCQ) based examination

Practical Examination (Total: 100 Marks | Duration: 3 Hours)

- Section A: Attempt 4 exercises, each exercise carries 20 marks (total 80 marks).
- Section B: Attempt 2 spotting exercises, each spotting carries 5 marks (total 10 marks).
- Practical record (5 marks)
- Chart and viva voice (5 marks)

Passing Criteria

- Minimum Passing Marks:
    - 40% marks in each individual paper
    - 50% overall average (aggregate) in all courses
- Division Classification:
    - First Division: 60% and above
    - Second Division: 50% to 59.99%
    - *Note:* There is no Third Division

Program/Class: M.Sc.	Year: First	Semester: First
Subject: Environmental Studies		
Course Code: 2150701	Course Title: Fundamentals of Environment and Geosciences	

Course outcome:

- CO1: Understand Earth's major systems and their environmental interactions.
- CO2: Explain core geoscience concepts relevant to environmental studies.
- CO3: Analyze the effects of natural and human activities on Earth systems.
- CO4: Apply scientific principles to assess environmental issues and interpret basic environmental and geological data for decision-making.

Credits: 4	Core Compulsory	
Max. Marks: 25+75	Min. Passing Marks: 40	

Unit	Topics	No. of Lectures
I	**Environment:** Definition, scope, and multidisciplinary nature of environmental studies/sciences; Components of the environment; Brief history of environmentalism. **Origin and internal structure of Earth:** core, mantle, and crust; Rocks and minerals: types (igneous and metamorphic), formation, and classification; Mineral resources and reserves; Environmental impacts of mineral extraction and processing; Introduction to landforms: tectonic (including plate tectonics) and climatic controls.	15
II	**Atmosphere and Climate Systems:** atmospheric structure and temperature relationships; Atmospheric stability, temperature inversions, and basic wind systems; Forces governing atmospheric motion: Coriolis, pressure gradient, frictional, geostrophic, and gradient winds; General circulation, air masses, weather fronts, and precipitation types; Indian monsoon, western disturbances, El Niño and La Niña events; Climate types in India; urban heat islands and their consequences.	15
III	**Hydrosphere and Land Resources**: distribution of water in earth, Hydrological cycle, Factors influencing the surface water, hydrology and hydrogeology; Darcy's law and its validity, groundwater fluctuations, hydraulic conductivity; Major basins and groundwater provinces of India; groundwater tracers, Land subsidence, effects of excessive use of groundwater, Environmental impacts of dams with recent case studies; Land-use planning, Soil surveys in relation to land-use planning, Methods of site selection and evaluation.	15
IV	**Geochemistry and Environmental Processes:** geochemical classification of elements' abundance of elements in bulk earth, crust, hydrosphere, and biosphere; Partitioning of elements during surficial geologic processes, Geochemical recycling of elements; Paleoclimate, Application of GIS in Geo environment; Biogeochemical factors in environmental health.	15

Suggested Readings

1. Lal, D. S. (2009). Climatology (10th ed.). Allahabad: Sharda Pustak Bhawan.
2. Singh, S. (2008). Physical Geography (Revised ed.). Allahabad: Prayag Pustak Bhawan.

3. Sharma, R. C., & Vatal, M. (2010). Oceanography for Geographers (4th ed.). New Delhi: Rajesh Publications.
4. Lutgens, F. K., & Tarbuck, E. J. (2019). The Atmosphere: An Introduction to Meteorology (14th ed.). New York: Pearson Education.
5. Botkin, Daniel B., and Keller, Edward A. Environmental Science: Earth as a Living Planet. 6th ed. John Wiley & Sons, USA. 2007.
6. Bouwer, H. Groundwater Hydrology. McGraw-Hill, New York. 1978.
7. Eby, N. Principles of Environmental Geochemistry. Brooks Cole, USA. 2003.
8. Faure, G. Inorganic Geochemistry. Prentice Hall. 1991.
9. Fetter, C.W. Applied Hydrogeology. 4th ed. Prentice Hall of India. 2001.
10. Krauskopf, K.B. Introduction to Geochemistry. McGraw Hill. 1994.

Sir Sitaram bhavan on-line. 16/6/25 16/6/25

Program/Class: M.Sc.	Year: First	Semester: First
Subject: Environmental Studies		
Course Code: 2150702	Course Title: Ecological Principles	

Course outcome:

- CO1: Define and explain fundamental ecological concepts and ecosystem processes.
- CO2: Analyze population dynamics, life history strategies, and human population impacts.
- CO3: Describe terrestrial and aquatic ecosystems and assess their ecological significance.
- CO4: Examine community interactions, ecological models, and drivers of speciation and extinction and evaluate the ecological and socio-economic implications of biological invasions and human-ecological systems.

Credits: 4	Core Compulsory	
Max. Marks: 25+75	Min. Passing Marks: 40	

Unit	Topics	No. of Lectures
I	**Fundamentals of Ecology:** History, concept, and major branches of ecology; Food chains, food webs, and ecological pyramids in dynamic environments; Energy flow and models; **Population ecology:** characteristics, dynamics, interactions, regulation; metapopulations, age-structured populations; Population genetics and implications; PAT formula.	15
II	**Ecosystem:** types, functions, and services; **Terrestrial ecosystems:** forest, desert, grassland; Climate-vegetation relationships: role of temperature and precipitation; Forest types of India; **Aquatic ecosystems:** freshwater (lentic and lotic) and marine systems; Characteristics, types, and components of aquatic ecosystems (pond, lake, rivers, estuaries, coral reefs, and open oceans); Wetlands: ecological significance and classification; Ramsar sites of India.	15
III	**Community Ecology:** Concepts and characteristics of ecological communities; Interactions: mutualism, commensalism, competition, predation, parasitism; **Community development:** ecological succession; Metacommunities and fugitive species **Population growth models:** Lotka–Volterra model, Leslie matrix model; **Speciation:** concepts and types; origin of species. **Extinction:** causes and historical perspective.	15
IV	**Industrial ecology:** concept and overview; **Human ecology:** Human population growth, settlement patterns, and environmental impacts; **Biological invasions:** concepts, pathways, mechanisms, and processes; Ecological, environmental, and economic impacts of invasive species; Case studies: major invasive plants and animals in World and India.	15

Suggested Readings

1. Begon, M., Townsend, C. R., and Harper, J. L. Ecology from Individuals to Ecosystems. Wiley-Blackwell, USA. 2005.
2. Chapman, J. L., and Reiss, M.J. Ecology: Principles and Applications. Cambridge University
3. Press, UK. 1998.

Sm Stfam bkum on-line. 16/6/25 16/6/25

4. Cotgreave, Peter and Forseth, Irwin. Introductory Ecology. Wiley-Blackwell, USA. 2002.
5. Cunningham, W. P. and Cunningham, M. A. Principles of Environment Science. Enquiry and Applications. 2nd ed. Tata McGraw Hill, New Delhi. 2004.
6. Kohli, R. K., Jose, S., Singh, H. P. and Batish, D. R. Invasive Plants and Forest Ecosystems. CRC Press / Taylor and Francis. 2009.
7. Leveque, C. Ecology: From Ecosystem to Biosphere. Science Publishers, USA. 2003.
8. Odum, E.P. Fundamentals of Ecology. W.B. Saunders, USA. Indian Reprint 1996 by Natraj Publishers, Dehradun. 1991.
9. Odum, E.P. Ecology: A Bridge between Science and Society. Sinauer Associates, Inc., USA. 1997.
10. Raven, Peter H., Hassenzahl, David M. and Berg, Linda R. Environment. 8th ed. John Wiley & Sons., USA. 2011.
11. Silvertown J. W. and Charlesworth, D. Introduction to Plant Population Biology. 4th ed. Wiley-Blackwell. 2001.
12. Townsend, C. R., Begon, M., and Harper, J. L. Essentials of Ecology. Wiley-Blackwell, USA. 2008

Sir Syllabus bkum on-line. 16/6/25 16/6/25

Program/Class: M.Sc.	Year: First	Semester: First
	Subject: Environmental Studies	
Course Code: 2150703	Course Title: Biodiversity and Conservation	

Course outcome:

- Explain the principles of biodiversity and its ecological, genetic, and conservation significance.
- Identify major threats to biodiversity and categorize species based on IUCN conservation status.
- Differentiate between in-situ and ex-situ conservation methods and protected area types.
- Evaluate conservation strategies for natural resources including forests, soil, water, and agriculture.
- Analyze national and community-driven biodiversity conservation efforts and policies.

Credits: 4	Core Compulsory	
Max. Marks: 25+75	**Min. Passing Marks:** 40	

Unit	Topics	No. of Lectures
I	**Conservation biology:** basics and principles; **Biodiversity:** concept and levels (alpha, beta, gamma); measurement methods; Global and Indian biodiversity overview; Valuing biodiversity: direct use, indirect use, optional, and intrinsic values; Biodiversity hotspots: concept and a brief account; hotspots of India, biodiversity of Shivalik Hills; Environmental heroes of India	15
II	**Major threats to biodiversity:** extinction, habitat destruction, fragmentation, degradation, climate change; Overexploitation, invasive species, emerging diseases; Vulnerability to extinction; IUCN categories; Red Data Book; **Conservation methods:** In-situ conservation: National Parks, Wildlife Sanctuaries, Biosphere Reserves, Sacred Groves; Ex-situ conservation: principles and examples; Genetic tools for conservation: DNA sequencing, molecular markers; Conservation outside protected areas; introduction to restoration ecology; Insect parasites and biological control	15
III	**Conservation:** Concept, objectives, and policy framework for conservation; **Forest resources:** Values of forest, conservation efforts, afforestation, Joint Forest Management; Forest legislation and community movements: Forest Conservation Act, Chipko, Apiko, Silent Valley, Gandhamardhan; **Wildlife conservation**: Legal frameworks; Wildlife Protection Act 1972; **Major projects:** Project Tiger, Project Elephant, Crocodile Conservation, Sea Turtle Project, Indo-Rhino Vision; Cheetah reintroduction, vulture rehabilitation; Breeding stock preservation, artificial stocking.	15
IV	**Soil resources conservation:** causes of degradation, erosion, reclamation of alkaline and saline soils; the role of soil microorganisms; Mineral resources: demographic quotient, resource depletion curves **Agricultural conservation:** arable land, crop genetic resources, pesticide hazards, Integrated Pest Management; **Aquatic systems:** conservation of wetlands, lake eutrophication, restoration strategies; **Desert and wasteland ecosystems:** conservation needs and strategies.	15

Suggested Readings

1. Frankel, O.H., Brown, A.H.D., and Burdon, J.J. Conservation of Plant Biodiversity. Cambridge University Press, UK. 1995.
2. Gaston, K. J. and Spicer, J. I. Biodiversity: An Introduction. Blackwell, UK. 1998.
3. Gadgil, Madhav and Rao, P.R.S. Nurturing Biodiversity: An Indian Agenda. Centre for Environment Education, Ahmedabad, India. 1999.
4. Hunter, Malcolm L., Jr., and Gibbs, James P. Fundamentals of Conservation Biology. 3rd ed. Wiley-Blackwell. 2006.
5. Perrings, Charles, Maler, Karl-Goran, Folke, Carl, Holling, C. S. and Jansson,
6. Van Andel, J. and Aronson, J. Restoration Ecology: The New Frontier. Blackwell, UK. 2005
7. Odum, E.P. Fundamentals of Ecology. W.B. Saunders, USA. 1991.
8. Primack, R.B. Essentials of Conservation Biology. 5th ed. Sinaeur Associates, Inc., USA. 2010.
9. Singh, J.S., Singh, S.P., and Gupta, S.R. Ecology, Environment and Resource Conservation. Anamaya Publishers, New Delhi, India. 2006.

Sir Sikkim bkum on-line. 16/6/25 16/6/25

Program/Class: M.Sc.	Year: First	Semester: First
Subject: Environmental Studies		
Course Code: 2150704	Course Title: Environmental Pollution	

Course outcome:

- CO1: Identify major sources and types of environmental pollutants across air, water, soil, and noise domains.
- CO2: Explain pollutant transport, dispersion, and monitoring methods using scientific models and tools.
- CO3: Assess pollution impacts on ecosystems, human health, and built environments.
- CO4: Interpret environmental quality standards and analyze relevant physicochemical and microbiological parameters and evaluate national environmental policies and control measures for pollution mitigation.

Credits: 4	Core Compulsory	
Max. Marks: 25+75	Min. Passing Marks: 40	

Unit	Topics	No. of Lectures
I	**Air pollution:** sources and classification of pollutants; **Meteorology and pollutant dispersion:** Lapse rates, mixing height, and plume behavior; Gaussian plume model; line and area source models; effective stack height calculation; Air Quality Index (AQI) and transport mechanisms; Monitoring techniques for SO_2, NO_x, CO, SPM; **Major phenomena:** Acid rain, types of smog, vehicular emissions, urban air quality; **Indoor air pollution:** sources, impacts, and control measures; Effects on human health, plants, animals, materials, and climate; Ambient air quality standards (India); Legal framework: The Air (Prevention and Control of Pollution) Act 1981	15
II	**Water and marine pollution:** surface and groundwater pollution, sources and ecological consequences; Ghyben-Herzberg relation (fresh-saline water interface), brackish water, water productivity; **Water quality assessment:** sampling and analysis (pH, EC, turbidity, TDS, hardness, chlorides, salinity, DO, BOD, COD, nitrates, phosphates, sulphates, heavy metals, organics); **Microbiological analysis:** MPN technique; **Marine pollution:** sources and abatement strategies; **Thermal pollution:** causes and ecological impacts; Drinking water quality standards (Indian and International); Legal framework: The Water (Prevention and Control of Pollution) Act 1974	15
III	**Soil pollution:** Soil sampling and physico-chemical analysis; Role of soil microorganisms in biogeochemical cycling; Soil contamination: industrial effluents, heavy metals, synthetic fertilizers; **Radioactive pollution:** sources, ionizing radiation effects, radiation dose and standards; Radiation protection protocols; Legal framework: The Environment (Protection) Act, 1986	15
IV	**Noise pollution:** Sources of noise pollution; Noise measurement: weighting networks and indices (Leq, L10, L50, L90, LDN, TNI); Influence of meteorological factors on sound propagation; Impacts on human health: hearing loss, stress, physiological effects; Noise dose-response, standards, and permissible limits; Noise control strategies: active and passive methods; Noise Pollution (Regulation and	15

	Control) Rules, 2000; **Biological and microbial pollutants:** types, sources, and health hazards; Safety and mitigation measures against biological contaminants	

Suggested Readings

1. Charbeneau, R.J. Groundwater Hydraulics, and Pollutant Transport. Prentice Hall, India. 2000.
2. Cutler, S.L., Environment Risks and Hazard. Prentice Hall of India, Delhi. 1999.
3. De, A.K., Environmental Chemistry. New Age International (P) Ltd. Publishers, New Delhi. 2000.
4. Fetter, C.W. Contaminant Hydrogeology. 2nd ed., Prentice Hall, India. 1999.
5. Hammer, M.J. & Hammer, M.J. Jr., Water & Waste Water Technology. Prentice Hall. 2000.
6. Hillel, D., Introduction to Soil Physics, Academic Press, New York. 1982.
7. Kapoor, B.S. Environmental Sanitation. S. Chand & Sons, New Delhi. 2000.
8. Sanai, V.S. Fundamentals of Soil. Kalayani Publishers, New Delhi. 1990.
9. Sharma, B.K. Environmental Chemistry, Goel Publishing House, Meerut. 2000.

Sir Sharma bhai on line. 16/6/25 16/6/25

Program/Class: M.Sc.	Year: First	Semester: First
Subject: Environmental Studies		
Course Code: 2150780	Course Title: Practical – I	

Course outcome:

- CO1: Demonstrate a practical understanding of Earth's physical structure, rock types, atmospheric profiles, and meteorological measurements through diagrammatic and field-based methods.
- CO2: Apply ecological sampling techniques such as quadrat analysis and biodiversity indices to quantify vegetation structure, species diversity, and community similarity.
- CO3: Interpret topographic, geological, and ecological data using maps, field navigation tools (compass, GPS), and statistical methods (e.g., Chi-square, similarity indices).
- CO4: Assess environmental quality through air and water pollutant monitoring, soil property analysis, and preparation of emission inventories using standard protocols.

Credits: 4	Core Compulsory	
Max. Marks: 100	Min. Passing Marks: 40	

Unit	Exercises	Lab Hours
I	1. Study of the internal structure of the Earth using diagrams and models. 2. Identification and description of hand specimens of igneous and metamorphic rocks. 3. Diagrammatic representation of atmospheric layers with their characteristics and temperature profiles. 4. Preparation and interpretation of wind roses based on directional wind data. 5. Measurement and estimation of rainfall, relative humidity, and air temperature using standard meteorological instruments. 6. Interpretation of topographic and geological maps for understanding terrain and lithology. 7. Field navigation using compass and Global Positioning System (GPS) devices.	15
II	1. To study vegetation using the quadrat method. 2. To calculate the density, frequency, abundance, and dominance of plant species in a grassland ecosystem using the quadrat method. 3. To determine the association between two plant species using the Chi-square test for independence. 4. To calculate the similarity index (e.g., Sorensen's or Jaccard's) between two adjacent plant communities. 5. Field visit to an aquatic (lake) and forest ecosystem for qualitative and quantitative study of biotic and abiotic components. 6. To identify and document common exotic invasive weed species and assess their ecological impact.	15
III	1. To calculate species diversity indices, including diversity, richness, evenness, and dominance. 2. To compute alpha, beta, and gamma diversity for assessing species distribution across habitats.	15

Sorry Sifani bkum on-line. Uinayakthi 16/6/25 16/6/25

	3. Field visits to observe and analyze the causes and consequences ofsoil degradation. 4. To study and compare different types of plantation systems (e.g., monoculture, mixed plantations). 5. Case study or visit to an ecological restoration site to understand rehabilitation strategies and outcomes. 6. To visit a Ramsar site for an assessment of wetland ecology and evaluation of existing threats and conservation challenges. 7. Visit a national park or wildlife sanctuary to understand their role in the protection and conservation of biodiversity.	
IV	1. To conduct sampling and monitoring of major air pollutants: SO_2, NO_x, CO, and Suspended Particulate Matter (SPM). 2. To determine the Air Quality Index (AQI) at selected locations representing varying pollution levels (e.g., less polluted and heavily polluted areas). 3. To collect and preserve surface and groundwater samples following standard protocols. 4. To analyze Dissolved Oxygen (DO), Chemical Oxygen Demand (COD), and Biochemical Oxygen Demand (BOD_3 and BOD_5) in industrial effluents or sewage samples. 5. To collect and prepare soil samples for laboratory analysis. 6. To determine selected physico-chemical properties of soil from polluted and non-polluted areas: pH, electrical conductivity, bulk density, organic carbon, and organic matter. 7. To prepare a vehicular emission inventory for a selected locality using primary or secondary data.	15

Suggested Readings

1. van der Pluijm, B. A., & Marshak, S. (2004). Earth structure: An introduction to structural geology and tectonics (2nd ed.). W. W. Norton & Company.
2. Pellant, C. (2000). Smithsonian handbooks: Rocks and minerals. DK Publishing.
3. Yee, Y. P. (2012). Atmospheric temperature profiles of the Northern Hemisphere: A compendium of data. Springer.
4. Carslaw, D. (n.d.). Wind and pollution roses. In The openair book.
5. World Meteorological Organization. (2008). Guide to meteorological instruments and methods of observation (WMO-No. 8, 7th ed.). WMO.
6. Burns, B., & Burns, M. (2025). Wilderness navigation: Finding your way using map, compass, altimeter & GPS (4th ed.). Mountaineers Books.
7. Caudill, C., & Trimble, T. (2019). Essential wilderness navigation: A real-world guide to finding your way safely in the woods with or without a map, compass or GPS. Page Street Publishing.
8. Sutherland, W. J. (Ed.). (2006). Ecological census techniques: A handbook (2nd ed.). Cambridge University Press.
9. Sutherland, W. J., Newton, I., & Green, R. E. (Eds.). (2004). Bird ecology and conservation: A handbook of techniques. Oxford University Press.
10. World Health Organization. (2006). Air quality guidelines: Global update 2005. Particulate matter, ozone, nitrogen dioxide and sulfur dioxide. WHO Regional Office for Europe.

Sw Stem bkum on-line. Vinayakthi 16/6/25 16/6/25

Program/Class: M.Sc.	**Year:** First	**Semester:** Second
Subject: Environmental Studies		
Course Code: 2150801	**Course Title:** Environmental Policy, Ethics, and Climate Governance	

Course outcome:

- CO1: Understand major international environmental treaties and frameworks.
- CO2: Analyze ethical, legal, and governance aspects of environmental protection at local, national, and global levels.
- CO3: Evaluate current and emerging environmental challenges.
- CO4: Apply knowledge of sustainability indicators and green technologies in real-world contexts and assess India's national missions and strategies for environmental conservation, climate resilience, and sustainable resource management.

Credits: 4	Core Compulsory	
Max. Marks: 25+75	**Min. Passing Marks:** 40	

Unit	Topics	No. of Lectures
I	**Global Environmental Agreements:** Stockholm Conference and creation of UNEP; Vienna Convention and Montreal Protocol; UN Earth Summits, Agenda 21; Convention on Biological Diversity, Aichi Targets; SDGs and MDGs; UNFCCC, Conference of Parties (COPs), Paris Agreement, Copenhagen Summit; Ramsar Convention on Wetlands; IPCC and IGBP reports (overview); **Climate change:** science, impacts, adaptation, sea-level rise; Human health implications and climate-induced displacement, climate refugees.	15
II	**Environmental Governance and Ethics:** Environmental ethics and rights; Environmental justice and green criminology; Environmental governance and communication; Role of stakeholders (NGOs, media) in environmental protection; Environmental conflicts at local, national, and global levels; Green economy and sustainable development goals; Bioterrorism and eco-terrorism; smoking impacts.	15
III	**Environmental health:** acid rain, plastic waste pollution; **Tools for Mitigation and Sustainability Metrics:** Ozone depletion and impacts on biota; Carbon trading, carbon credits, carbon sequestration, carbon and water footprints; REDD and REDD+; Green building concepts: GRIHA rating, LEED India; Ecolabelling and Ecomark, Energy and food security.	15
IV	**Environmental challenges in India:** hydropower projects, vehicular emission norms, epidemiological concerns, and environmental disasters **National Missions under India's climate action plan:** National Solar Mission; Mission for Enhanced Energy Efficiency; Mission on Sustainable Habitat; National Water Mission; Namami Gange Programme; National Mission for Sustaining the Himalayan Ecosystem; National Mission for a Green India; National Mission on Sustainable Agriculture; Mission on Strategic Knowledge for Climate Change;	15

Suggested Readings

1. Botkin, Daniel B. and Keller, Edward A. Environmental Science: Earth as a Living Planet. 6th d. John Wiley & Sons, USA. 2007.

2. Chasek, P. S. The Global Environment in the Twenty-First Century - Prospects for International Co-operation. Indian Reprint by Manas Publications, New Delhi. 2004.
3. Cunningham, W. P. and Cunningham, M. A. Principles of Environment Science. Enquiry and Applications. 2ed. Tata McGraw Hill, New Delhi. 2004.
4. Dash, S. K. Climate Change-An Indian Perspective. Centre for Environment Education and Cambridge University Press Pvt. Ltd., New Delhi. 2007.
5. Hardy, John T. Climate Change: Causes, Effects, Solutions. Wiley & Sons, USA. 2003.
6. Harris, F. Global Environmental Issues. Wiley & Sons, Inc., USA. 2004.
7. Singh, J.S., Singh, S.P. and Gupta, S.R. Ecology, Environment and Resource Conservation. Anamaya Publishers, New Delhi, India. 2006.
8. Speth, J. C. Global Environmental Challenges – Transitions to a Sustainable World. Orient Longman Pvt. Ltd., New Delhi. 2004.
9. UNEP. Global Environmental Outlook 3: Past, Present and Future. Earthscan Publications. 2002.

Sir Sharma bhavan on-line. 16/6/25 16/6/25

Program/Class: M.Sc.	Year: First	Semester: Second
Subject: Environmental Studies		
Course Code: 2150802	Course Title: Solid Waste Management and Techniques	

Course outcome:

- CO1: Classify and characterize various types of solid waste and their sources.
- CO2: Design and evaluate integrated solid waste management systems, including collection, transportation, and disposal.
- CO3: Assess recycling, composting, and waste-to-energy technologies for sustainable waste processing.
- CO4: Interpret and apply relevant waste management rules, policies, and technological tools in planning and monitoring.

Credits: 4	Core Compulsory	
Max. Marks: 25+75	Min. Passing Marks: 40	

Unit	Topics	No. of Lectures
I	**Types and sources of waste:** Municipal, Special wastes (biomedical, e-waste, slaughterhouse, plastic, tyre, battery, domestic hazardous waste); Waste generation and characterization (ultimate and proximate analysis); **Solid Waste Management (SWM) systems:** Centralized and decentralized models, Functional elements (segregation, collection, storage, transportation, transfer stations); Integrated SWM system, waste management hierarchy; Transportation container systems: hauled vs. stationary; Route layout design.	15
II	**Recycling and recovery:** Material Recovery Facilities (MRFs); Recycling of aluminum, glass, plastic, paper; **Composting and biological treatments:** Composting, vermicomposting, biomethanation; **Thermal and energy recovery technologies:** Incineration, pyrolysis, gasification, refuse-derived fuels; **Construction and demolition (C&D) waste:** Management, reuse potential, and environmental concerns; **Disposal practices:** Open dumping and burning—environmental impacts.	15
III	**Landfilling methods:** Types, design, and operational aspects; Site selection and planning; **Engineering components:** Liners (clay, geomembrane, HDPE), leachate collection and analysis, gas collection systems; **Environmental impacts:** Leachate and gas emissions, linkages to climate change; **Closure and post-closure care:** Landfill and dumpsite reclamation, buffer zone guidelines, protection measures at disposal sites.	15
IV	**Regulatory framework:** National SWM Policy, SWM Rules 2016, Plastic Waste Rules 2016, C&D Waste Rules 2016; **Technological tools:** Role of ICT, GIS in SWM planning and monitoring; **Institutional roles:** Stakeholders' responsibilities, role of the National Green Tribunal; **National programs and initiatives:** Swachh Bharat Mission, Smart Cities, Swachh Survekshan, Garbage-Free City Star Rating; Best practices in SWM across the value chain.	15

Suggested Readings

1. Bombade, S., & Joshi, D. (2020). Solid waste management. Tech-Neo Publications.

2. Chang, N. B., & Pires, A. (2018). Sustainable solid waste management: A systems engineering approach. Wiley.
3. Kreith, F. (2002). Handbook of solid waste management. McGraw Hill Publishers.
4. Kumar, R., & Singh, R. N. (2006). Municipal water and wastewater treatment. Capitol Publishing Company.
5. Noble, G. (1976). Sanitary landfill design handbook. Technomic.
6. Peavy, H. S., Rowe, D. R., & Tchobanoglous, G. (1985). Environmental engineering (International ed.). McGraw-Hill.
7. Shah, K. L. (1999). Basics of solid and hazardous waste management technology. McGraw Hill.
8. Tchobanoglous, G. (2014). Integrated solid waste management: Engineering principles and management. McGraw Hill.
9. Vesilind, P. A., Worrell, W., & Reinhart, D. (2002). Solid waste engineering. Brooks/Cole Thomson Learning.
10. White, P., Frank, M., & Hindle, P. (1999). Integrated solid waste management: A life cycle inventory. Chapman & Hall.

Sir Efani bkum on-line. 16/6/25 16/6/25

Program/Class: M.Sc.	Year: First	Semester: Second
Subject: Environmental Studies		
Course Code: 2150803	Course Title: Natural Resources, Disasters, and Energy Management	

Course outcome:

- CO1: Apply principles to assess environmental resources and disaster risk mitigation.
- CO2: Evaluate historical environmental movements and major environmental disasters.
- CO3: Develop water and watershed management strategies for sustainable rural development.
- CO4: Analyze and compare various conventional and renewable energy sources with respect to environmental impact.

Credits: 4	Core Compulsory	
Max. Marks: 25+75	**Min. Passing Marks:** 40	

Unit	Topics	No. of Lectures
I	**Natural resources and their classification:** Renewable vs. non-renewable resources; Biotic and abiotic resources; Resource distribution and utilization: Forests, water, minerals, fossil fuels, biodiversity; **Resource degradation:** Overexploitation, deforestation, desertification, mining impacts; Sustainable resource management strategies: Conservation principles, carrying capacity, equity in resource access.	15
II	**Disaster management:** Definitions, types and classifications, risk analysis, causes and effects, damage and mitigation factors, disaster prediction, preparedness, and communication strategies. **Environmental disasters:** Minamata, Love Canal, Bhopal Gas Tragedy (1984), Chernobyl (1986), Fukushima Daiichi (2011).	15
III	**Watershed management:** Definitions, principles, rainwater harvesting, water budgeting, water balance approach; Participatory Rural Appraisal (PRA) in watershed programs; **Environmental implications of energy use:** Global and Indian energy use patterns, CO_2 emissions in developed vs. developing countries.	15
IV	**Energy resources;** Renewable: Hydroelectric, tidal, wind, ocean thermal, and bioenergy—principles and generation methods; Non-renewable energy resources; **Fossil fuels:** Types, composition, characteristics, energy content (coal, petroleum, natural gas), shale oil, coal bed methane, gas hydrates, gross vs. net calorific value; **Solar energy:** Solar radiation spectrum, solar collectors, and solar ponds; **Nuclear energy:** Principles of fission and fusion, nuclear fuels, types of reactors.	15

Suggested Readings

1. Aslokar, S. R., & Gopichandran, R. (2005). Preventive environmental management: An Indian perspective. Foundation Books.
2. Dhameja, S. K. (2000). Environmental engineering and management. S. K. Kataria & Sons.
3. Hussen, A. (2004). Principles of environmental economics (2nd ed.). Routledge.
4. Kolstad, C. D. (2000). Environmental economics. Oxford University Press.

Om-line. 16/6/25 16/6/25

5. Quaschning, V. (2006). Understanding renewable energy systems. Earthscan Publications Ltd.
6. Stavins, R. N. (2005). Economics of the environment: Selected readings (5th ed.). W. W. Norton & Company.
7. Tietenberg, T. (2004). Environmental and natural resource economics (6th ed.). Pearson Education.

Sm Sfam bkum on-line. Vinayakthi 16/6/25 MP 16/6/25

Program/Class: M.Sc.	Year: First	Semester: Second
	Subject: Environmental Studies	
Course Code: 2150804	Course Title: Environmental Awareness, Impact Assessment, and Auditing	

Course outcome:

- CO1: Understand the principles, legal frameworks, and procedural steps of Environmental Impact Assessment (EIA) and Environmental Clearance processes in India.
- CO2: Apply impact prediction methods and analytical tools (e.g., matrix, checklist, GIS) for evaluating environmental consequences of developmental projects.
- CO3: Evaluate the objectives, process, and benefits of environmental auditing, including Green Audit and ISO 14000 Environmental Management Systems.
- CO4: Demonstrate awareness of environmental education tools, national regulatory mechanisms, and community engagement strategies for promoting sustainable development.

Credits: 4	Core Compulsory	
Max. Marks: 25+75	Min. Passing Marks: 40	

Unit	Topics	No. of Lectures
I	**Introduction to Environmental Impact Assessment:** Concept and significance of EIA; EIA process and structure: screening, scoping, baseline studies; Environmental Management Plan (EMP) and EIA report structure; Overview of EIA Notification (MoEFCC), Environmental Clearance process; Role of Expert Appraisal Committees (EAC/SEAC) and Public Hearings; Key sectors requiring EIA clearance in India	15
II	**EIA Methodologies and Evaluation Tools:** Impact identification and prediction methods: checklist, matrix, and overlay approaches; Impact evaluation and mitigation strategies; Cost-benefit analysis and life cycle analysis in EIA; Role of GIS and remote sensing in EIA; Critical review procedures for EIA reports	15
III	**Environmental Auditing and Green Planning:** Concept, objectives, and need for environmental audits; Types and methods of auditing: process steps and reporting formats; Green Audit and Environmental Management System (EMS): ISO 14000; Green building concept and IGBC rating systems; Environmental planning for smart cities and institutional campuses	15
IV	**Environmental Awareness and Legal Frameworks:** Principles and objectives of environmental education; Role of ICT tools, Eco-Clubs, and citizen science in awareness; Key environment days and campaigns: themes and significance; Concept of environmental justice and the National Green Tribunal (NGT); Environmental footprints and Environmental Social Responsibility (ESR)	15

Suggested Readings

1. Barthwal, R. R. (2012). Environmental impact assessment (2nd ed.). New Age International.

Sny Sfani bkum On-line. Vinay Sethi 16/6/25 16/6/25

2. Reddy, A. H. (2017). Environmental impact assessment: Theory and practice. Butterworth-Heinemann.
3. Ghosh, S. K., & Sengupta, A. K. (2002). The first book in the world on ISO 14000 auditing: A user-friendly practical guide for implementation and auditing of environmental management systems. IIM Bangalore.
4. Woodside, G., & Aurrichio, P. (2006). ISO 14001 auditing manual: Step-by-step guide to implementing and auditing an EMS. McGraw-Hill.
5. Kalita, D. J. (2016). Environmental impact assessment in India: An appraisal. Dimorian Review, 3(1), 50–60.
6. INFLIBNET Centre. (n.d.). Environmental auditing and environmental management: Green buildings, GRIHA, ISO 14000 [E-book chapter]. INFLIBNET.
7. Sharma, M., Bhateria, R., & Singh, R. (2025). Environmental impact assessment: A journey to sustainable development. Springer.

Smv Sifani bkum on-line. Vinayakthi 16/6/25 mp 16/6/25

Program/Class: M.Sc.	Year: First	Semester: Second
Subject: Environmental Studies		
Course Code: 2150880	Course Title: Practical – II	

Course outcome:

- CO1: Analyze and evaluate environmental quality through applied methods such as waste characterization, carbon footprint estimation, and toxicity analysis of wastewater.
- CO2: Investigate climate change risks and their socio-economic impacts using case studies, with emphasis on policy frameworks and adaptive measures including REDD/REDD+.
- CO3: Execute field-based environmental studies through institutional visits and surveys related to waste management, green infrastructure, and ecological conservation.
- CO4: Design, conduct, and assess interdisciplinary environmental awareness and protection initiatives considering ecological, legal, and social perspectives.

Credits: 4	Core Compulsory	
Max. Marks: 100	Min. Passing Marks: 40	

Unit	Exercises	Lab Hours
I	1. Profiling and analysis of smokers in the region. 2. Project report on a visit to a green building. 3. A case study of any major environmental issue. 4. Project/case study on Climate change risks and adaptability. 5. To calculate the carbon footprint of anthropogenic activities. 6. A case study to estimate impacts of climate change on poverty. 7. Study of the REDD/REDD+ programme in India.	15
II	1. A visit to the Composting/Vermi composting Unit /RDF plant/Sanitary landfill. 2. To prepare a list of materials from the municipal waste stream that can be reused/recycled. 3. To determine the pH and moisture content of the solid waste sample. 4. Analysis of Swachh Survekshan parameter. 5. Use of Swachhata App. 6. Questionnaire on survey related to waste management	15
III	1. To study environment protection movement (like Chipko and Narmada Bachao Andolan, etc.). 2. To study working and the significance of NGT. 3. Functioning of various Departments and ministries in environmental promotion and protection. 4. To study protection of Taj Mahal and its guidelines. 5. Survey on environment-related issues in the surroundings.	15
IV	1. Preparation of public hearing notices for proposed developmental projects in compliance with EIA guidelines. 2. Organization and documentation of activities conducted for the celebration of internationally recognized environment-related days. 3. Design and preparation of environmental awareness materials (e.g., posters, brochures, digital content) for outreach purposes. 4. Conduct of environmental awareness drive within a selected locality or institution.	15

	5. Execution of an environmental survey to assess public perception, behavior, or awareness regarding key environmental issues. 6. Completion of thematic assignments or case studies as directed by the course instructor.	

Suggested Readings

1. Brinkmann, R., & Garren, S. J. (Eds.). (2018). The Palgrave handbook of sustainability: Case studies and practical solutions. Palgrave Macmillan.
2. Hung, Y.-T., Wang, L. K., & Shammas, N. K. (Eds.). (2013). Handbook of environment and waste management (Vol. 2): Land and groundwater pollution control. World Scientific.
3. Muthu, S. S. (2016). The carbon footprint handbook. CRC Press.
4. Tudor, T., & Dutra, C. (Eds.). (2020). The Routledge handbook of waste, resources and the circular economy. Routledge.
5. Zhou, S. W. W., Zhou, Y., & Tan, R. R. (2019). Carbon management for a sustainable environment. Springer.
6. National Park Service. (2018). Using scenarios to explore climate change: A handbook for practitioners. U.S. Department of the Interior.
7. Lame, M., & Marcantonio, R. (2022). Environmental management: Concepts and practical skills. Cambridge University Press.
8. Tchobanoglous, G., & Kreith, F. (Eds.). (2002). Handbook of solid waste management (2nd ed.). McGraw-Hill.

Sm Stfani bkum on-line. Vinayakthi 16/6/25 MP 16/6/25

Program/Class: M.Sc.	Year: Second	Semester: Third
Subject: Environmental Studies		
Course Code: 2150901	**Course Title:** Environmental Analysis: Techniques and Instrumentation	

Course outcome:

- CO1: Demonstrate proficiency in instrumental techniques for environmental chemical analysis, including spectroscopy, chromatography, and mass spectrometry.
- CO2: Interpret and analyze data generated from analytical instruments, ensuring accuracy, precision, and adherence to quality-control standards.
- CO3: Apply laboratory best practices—including SOPs, safety protocols, and waste management—in real-world environmental testing scenarios.
- CO4: Evaluate environmental samples for contaminant profiles such as heavy metals, PAHs, and pesticide residues using appropriate analytical methodologies.

Credits: 4	Core Compulsory	
Max. Marks: 25+75	**Min. Passing Marks:** 40	

Unit	Topics	No. of Lectures
I	**Analytical principles**: Accuracy, precision, and types of errors (determinate, indeterminate); Concepts of absolute and relative error, significant figures; **Calibration methods:** Calibration curves and standard curves; Quality Assurance (QA) and Quality Control (QC) in environmental analysis; **Sample preparation:** Collection, preservation, storage, and handling (non-biomedical and non-hazardous); Introduction to analytical data processing and interpretation.	15
II	**Spectroscopic Techniques in Environmental Analysis:** UV-VIS Spectrophotometry: Principle, instrumentation, and environmental applications; Atomic Absorption Spectroscopy (AAS) and Inductively Coupled Plasma Atomic Emission Spectroscopy (ICP-AES): Analysis of trace metals in water and soil; Inductively Coupled Plasma Mass Spectrometry (ICP-MS): High-sensitivity elemental analysis; Fourier Transform Infrared Spectroscopy (FTIR): Organic compound detection; X-Ray Fluorescence (XRF): Analysis of metals in solid samples.	15
III	**Chromatographic and Separation Techniques:** High Performance Liquid Chromatography (HPLC): Instrumentation and application in water/soil pollutant analysis; Gas Chromatography (GC) and GC-MS: Detection of volatile organic pollutants and pesticide residues; Ion Chromatography: Determination of anions and cations in environmental samples; Electrophoresis (Capillary): Principles and environmental application; Paper and Thin Layer Chromatography (TLC): Fundamentals and use in qualitative analysis.	15
IV	**Advanced Instrumentation and Laboratory Standards:** Mass Spectrometry (MS): Principles and applications in pollutant identification; X-Ray Diffraction (XRD): Mineralogical analysis of soils and sediments; Scanning and Transmission Electron Microscopy (SEM, TEM): Microstructural analysis in environmental studies: Analysis of Polycyclic Aromatic Hydrocarbons (PAHs), pesticide residues, and Persistent Organic Pollutants (POPs); **Good Laboratory Practices (GLP):** SOPs, lab safety, chemical labeling, incident reporting;	15

on-line. 16/6/25 16/6/25

	Laboratory accreditation and certification (e.g., NABL, ISO standards); Management of chemical and analytical waste in environmental labs	

Suggested Readings

1. Down, R. D., & Lehr, J. H. (Eds.). (2004). Environmental instrumentation and analysis handbook. John Wiley & Sons.
2. Rajvaidya, N., & Markandey, D. K. (2011). Environmental analysis and instrumentation. A.P.H. Publishing Corporation.
3. Repudi, L., Nuli, M. V., Chagarlamudi, K., Saranya, V., & Muthukumarasamy, R. (2024). Instrumental methods of analysis. Integrated Publications.
4. Khandpur, R. S. (2023). Handbook of analytical instrumentation (2nd ed.). McGraw-Hill Education.
5. Nigam, A., & Gupta, R. (2022). Environmental analysis laboratory handbook. Wiley India.
6. Smith, R. B. (2003). Soil and environmental analysis: Modern instrumental techniques (3rd ed.). Taylor & Francis.
7. Vallero, D. A., & Yadav, D., Kumar, P., & Singh, P. (Eds.). (2021). Hazardous waste management: An overview of advanced and cost-effective solutions. Academic Press.

Smr Sifani bkum on-line. Vinayathi 16/6/25 MP 16/6/25

Program/Class: M.Sc.	Year: Second	Semester: Third
Subject: Environmental Studies		
Course Code: 2150902	Course Title: Environmental Chemistry and Toxicology	

Course outcome:

- CO1: Explain key chemical principles and redox processes that govern environmental reactions in air, water, and soil systems.
- CO2: Interpret the behavior and transformation of environmental pollutants through chemical equilibria, kinetics, and speciation.
- CO3: Evaluate the sources, interactions, and toxic effects of major inorganic and organic environmental contaminants.
- CO4: Apply principles of green chemistry to minimize chemical hazards and promote sustainable environmental practices.

Credits: 4	Core Compulsory	
Max. Marks: 25+75	**Min. Passing Marks:** 40	

Unit	Topics	No. of Lectures
I	**Environmental Chemical Principles:** Gibbs free energy, chemical potential, redox potential (Eh), and stoichiometry in environmental systems; Chemical equilibria and kinetics related to pollutant behavior; Solubility of gases in water: Henry's Law, carbonate equilibrium system; **Chemistry of soils:** mineral-organic interactions, ion exchange (physiosorption, ligand exchange), precipitation–dissolution dynamics; Environmental relevance of hydrocarbon classification and radioisotopes	15
II	**Atmospheric Chemistry:** Chemical composition of the atmosphere: ions, radicals, trace gases; Thermochemical and photochemical atmospheric reactions; Chemistry of primary and secondary air pollutants: ozone, PAN, NO_x, SO_2, VOCs; Sulfur and halogen cycles in the atmosphere; **Green Chemistry:** concepts, need, and the 12 principles with environmental case examples	15
III	**Water chemistry:** precipitation/dissolution, redox reactions, complexation; DO, BOD, COD: theoretical basis and environmental implications; Concept of salinity, suspended solids, sedimentation, coagulation; Seawater vs. freshwater vs. groundwater: comparative chemical composition; Speciation of metals and nutrients in aquatic systems; Threshold limit values (TLVs) and international standards for drinking water	15
IV	**Environmental Toxicology:** classification and behavior of environmental toxicants: metals, organics, xenobiotics; Toxicodynamics and fate of contaminants (e.g., pesticides, PCBs, VOCs); Biochemical and health effects of arsenic, mercury, cadmium, lead, selenium, ozone, CO, PAN, BFRs; Bioaccumulation, biotransformation, and biomagnification concepts; Overview of occupational carcinogens and chemical exposure guidelines	15

Suggested Readings

1. Dara, S. S., & Mishra, D. D. (2022). A Textbook of Environmental Chemistry and Pollution Control (9th ed.). S. Chand Publishing.

Om-line. 16/6/25 16/6/25

2. Manahan, S. E. (2017). Environmental Chemistry (10th ed.). CRC Press.
3. Connell, D. W., & Miller, G. J. (2020). Chemistry and Ecotoxicology of Pollution. Wiley India.
4. Banerjee, G. C. (2021). Environmental Pollution and Control. Oxford & IBH Publishing.
5. Awasthi, I. C. (2020). Environmental Toxicology. Campus Books International.
6. Khan, M. A., & Khan, I. (2022). Environmental Chemistry with Green Chemistry Practices. Ane Books Pvt. Ltd.
7. Trivedi, R. K., & Goel, P. K. (2018). Chemical and Biological Methods for Water Pollution Studies. Environmental Publications.

Sir Sylvia bkum on-line. 16/6/25 16/6/25

Program/Class: M.Sc.	Year: Second	Semester: Third
	Subject: Environmental Studies	
Course Code: 2150903	Course Title: Remote Sensing and GIS in Environmental Studies	

Course outcome:

- CO1: Explain the fundamental principles of remote sensing, electromagnetic radiation, and sensor systems relevant to environmental data acquisition.
- CO2: Apply GIS and GPS tools for spatial data handling, mapping, and ground-truth validation in environmental contexts.
- CO3: Analyze environmental problems such as land use change, deforestation, and water resource degradation using geospatial technologies.
- CO4: Evaluate risk and vulnerability in natural disaster-prone regions through geospatial modeling and hazard mapping.

Credits: 4	Elective	
Max. Marks: 25+75	Min. Passing Marks: 40	

Unit	Topics	No. of Lectures
I	**Principles of Remote Sensing:** Concept, scope, and applications of remote sensing in environmental studies; Electromagnetic radiation (EMR): Properties and interactions with atmosphere and surface features; **Sensor platforms and scanning systems:** Types and resolutions (spatial, spectral, temporal, radiometric); Spectral signatures and image characteristics; Introduction to visual image interpretation and satellite data products	15
II	**Geographic Information System (GIS):** Definition, components, and significance; Spatial data types: Raster and vector models; Attribute data handling and metadata concepts; Map scale, projections, coordinate systems, and transformations; **Global Positioning System (GPS):** Principles, receiver types, accuracy, and field applications	15
III	**RS & GIS in Environmental Resource Monitoring:** Land use and land cover mapping and change detection; Monitoring of surface water bodies and watershed parameters; Detection of deforestation and forest fragmentation; Wetland delineation, waterlogging assessment; Applications in air quality hotspot mapping (e.g., urban heat islands, dust storms)	15
IV	**RS & GIS in Hazard and Risk Analysis:** Use of geospatial tools in disaster risk reduction and hazard zoning; Case studies: Flood risk modeling, landslide susceptibility, drought assessment; Role of geoinformatics in early warning systems and emergency planning; Vulnerability and exposure mapping for climate-related risks	15

Suggested Readings

1. Pandey, P. (Ed.). (2023). Remote sensing & GIS applications in environmental science. INFLIBNET Centre.
2. Santra, A., & Mitra, S. (Eds.). (2016). Remote sensing techniques and GIS applications in earth and environmental studies. IGI Global.
3. Bhatta, B. (2020). Remote sensing and GIS (3rd ed.). Oxford University Press India.

On-line. 16/6/25 16/6/25

4. Weng, Q. (2009). Remote sensing and GIS integration: Theories, methods, and applications. McGraw-Hill Professional.
5. Roy, P. S., Dwivedi, R. S., & Vijayan, D. (Eds.). (2010). Remote sensing applications. National Remote Sensing Centre, ISRO.
6. Moharir, K. N., Pande, C. B., & Pandey, P. (2023). Remote sensing and GIS application in forest conservation planning. Springer.
7. Dutta, J., Medhi, S., & Gogoi, M. (2025). Application of remote sensing and GIS in environmental monitoring and management. In Remote sensing and GIS techniques in hydrology (pp. 1–34). IGI Global.

Program/Class: M.Sc.	Year: Second	Semester: Third
Subject: Environmental Studies		
Course Code: 2150904	Course Title: Industrial and Biomedical Waste Management	

Course outcome:

- CO1: Explain the classification, sources, and environmental impacts of hazardous, e-waste, and biomedical waste.
- CO2: Apply appropriate treatment and disposal methods for different types of hazardous and biomedical waste.
- CO3: Evaluate industrial and hospital waste management systems, including effluent treatment and regulatory compliance.
- CO4: Demonstrate understanding of national waste management rules and sustainable practices in waste handling.

Credits: 4	Elective	
Max. Marks: 25+75	Min. Passing Marks: 40	

Unit	Topics	No. of Lectures
I	**Electronic Waste (e-Waste):** Definition, types, sources, and environmental impacts; E-Waste Management: Methods of collection, handling, recycling, and disposal; Regulatory Framework: E-Waste (Management and Handling) Rules; **Radioactive Waste:** Sources, classification, characteristics, and health/environmental impacts; **Hazardous Wastes:** Definition, types, properties, sources (e.g., lead and mercury poisoning); Hazardous Waste Handling: Generation, collection, segregation, and associated health risks	15
II	**Treatment Methods for Hazardous Waste:** Neutralization, Oxidation-reduction, Precipitation, Solidification and stabilization, Incineration, Waste Immobilization and Destruction Technologies, Transportation and Disposal Protocols; **Industrial Effluent Management:** Disposal standards and regulatory norms; Importance of site selection for industries; Common Effluent Treatment Plants (CETPs); **Industry-Specific Waste Considerations:** Textile, Pulp and paper, Distilleries, Dairy and food processing, Cement industry; **Fly ash:** sources, composition, and utilization.	15
III	**Biomedical Waste:** Definition, classification, and composition; **Types:** Solids, liquids, sharps, pathological waste, chemical and radioactive materials; **Segregation and Storage:** Color-coded bags and containers; Documentation and labeling practices; **Handling and Transport:** On-site handling, Off-site transportation, Authorization and reporting of accidental spills; **Regulatory Guidelines:** Overview of biomedical waste handling protocols	15
IV	**Treatment and Disposal Techniques:** Incineration, Autoclaving, Microwave irradiation, Chemical disinfection; **Biomedical Waste Treatment Facilities (BMWTF):** Collection, storage, and transport, infrastructure, Record-keeping and monitoring protocols; Hospital Effluent Treatment Plants (HETPs): Structural components, Operational mechanisms; **Legal Framework:** Bio-Medical Waste (Management and Handling) Rules; Hazardous Waste (Management and Handling) Rules;	15

	Concept of Green Hospitals: Sustainable practices in healthcare waste management	

Suggested Readings

1. Bhat, S. (Ed.). (2018). Handbook on chemicals and hazardous waste management and handling in India. Centre for Environmental Law, Education, Research & Advocacy (CEERA), National Law School of India University.
2. Radhakrishnan, R. (2007). Biomedical waste management. Sumit Enterprises.
3. Kumar, S., Negi, S., Rani, A., Chang, C.-T., & Hu, A. H. (2023). Solid and hazardous waste management (Indian ed.). NIPA Books & CSIR-NEERI.
4. Bhatia, S. C. (2023). Solid and hazardous waste management (2nd ed.). Atlantic Publishers & Distributors.
5. Gupta, O. P. (n.d.). Elements of solid hazardous waste management. Khanna Books.
6. Shahul, A. (2023). Heavy Metal: How a global corporation poisoned Kodaikanal. Pan Macmillan India.

Sm Sharma bkum on-line. Vinayakthi 16/6/25 MP 16/6/25

Program/Class: M.Sc.	Year: Second	Semester: Third
Subject: Environmental Studies		
Course Code: 2150980	Course Title: Practical – III	

Course outcome:

- CO1: Perform laboratory techniques for the preparation, separation, and analysis of environmental samples using titrimetric, spectrophotometric, chromatographic, and instrumental methods, including Soxhlet extraction and flame photometry.
- CO2: Assess air and water quality through field monitoring, laboratory analysis, and evaluation of treatment efficiencies using standard physicochemical and biological parameters.
- CO3: Apply remote sensing and GIS tools for environmental interpretation, spatial analysis, and thematic mapping to support land use and resource management studies.
- CO4: Analyze biomedical, hazardous, and electronic waste management systems through field surveys, site visits, and protocol-based evaluations focusing on compliance, risk, and health impacts.

Credits: 4	Core Compulsory	
Max. Marks: 100	Min. Passing Marks: 40	

Unit	Exercises	Lab Hours
I	1. Preparation of standard solutions and construction of calibration curves for quantitative analysis. 2. Quantitative estimation of analytes using titrimetric and spectrophotometric methods. 3. Paper chromatography for separation and identification of amino acids; calculation of Rf values. 4. Compound extraction using Soxhlet apparatus (e.g., extraction of plant pigments or soil organics). 5. Preliminary functional group identification in organic samples (alcohols, phenols, acids, carbonyls). 6. Operation of flame photometer for analysis of sodium and potassium in water samples. 7. Demonstration visit to analytical laboratories to understand working principles of AAS, HPLC, GC, and UV-VIS.	15
II	1. Ambient air quality monitoring for SO_2, NO_x, CO, and SPM using field sampling kits and high-volume air samplers. 2. Study of the working principles and efficiency of air pollution control devices (e.g., cyclone separator or electrostatic precipitator) through model or lab-scale demonstration. 3. Comparative analysis of tailpipe emissions from different vehicle types and fuels using mobile emission testing kits or available datasets. 4. Estimation of pollutant removal efficiency using adsorption or absorption columns for gaseous pollutants (e.g., ammonia or SO_2). 5. Determination of physicochemical parameters (e.g., turbidity, pH, chlorine, hardness) of treated water from a water treatment plant or RO system. 6. Collection and analysis of wastewater samples from a Sewage Treatment Plant (STP): BOD, COD, TSS, and pH.	15

On. line. 16/6/25 16/6/25

	7. Visit to an Effluent Treatment Plant (ETP) and preparation of a field report including treatment steps, operational data, and compliance status.	
III	1. Observation and analysis of spectral signatures of basic surface features (e.g., water, vegetation, soil, built-up). 2. Visual interpretation of satellite imagery for identifying land cover features. 3. Digitization of point, line, and polygon features from raster maps in a GIS environment. 4. Creation and editing of attribute tables; importing external data and joining tables in GIS. 5. Basic spatial analysis and map classification techniques; generating thematic maps with layout elements (legend, scale, title). 6. Identification and classification of land use/land cover types using the BHUVAN portal.	15
IV	1. Conduct a survey of the town to compile a list of clinics, nursing homes, dispensaries, tertiary care centers, multi-specialty hospitals, and other healthcare facilities. 2. Demonstrate the process of sterilization using an autoclave. 3. Explain the role of color coding in biomedical waste (BMW) management. 4. Collect data on methods used for handling and transporting hospital waste within the city. 5. Visit a hazardous waste generation or disposal site to study its operational practices. 6. Visit the university health center or dental institute to assess biomedical waste management practices. 7. Prepare a list of electronic waste (e-waste) along with their components and sources.	15

Suggested Readings

1. Manahan, S. E. (2017). Environmental chemistry (10th ed.). CRC Press.
2. Sawyer, C. N., McCarty, P. L., & Parkin, G. F. (2003). Chemistry for environmental engineering and science (5th ed.). McGraw-Hill.
3. Baird, R. B., Eaton, A. D., & Rice, E. W. (Eds.). (2017). Standard methods for the examination of water and wastewater (23rd ed.). American Public Health Association.
4. Radojevic, M., & Bashkin, V. N. (2006). Practical environmental analysis (2nd ed.). Royal Society of Chemistry.
5. Kumar, L. (2020). Geographic information system (GIS): Basics, applications and research. CRC Press.
6. Jensen, J. R. (2015). Introductory digital image processing: A remote sensing perspective (4th ed.). Pearson.
7. Chartier, Y., Emmanuel, J., Pieper, U., Prüss, A., Rushbrook, P., Stringer, R., ... & Zghondi, R. (2014). Safe management of wastes from health-care activities (2nd ed.). World Health Organization.

Sm Stefan bkum on-line. Vinayakthi 16/6/25 MP 16/6/25

8. Kiddee, P., Naidu, R., & Wong, M. H. (2013). Electronic waste management approaches: An overview. Waste Management, 33(5), 1237–1250.

Sir Hard bkum on-line. 16/6/25 16/6/25

Program/Class: M.Sc.	Year: Second	Semester: Fourth
	Subject: Environmental Studies	
Course Code: 2151001	Course Title: Statistical Applications and Research Methodology	

Course outcome:

- CO1: Apply statistical tools to analyze and interpret environmental data.
- CO2: Design and conduct scientific research using appropriate methodologies and ethical practices.
- CO3: Demonstrate competency in scientific writing, referencing, and use of academic databases.
- CO4: Explain the fundamentals of intellectual property rights and funding mechanisms for research projects.

Credits: 4	Core Compulsory	
Max. Marks: 25+75	Min. Passing Marks: 40	

Unit	Topics	No. of Lectures
I	**Introduction to biostatistics:** its role in environmental sciences; Types of data: qualitative and quantitative; variables and attributes; Data collection, cleaning, and representation; Tabulation and graphical presentation (bar, histogram, scatter plot, etc.); Measures of central tendency: mean, median, mode; Measures of dispersion: standard deviation, standard error, range	15
II	**Probability distributions:** Normal, Binomial, Poisson (basic features and applications); Parametric vs. non-parametric methods; t-test, chi-square test, ANOVA (one-way); Correlation and regression analysis (linear and non-linear); Concept of hypothesis testing, Type I & II errors, level of significance; Confidence intervals and degrees of freedom	15
III	**Research process and types of scientific literature:** articles, reviews, theses; Components of a research article: title, abstract, keywords, introduction, methods, results, discussion, conclusion; Scientific writing: tables, figures, citation styles, proofreading and editing; Oral and poster presentation techniques; Overview of journal selection, impact factor, CiteScore; h-index, author rights, plagiarism and academic ethics; Online databases: Scopus, WoS, Sodhganga, etc.	15
IV	**Intellectual Property Rights:** patents, copyright, trademark, traditional knowledge; Patent filing process (basic steps), licensing, infringement overview; Research proposal development: objectives, methodology, budget justification, outcomes; Grant writing strategies and structure; National and international funding agencies for environmental research	15

Suggested Readings

1. Kothari, C. R., & Garg, G. (2019). Research methodology: Methods and techniques (4th ed.). New Age International Publishers.
2. Montgomery, D. C., & Runger, G. C. (2014). Applied statistics and probability for engineers (6th ed.). Wiley.
3. Sokal, R. R., & Rohlf, F. J. (2012). Biometry: The principles and practice of statistics in biological research (4th ed.). W.H. Freeman.

Sir Stefani bkum on-line. Vinayakthi 16/6/25 16/6/25

4. Glanzel, W. (2013). Bibliometrics as a research field: A course on theory and application of bibliometric indicators. Springer.
5. World Intellectual Property Organization. (2020). WIPO intellectual property handbook (2nd ed.). WIPO.
6. Das, H. K. (2018). Biostatistics and research methodology. Jaypee Brothers Medical Publishers.

Sm Stfam bkum on-line. Vinayakathi 16/6/25 MP 16/6/25

Program/Class: M.Sc.	Year: Second	Semester: Fourth
	Subject: Environmental Studies	
Course Code: 2151002	Course Title: Environmental Biotechnology	

Course outcome:

- CO1: Explain the principles and applications of bioremediation, biodegradation, and phytoremediation.
- CO2: Analyze the role of microorganisms and plants in the transformation and detoxification of environmental pollutants.
- CO3: Evaluate biotechnological approaches for managing environmental contaminants and resource recovery.
- CO4: Apply environmental microbiology and toxicology concepts to real-world pollution control and ecosystem restoration.

Credits: 4	Core Compulsory	
Max. Marks: 25+75	Min. Passing Marks: 40	

Unit	Topics	No. of Lectures
I	**Bioremediation concepts:** Principles, planning, and management of bioremediation; **In situ and ex situ approaches:** constraints and prioritization in bioremediation projects; Evaluation methodologies for bioremediation effectiveness; Role of biotechnology in resource conservation and management; **Bioenergy and resource recovery:** Biogas and biofuel generation; Microbial applications in mineral extraction and energy recovery; **Biofertilizer technology:** Production and application; *Azolla*, *Spirulina*, PGPR, AMF; Fermentation technology	15
II	**Biodegradation processes:** Factors influencing biodegradation efficiency; Techniques for determining biodegradability; Contaminant availability for microbial degradation; Bioremediation of volatile organic compounds (VOCs); **Microbial and plant-assisted remediation:** Bio-stimulation and bioaugmentation strategies; Phytoremediation of xenobiotics; Bioaccumulation of metals using plants; Composting and vermicomposting.	15
III	**Degradation of organic pollutants:** Petroleum hydrocarbons and associated heavy metals; Halogenated hydrocarbons; Polycyclic aromatic hydrocarbons (PAHs); Pesticides and detergents; **Biosorption and microbial interactions:** Biosorption mechanisms in heavy metal removal; Oil field microbiology and hydrocarbon degradation; Microbial strategies in improved oil recovery and oil spill mitigation	15
IV	**Xenobiotics and biotransformation:** Persistence and biomagnification; Microbial interactions with xenobiotic compounds; Phase I and II reactions; Cytochrome P450-mediated pathways; Biotransformation using bacteria, fungi, and plants; **Toxicology:** Absorption, distribution, excretion of toxic substances; Acute vs. chronic toxicity, LD50, LC50, and bioassays; Threshold limit value, and margin of safety, and therapeutic index; Major waterborne diseases and airborne microbial contaminants	15

Suggested Readings

On-line. 16/6/25 16/6/25

1. Evano, G. H., & Furlong, J. C. (2004). Environmental biotechnology: Theory and application. John Wiley & Sons.
2. Jjemba, P. K. (2004). Environmental microbiology: Theory and application. Science Publishers.
3. Pepper, I. L., & Gerba, C. P. (2005). Environmental microbiology: Laboratory manual. Elsevier.
4. Ratledge, C., & Kristiansen, B. (2002). Basic biotechnology (2nd ed.). Cambridge University Press.
5. Rittman, B., & McCarty, P. L. (2000). Environmental biotechnology: Principles and applications (2nd ed.). Tata McGraw-Hill.
6. Rittmann, B. E., & McCarty, P. L. (2001). Environmental biotechnology: Theory and application. McGraw-Hill.

Sir Stefani bkum on line. 16/6/25 16/6/25

Program/Class: M.Sc.	Year: Second	Semester: Fourth
	Subject: Environmental Studies	
Course Code: 2151003	Course Title: Environmental Control Systems and Treatment Technologies	

Course outcome:

- CO1: Demonstrate proficiency in environmental monitoring and pollution-control technologies for air and water systems.
- CO2: Analyze and critique the performance of pollution control devices and treatment systems using relevant parameters and standards.
- CO3: Apply Indian and international regulatory frameworks to assess environmental compliance.
- CO4: Propose optimized, sustainable strategies for pollution prevention and remediation based on scientific principles.

Credits: 4	Core Compulsory	
Max. Marks: 25+75	Min. Passing Marks: 40	

Unit	Topics	No. of Lectures
I	**Air quality monitoring programmes:** scope, objectives, and planning strategies; **Survey design:** sampling frequency, duration, averaging times, and sample size determination; Measurement of ambient air pollutants and stack emissions: basic principles and field instruments; **Particulate matter control devices:** Principles and operation of settling chambers, centrifugal collectors, fabric filters, wet scrubbers, electrostatic precipitators, and cyclones; Selection criteria and performance evaluation of particulate control technologies	15
II	**Techniques for controlling gaseous emissions:** adsorption, absorption, condensation, combustion (including catalytic combustion); Manual and automated air quality monitoring systems; **Control of emissions from mobile sources:** Automobile exhaust characteristics and mitigation strategies; Indian vehicular emission standards and challenges in enforcement; Urban air quality management approaches and recent technological innovations	15
III	**Treatment of surface and groundwater:** unit operations in water treatment plants; Overview of primary, secondary, and advanced water treatment techniques; Chemical and physical water treatment processes: Filtration, Coagulation–Flocculation, Sedimentation; Oxidation–Reduction and Disinfection: Chlorination, ozonation, permanganate, UV; Membrane technologies: reverse osmosis, ultrafiltration, and electrodialysis; Water quality standards (IS/WHO), and modelling of point-source pollution in water bodies	15
IV	**Municipal sewage treatment:** Pre-treatment, primary, secondary, and tertiary methods; Physical, chemical, and biological wastewater treatment processes; Management and treatment of industrial effluents: Sector-specific concerns (without repeating industry-wise sources); Treatment goals and discharge standards; Wastewater reuse, resource recovery, and sustainable discharge practices; Common Effluent Treatment Plants (CETPs): design considerations, economics, and management models	15

on-line. 16/6/25 16/6/25

Suggested Readings

1. Singh, S., Rathinam, K., Gupta, T., & Agarwal, A. K. (Eds.). (2021). Pollution control technologies: Current status and future prospects. Springer.
2. Yerramilli, A. (2020). Air pollution prevention and control technologies (2nd ed.). BS Publications.
3. Rao, C. S. (2021). Environmental pollution control engineering (4th ed.). New Age International.
4. Anjaneyulu, Y. (2002). Textbook of air pollution and control technologies. Allied Publishers.
5. Mohsin, A. H. M. A. M., Hussein Khalaf, F. H., Nasser, A. W. H., & Mahmoud, M. M. M. (2025). Environmental engineering and pollution control technologies: Principles, applications, and innovations. Bright Sky Publications.
6. Richa, Gadgil, A. D., Das, A., Ashokkumar, P., Munjal, N., & Periasamy, J. K. (2024). Advancements in filtration technologies for air and water pollution control. In Environmental applications of carbon-based materials (pp. 1–29). IGI Global.
7. Shahul, A. (2023). Heavy metal: How a global corporation poisoned Kodaikanal. Pan Macmillan India.

Sm Sifani bkum on-line. Vinayakthi 16/6/25 mf 16/6/25

Program/Class: M.Sc.	Year: Second	Semester: Fourth
Subject: Environmental Studies		
Course Code: 2151065	**Course Title:** Research Project	

Course outcome:

- CO1: Identify a relevant and feasible environmental research problem.
- CO2: Formulate appropriate research objectives, hypotheses, and methodology.
- CO3: Collect, analyze, and interpret primary and/or secondary data.
- CO4: Write a structured scientific report in thesis format and present their findings effectively.

Credits: 4	Core Compulsory	
Max. Marks: 25+75	**Min. Passing Marks:** 40	

Stage	Focus Areas	No. of Contact Hours
I	Orientation, topic selection, problem formulation, literature review	15
II	Research design, methodology finalization, data collection plan	15
III	Data analysis (quantitative/qualitative), interpretation, results drafting	15
IV	Report writing, research paper publication, formatting, bibliography, viva preparation, plagiarism checks	15

Suggested Readings

1. Kothari, C. R., & Garg, G. (2019). Research Methodology: Methods and Techniques (4th ed.). New Age International.
2. Creswell, J. W. (2014). Research Design: Qualitative, Quantitative, and Mixed Methods Approaches (4th ed.). SAGE.
3. Patten, M. L., & Newhart, M. (2018). Understanding Research Methods (10th ed.). Routledge.
4. Walliman, N. (2017). Your Research Project: Designing and Planning Your Work (3rd ed.). SAGE.
5. Environmental research articles from suitable journals such as Environmental Monitoring and Assessment, Journal of Environmental Management, Current Science, Ecological Indicators, etc.

On-line. 16/6/25 16/6/25

Program/Class: M.Sc.	Year: Second	Semester: Fourth
	Subject: Environmental Studies	
Course Code: 2151080	Course Title: Practical – IV	

Course outcome:

- CO1: Analyze environmental datasets using descriptive and inferential statistics, and demonstrate proficiency in statistical software tools such as Excel, SPSS, and OriginPro for interpretation and reporting.
- CO2: Conduct environmental biotechnology experiments to evaluate biodegradability, toxicity, and microbial responses in water and soil systems using biological assays and biofertilizer assessment.
- CO3: Perform laboratory-based environmental chemical analyses including COD, BOD, DO, metal speciation, ozone quantification, and smog simulation to evaluate pollution and toxicity.
- CO4: Compile research-oriented data logbooks and prepare reports aligned with environmental project goals, including hypothesis testing and impact simulations based on EIA protocols.

Credits: 4	Core Compulsory	
Max. Marks: 100	Min. Passing Marks: 40	

Unit	Exercises	Lab Hours
I	1. Collection of data related to environmental parameters from primary and secondary sources. 2. Calculation of mean, mode, median, standard error, and standard deviation using tabulated data. 3. Use of statistical software and its usage for data entry, visualization, and descriptive analysis. 4. Determination of F-value, t-value, and one-way analysis of variance using appropriate statistical tools. 5. Calculation of r value for correlation analysis between two environmental variables. 6. Null hypothesis and Chi-square test for categorical data interpretation. 7. Basic tools of statistical analysis: Excel, SPSS, OriginPro etc. for computation and report preparation.	15
II	1. To determine the biodegradability of wastewater samples using aquatic macrophyte species. 2. To evaluate the biosorption capacity of plant biomass for color and turbidity removal of wastewater sample. 3. To determine the acute toxicity of a given wastewater on aquatic plant *Lemna* sp. 4. To demonstrate anaerobic digestion and estimate methane production from kitchen/agricultural waste. 5. To estimate microbial biomass carbon and dehydrogenase activity in polluted vs. unpolluted soils. To prepare biofertilizer using composted agricultural waste and assess NPK nutrient content.	15

III	1. Determination of carbonate and bicarbonate alkalinity in water samples. 2. Redox titration to estimate chemical oxygen demand (COD) in a sample. 3. Simulation of photochemical smog formation using model chemical systems in lab. 4. Quantitative estimation of ozone in ambient air using the indigo method. 5. Speciation study of heavy metals using complexometric titration. 6. Measurement of BOD and DO in different water samples (river, groundwater, treated water). 7. Toxicity assay of common pesticide using seed germination test. 8. Comparative study on bioaccumulation tendency of metals using model systems (e.g., Lemna bioassay).	15
IV	1. To prepare data logbook in accordance with research project assigned by instructor/supervisor	15

Suggested Readings

1. Zar, J. H. (2010). Biostatistical analysis (5th ed.). Pearson.
2. Lind, D. A., Marchal, W. G., & Wathen, S. A. (2021). Statistical techniques in business and economics (18th ed.). McGraw-Hill.
3. Pepper, I. L., Gerba, C. P., & Gentry, T. J. (2014). Environmental microbiology (3rd ed.). Academic Press.
4. Bitton, G. (2014). Wastewater microbiology (4th ed.). Wiley-Blackwell.
5. Sawyer, C. N., McCarty, P. L., & Parkin, G. F. (2003). Chemistry for environmental engineering and science (5th ed.). McGraw-Hill.
6. Clesceri, L. S., Greenberg, A. E., & Eaton, A. D. (Eds.). (1998). Standard methods for the examination of water and wastewater (20th ed.). American Public Health Association.
7. Prasad, M. N. V. (2004). Heavy metal stress in plants: From biomolecules to ecosystems (2nd ed.). Springer.
8. Prajapati, R. K., & Tripathi, B. D. (2008). Environmental pollutants and their biodegradation. APH Publishing.

Smv Sifani bkum on-line. Vinayakathi 16/6/25 mf 16/6/25

Faculty	Category / Course Type	Title of Course(s) that can be studied online	Credits	Duration (weeks)	Certificate	Instructor(s)	Platform / Coordinator
Science	Skill Enhancement Course	Environmental Studies (core module)	2	12	Yes	Prof. Orus Ilyas & Dr. Sharad Kumar	CEC-SWAYAM
Science	Skill Enhancement Course	Environmental Core: ecosystem, energy, pollution	2	12	Yes	–	CEC-SWAYAM
Science	Skill Enhancement Course	Environmental Science – interdisciplinary	3	12	Yes	Prof. Sudha Goel & Prof. Shamik Chowdhury	NPTEL
Science	Skill Enhancement Course	Environment & Development (ethics, policy, community)	3	12	Yes	Prof. Ngamjahao Kipgen	NPTEL
Science	Skill Enhancement Course	Environmental Pollution & Human Health	4	12	Yes	Dr. Javid A Parray	CEC-SWAYAM
Science	Skill Enhancement Course	Environmental Sustainability & Law	2	8	Yes	–	SWAYAM-IGNOU
Science	Skill Enhancement Course	Marine Litter & Nature-based Solutions	1–2 (self-paced)	~10–30	Yes	UNEP instructors	edX/UNEP
Science	Skill Enhancement Course	Environmental Economics / Pollution Control	3	12	Yes	Faculties from Tumkur Univ. / IIT KGP	CEC-SWAYAM / NPTEL

Notes:

Sw Shami bkum on-line. Uinayakthi 16/6/25 16/6/25

- Credits reflect typical SWAYAM/NPTEL modules (2–4 credit points for 8–12 weeks).
- Platforms include CEC-SWAYAM, NPTEL, IGNOU, and global MOOC providers.
- Diagnosis of real-time certificate issuance ensures academic recognition and skill validation.