RANI RASHMONI GREEN UNIVERSITY

NOTIFICATION

It is hereby notified for the information of all concerned that the Hon'ble Vice-Chancellor, on 25th August 2025, has been pleased to approve the Syllabus of the Two-Year (Four-Semester) M.Sc. Programme in Environmental Science of the University. The syllabus was duly finalized by the experts of the Syllabus Committee, as incorporated in the accompanying pamphlet.

This syllabus shall come into effect from the Academic Session 2025–2026.

By order of the Hon'ble Vice-Chancellor

[Prof. Amiya Kumar Panda]
Hon'ble Vice-Chancellor

Rani Rashmoni Green University

Tarakeswar, Hooghly-712409

The 25th August, 2025

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RANI RASHMONI GREEN UNIVERSITY
TARAKESWAR, HOOGHLY

Syllabus
of
Master of Science (M.Sc.)
in
Environmental Science

Under Semester System
Course Duration: 2 years, 4 Semesters
[W.e.f. : 2025-2026]

Programme Structure: Papers in Environmental Science

Semester	Course Code	Course Title	Full Marks	Credit	Lecture Hours
I	GE-100	Environment Studies	50	4	40
	EVS-101	Ecosystems and Ecology	50	4	40
	EVS-102	Environmental Geology	50	4	40
	EVS-103	Biodiversity and Conservation	50	4	40
	EVS-104	Hydrology, Water Resources and Management	50	4	40
	EVS-105	Environmental Chemistry (Practical)	50	4	40
	Total		**300**	**24**	**240**
II	EVS-201	Environment, Ecology, and Sustainable Development (Generic Elective – Environment)	50	4	40
	EVS-202	Marine Environment	50	4	40
	EVS-203	Energy and Environment	50	4	40
	EVS-204	Atmospheric Processes	50	4	40
	EVS-205	Pollution and Its Management	50	4	40
	EVS-206	RS, GIS and GNSS (Practical)	50	4	40
	Total		**300**	**24**	**240**
III	EVS-301	Environmental Pollution, Chemistry, and Management (Generic Elective – Environment)	50	4	40
	EVS-302	Environmental Microbiology and Biotechnology	50	4	40
	EVS-303	Solid and Hazardous Waste Management	50	4	40
	EVS-304	Environmental Management, Law and Policies	50	4	40
	EVS-305	Statistical Applications in Environmental Sciences	50	4	40
	EVS-306	Advanced Environmental Monitoring & Analytical Techniques (Practical)	50	4	40
	Total		**300**	**24**	**240**
IV	EVS-401	Environmental Chemistry	50	4	40
	EVS-402	Molecular Biology and Immunology for Environmental Science	50	4	40
	EVS-403A	Environmental Hydrology (Special Paper – Theory)	50	4	40
	EVS-404A	Hydrological Techniques & Watershed Analytics (Special Paper – Practical)	50	4	40
	EVS-405	Dissertation	50	4	80
	EVS-406	Field Report/ Internship	50	4	80
	Total		**300**	**24**	**320**
Grand Total			**1200**	**96**	**1040**

GE: **Compulsory paper**

EVS: **Environmental Science**

CBCS: **Generic Elective**

Note: Written - 40 Marks and Internal Assessment -10 Marks (For Theory papers)

Overview: Marks and Credit Distribution

Semester	Paper type	No. of papers	Marks	Credit	Total marks	Total credit
I	Theory	5	250	20	300	24
	Practical	1	50	4		
II	Theory	5	250	20	300	24
	Practical	1	50	4		
III	Theory	5	250	20	300	24
	Practical	1	50	4		
IV	Theory	3	150	12	300	24
	Practical/Dissertation/Internship	3	150	12		
Total		**24**	**-**	**-**	**1200**	**96**

Question Pattern for Theory papers

sl.no	Marks of the question	Total number of questions	Questions should be attended	Total Marks
1	2	6	4	8
2	4	6	4	16
3	8	4	2	16
		Total	**10**	**40**

Programme Outcomes (POs): M.Sc. in Environmental Science

Graduates of this programme will be able to:

1. **Holistic Knowledge**: Acquire an integrated understanding of environmental systems (biosphere, hydrosphere, lithosphere, and atmosphere) and their interactions with human society.
2. **Research & Innovation**: Design and execute independent, original research using advanced field, laboratory, and geospatial techniques, contributing to global environmental knowledge.
3. **Analytical Skills**: Apply statistical, computational, and modeling approaches to analyze environmental data and predict future scenarios of climate, resources, and sustainability.
4. **Global & Local Relevance**: Critically evaluate global environmental issues such as climate change, biodiversity loss, and pollution, while formulating context-specific sustainable solutions.
5. **Policy & Governance**: Demonstrate an advanced understanding of environmental policies, governance structures, and legal frameworks at local, national, and international levels.
6. **Ethics & Sustainability**: Integrate environmental ethics, equity, and sustainable development principles in scientific research, professional practice, and community engagement.
7. **Professional Competency**: Develop skills for careers in academia, environmental consultancy, NGOs, industries, and government organizations, with leadership potential in sustainability transitions.
8. **Communication & Lifelong Learning**: Communicate scientific knowledge effectively across disciplines and continue lifelong learning in response to emerging global environmental challenges.

Semester-I: Syllabus

Paper	Course/Unit	Marks	Lecture Hours	Credit Point
GE-100	Fundamentals of Environment	50	40	4
Unit I	Introduction to Environment			
Unit II	Natural Resources and their Management			
Unit III	Environmental Degradation			
Unit IV	Environmentalism			
Unit V	Environmental Governance			
Unit-VI	Green Campus Initiative			
EVS-101	Ecosystems and Ecology	50	40	4
Unit I	Fundamentals of Ecology			
Unit II	Ecosystem Structure and Function			
Unit III	Population, Community, Ecosystem Diversity			
Unit IV	Biomes and Applied Ecosystem Studies			
Unit V	Human Impact, Ecological Restoration, and Sustainability			
EVS-102	Environmental Geology	50	40	4
Unit I	Fundamentals of Environmental Geology			
Unit II	Geological Processes and Earth Materials			
Unit III	Natural Hazards and Disaster Management			
Unit IV	Environmental Impact of Geological Resources			
Unit V	Applied Environmental Geology and Sustainability			
EVS-103	Biodiversity and Conservation	50	40	4
Unit I	Concepts and Importance of Biodiversity			
Unit II	Biodiversity Assessment and Documentation			
Unit III	Threats to Biodiversity and Extinction			
Unit IV	Conservation Strategies and Approaches			
Unit V	Biodiversity Governance and Global Initiatives			
EVS-104	Hydrology, Water Resources and Management	50	40	4
Unit I	Fundamentals of Water Resources			
Unit II	Assessment and Monitoring of Water Resources			
Unit III	Fundamentals of Hydrology and Water Pollution			
Unit IV	Water Resource Management and Conservation			
Unit V	Policies, Governance, and Global Perspectives			
EVS-105 (Practical)	Environmental Chemistry	50	40	4
Unit I	Gravimetric and Volumetric Analysis			
Unit II	Instrumental Techniques – Spectrophotometry and Colorimetry			
Unit III	Chromatography and Electrochemical Methods			
Unit IV	Environmental Sample Analysis and Data Handling			
Unit V	Laboratory Notebook and Viva Voice			
Total		300	240	**24**

Course Outcomes (COs): Semester I

Sl. No.	Paper Code	Paper Name	Course Outcomes (COs)
1	GE-100	Fundamentals of Environment	Students will understand foundational concepts of environment and sustainability, critically assess natural resource utilization, and evaluate human impacts on Earth systems.
2	EVS-101	Ecosystems and Ecology	Students will analyze ecosystem structures and functions, quantify energy flow and biogeochemical cycles, and evaluate biodiversity conservation strategies.
3	EVS-102	Environmental Geology	Students will assess geological processes, natural hazards, and earth resources, applying geological knowledge to environmental management and disaster risk reduction.
4	EVS-103	Biodiversity and Conservation	Students will evaluate global and regional biodiversity patterns, threats, and policies, applying conservation strategies aligned with UN Sustainable Development Goals.
5	EVS-104	Hydrology, Water Resources and Management	Students will demonstrate understanding of hydrological processes, water resource management, and watershed dynamics, applying modern hydrological models.
6	EVS-105	Environmental Chemistry (Practical)	Students will acquire laboratory skills for analyzing air, water, and soil chemistry; learn pollutant detection; and apply analytical tools to assess environmental quality.

Semester-II: Syllabus

Paper	Course/Unit	Marks	Lecture Hours	Credit Point
EVS-202	Marine Environment	50	40	4
Unit I	Introduction to Marine Environmental Science			
Unit II	Marine Ecosystems and Biodiversity			
Unit III	Ocean-Atmosphere Interactions and Climate Regulation			
Unit IV	Marine Pollution and Environmental Degradation			
Unit V	Marine Governance, Policies, and Sustainable Use			
EVS-203	Energy and Environment	50	40	4
Unit I	Fundamentals of Energy and Environment			
Unit II	Non-Renewable Energy Sources and Their Impacts			
Unit III	Renewable and Alternate Energy Systems			
Unit IV	Sustainable Energy Management and Technologies			
Unit V	Energy Policy, Planning, and Global Initiatives			
EVS-204	Atmospheric Processes	50	40	4
Unit I	Structure and Composition of the Atmosphere			
Unit II	Solar Radiation and Energy Balance			
Unit III	Atmospheric Dynamics and Circulation			
Unit IV	Weather Systems and Climate Patterns			
Unit V	Atmospheric Chemistry and Human Impacts			
EVS-205	Pollution and Its Management	50	40	4
Unit I	Introduction to Environmental Pollution			
Unit II	Air Pollution and Control			
Unit III	Water and Soil Pollution			
Unit IV	Noise, Thermal, and Radiation Pollution			
Unit V	Emerging Contaminants and Pollution Management			
EVS-206 (Practical)	Remote Sensing, GIS and GNSS	50	40	4
Unit I	Principles of Remote Sensing			
Unit II	Techniques in Remote Sensing			
Unit III	Principles of Geographical Information System			
Unit IV	Techniques in Geographical Information System			
Unit V	Global Navigation Satellite System– Principles and Techniques			
EVS-201	**Environment, Ecology, and Sustainable Development**	50	40	4
Unit I	Fundamentals of Environment and Ecology			
Unit II	Biodiversity and Conservation			
Unit III	Environmental Geology and Natural Hazards			
Unit IV	Atmospheric Processes and Climate Change			
Unit V	Sustainable Resource and Energy Management			
Total		**300**	**240**	**24**

Course Outcomes (COs): Semester II

Sl. No.	Paper Code	Paper Name	Course Outcomes (COs)
1	EVS-201	Environment, Ecology, and Sustainable Development	Students from other disciplines will gain interdisciplinary knowledge of environment and sustainability, fostering cross-domain research and awareness.
2	EVS-202	Marine Environment	Students will understand oceanographic processes, marine biodiversity, and human impacts on oceans, with emphasis on blue economy and coastal sustainability.
3	EVS-203	Energy and Environment	Students will evaluate renewable and non-renewable energy resources, analyze energy–environment linkages, and propose sustainable energy solutions.
4	EVS-204	Atmospheric Processes	Students will study weather systems, atmospheric circulation, and climate dynamics, with applications to climate change research and forecasting.
5	EVS-205	Pollution and Its Management	Students will critically analyze air, water, and soil pollution, explore control technologies, and evaluate policies for pollution management.
6	EVS-206	RS, GIS and GNSS (Practical)	Students will develop technical expertise in remote sensing, GIS, and GNSS for environmental mapping, modeling, and decision support.

Semester-III: Syllabus

Paper	Course/Unit	Marks	Lecture Hours	Credit Point
EVS-302	Environmental Microbiology & Biotechnology	50	40	4
Unit I	Fundamentals of Environmental Microbiology			
Unit II	Microbial Processes and Environmental Applications			
Unit III	Environmental Biotechnology – Principles and Tools			
Unit IV	Applied Environmental Biotechnology			
Unit V	Microbial Risk, Regulation, and Sustainable Use			
EVS-303	Solid and Hazardous Waste Management	50	40	4
Unit I	Introduction to Waste Management			
Unit II	Solid Waste: Sources, Composition, and Disposal Methods			
Unit III	Hazardous Waste Management			
Unit IV	Waste Minimization and Recycling Technologies			
Unit V	Global Waste Management Practices and Policies			
EVS-304	Environmental Management, Law and Policies	50	40	4
Unit I	Foundations of Environmental Management			
Unit II	Natural Resource and Disaster Risk Management			
Unit III	Environmental Laws and Regulatory Frameworks – National			
Unit IV	International Environmental Law and Agreements			
Unit V	Environmental Policy and Governance			
EVS-305	Statistical Applications in Environmental Sciences	50	40	4
Unit I	Univariate Statistical Analysis			
Unit II	Bivariate Statistical Analysis			
Unit III	Multivariate Statistical Analysis and Spatial Statistics			
Unit IV	Inferential Statistics			
EVS-306 (Practical)	Advanced Environmental Monitoring & Analytical Techniques	50	40	4
Unit I	Geo-Spatial and Geological Data Interpretation			
Unit II	Climate, Air Quality, and Environmental Monitoring			
Unit III	Environmental Quality and Biogeochemical Assessments			
Unit IV	Microbial, Biotechnological, and Ecological Techniques			
Unit V	Viva Voice and Laboratory Note book			
EVS-301	Environmental Pollution, Chemistry, and Management	50	40	4
Unit I	Understanding the Environment			
Unit II	Pollution and Control Technologies			
Unit III	Environmental Chemistry and Microbiology			
Unit IV	Environmental Data and Statistical Tools			
Unit V	Environmental Management, Law, and Governance			
Total		**300**	**240**	**24**

Course Outcomes (COs): Semester III

Sl. No.	Paper Code	Paper Name	Course Outcomes (COs)
1	EVS-301	Environmental Pollution, Chemistry, and Management	Interdisciplinary learners will apply environmental principles to their fields, promoting collaborative problem-solving for sustainability.
2	EVS-302	Environmental Microbiology and Biotechnology	Students will investigate microbial diversity, biotechnology applications, and bio-remediation techniques for sustainable resource management.
3	EVS-303	Solid and Hazardous Waste Management	Students will evaluate waste generation, disposal technologies, and circular economy models for sustainable waste management.
4	EVS-304	Environmental Management, Law and Policies	Students will understand environmental governance, international treaties, and policy instruments, applying them to real-world case studies.
5	EVS-305	Statistical Applications in Environmental Sciences	Students will apply statistical tools and models for environmental data analysis, hypothesis testing, and predictive modeling.
6	EVS-306	Advanced Environmental Monitoring & Analytical Techniques (Practical)	Students will gain advanced laboratory and field monitoring skills, including instrumentation, sampling design, and data interpretation.

Semester-IV: Syllabus

Paper	Course/Unit	Marks	Lecture Hours	Credit Point
EVS-401	Environmental Chemistry	50	40	4
Unit I	Fundamentals of Environmental Chemistry			
Unit II	Chemistry of Air and Atmospheric Reactions			
Unit III	Aquatic Chemistry and Water Pollution			
Unit IV	Soil and Sediment Chemistry			
Unit V	Environmental Analytical Chemistry and Toxicology			
EVS-402	Molecular Biology & Immunology for Environmental Science	50	40	4
Unit I	Fundamentals of Molecular Biology			
Unit II	Molecular Techniques in Environmental Analysis			
Unit III	Principles of Immunology			
Unit IV	Disease Ecology and Disease Biology			
Unit V	Environmental Biotechnology, Epidemiology and Public Health			
EVS-403A (Special Paper)	Environmental Hydrology (Theory)	50	40	4
Unit I	Advanced Hydrological Processes and Measurement Techniques			
Unit II	Surface and Subsurface Water Systems			
Unit III	Hydrological Hazards and Environmental Risk Management			
Unit IV	Water Quality, Monitoring, and Emerging Technologies			
Unit V	Water Governance, Policy, and Global Sustainability			
EVS-404A (Special Paper)	Hydrological Techniques & Watershed Analytics (Practical)	50	40	4
Unit I	**Advanced Field Methods**			
Unit II	**Hydrochemical Laboratory Techniques**			
Unit III	**Spatial and Modeling Applications**			
Unit IV	**Research Projects and Analytical Reporting**			
EVS-405	Dissertation / Internship	50	80	4
EVS-406	Field Report	50	80	4
Total		**300**	**320**	**24**

Course Outcomes (COs): Semester IV

Sl. No.	Paper Code	Paper Name	Course Outcomes (COs)
1	EVS-401	Environmental Chemistry	Students will integrate chemical principles with environmental processes, analyzing contaminant behavior, cycles, and mitigation strategies.
2	EVS-402	Molecular Biology and Immunology for Environmental Science	Students will apply molecular biology and immunological techniques in environmental research, including DNA analysis and biomonitoring.
3	EVS-403A	Environmental Hydrology (Special Paper – Theory)	Students will analyze hydrological processes, groundwater dynamics, and hydrological modeling for sustainable water resource planning.
4	EVS-404A	Hydrological Techniques & Watershed Analytics (Special Paper – Practical)	Students will apply hydrological field and computational techniques, watershed modeling, and GIS-based hydrological analysis.
5	EVS-405A	Dissertation / Internship	Students will independently design and execute a research project or professional internship, applying theoretical knowledge to practical challenges.
6	EVS-405B	Field Report	Students will conduct field investigations, synthesize observations into structured reports, and critically interpret environmental case studies.

Contents

SEMESTER I

GE-100: FUNDAMENTALS OF ENVIRONMENT (Theoretical- 50 marks/4 credits)

Unit 1: Introduction to Environment

1.1. Definition, Scope, and Importance of Environment

1.2. Multidisciplinary Nature of Environment

1.3. Man-Environment Relationship: Past and Present

1.4. Components of the Environment: Atmosphere, Hydrosphere, Lithosphere, and Biosphere

Unit 2: Natural Resources and their Management

2.1. Types of Natural Resources: Renewable and Non-Renewable

2.2. Land and Soil Resources: Degradation, Desertification, and Conservation

2.3. Water Resources: Freshwater Crisis, Groundwater Depletion, and Sustainable Use

2.4. Forest and Wildlife Resources: Deforestation, Afforestation, and Wildlife Protection

Unit 3: Environmental Degradation

3.1. Types of Pollution: Air, Water, Soil, and Noise Pollution

3.2. Major Pollutants and Their Effects on Human Health and Ecosystems

3.3. Waste Management: Solid Waste, Hazardous Waste, and Plastic Pollution

3.4. Urbanization and Its Environmental Impact

Unit 4: Environmentalism

4.1. Definition, dimensions, and types of Environmentalism.

4.2. Environmental ethics and its types: Anthropocentric, Biocentric, and Eco-centric ethics.

4.3. Sustainable Development Goals (SDGs) and their 17 global goals set.

4.4. Millennium Development Goals (MDGs) and their 8 global goals set.

Unit 5: Environmental Governance

5.1. Environmental Protection Act (1986), Water Act (1974), and Air Act (1981)

5.2. National Biodiversity Action Plan and Wildlife Protection Act (1972)

5.3. International Agreements: Paris Agreement, Kyoto Protocol, Montreal Protocol, and Rio Summit.

5.4. Role of Government, NGOs, and Citizens in Environmental Governance

6. Green Campus Initiative

EVS-101: ECOSYSTEMS AND ECOLOGY (Theoretical- 50 marks/4 credits)

Unit 1: Fundamentals of Ecology

1.1. Definition, Scope, and Relevance of Ecology
1.2. Autecology and Synecology: Concepts and Applications
1.3. Levels of Ecological Organization: Individual to Biosphere
1.4. Ecological Indicators, Ecological Efficiency, Ecological Footprints

Unit 2: Ecosystem Structure and Function

2.1. Ecosystem: Concept, Types, Components and Functions: Ecological Succession;
2.2. Energy Flow in Ecosystems: Food Chain, Food Web, and Ecological Pyramids
2.3. Biogeochemical Cycles: Carbon, Nitrogen, Phosphorus, and Water
2.4. Primary Productivity, Decomposition,Ecosystem Metabolism, NPP, GPP

Unit 3: Population, Community, Ecosystem Diversity

3.1. Population Ecology: Density, Growth Patterns, and Regulation Mechanisms; Ecological Succession
3.2. Community Ecology: Structure, Stratification, and Succession
3.3. Species Interactions: Competition, Predation, Mutualism, and Parasitism
3.4. Ecosystem diversity: Definition and its global & national status

Unit 4: Biomes and Applied Ecosystem Studies

4.1. Major Terrestrial Biomes: Forests, Grasslands, Deserts, and Tundra
4.2. Freshwater and Marine Biomes: case study (East Kolkata Wetland and Sundarbans Mangrove Ecosystem)
4.3. Ecosystem Services: Classification, Valuation, and Human Dependence

4.4. Conservation and Preservation of Biomes

Unit 5: Human Impact, Ecological Restoration, and Sustainability

5.1. Anthropogenic Impacts: Deforestation, Habitat Loss, Invasive Species, Pollution – land air and water
5.2. Climate Change &Ecology: Causes, Effects, and Ecological Responses
5.3. Ecological Restoration and Sustainable Resource Management
5.4. UN Decade on Ecosystem Restoration

EVS-102: ENVIRONMENTAL GEOLOGY (Theoretical- 50 marks/4 credits)

Unit 1: Fundamentals of Environmental Geology

1.1. Definition, Scope, and Importance of Environmental Geology
1.2. Branches of Geology Relevant to Environmental Studies
1.3. Earth's Internal Structure, Continental Drift Theory, Seafloor Spreading and Plate Tectonics
1.4. Man–Earth Interaction: Geosphere and Environmental Changes

Unit 2: Geological Processes and Earth Materials

2.1. Rocks and Minerals: Types, Formation, and Environmental Significance
2.2. Weathering, Erosion, and Soil Formation
2.3. Geological Time Scale and Stratigraphy
2.4. Surface and Groundwater Geology: Aquifers and Recharge Zones

Unit 3: Natural Hazards and Disaster Management

3.1. Earthquakes: Causes, Effects, and Seismic Zonation; Tsunami: Causes and Consequences
3.2. Volcanoes, Avalanche, GLOF, Landslides and Subsidence: Mechanisms, Risk Zones, and Mitigation
3.3. Floods and Droughts: Geological Perspective and Environmental Impact
3.4. Desert and Desertification;Disaster Risk Reduction (DRR) and Early Warning Systems

Unit 4: Environmental Impact of Geological Resources

4.1. Mineral Resources: Types, Extraction, Environmental Degradation, and Management
4.2. Fossil Fuels: Formation, Uses, and Environmental Consequences; Fuel Geology
4.3. Building Materials: Geological Sources and Ecological Considerations
4.4. Geological Issues in Urban Planning and Infrastructure Development

Unit 5: Applied Environmental Geology and Sustainability

5.1. Geotechnical Investigations for Environmental Planning
5.2. Groundwater Pollution and Remediation Techniques
5.3. Land Subsidence and Coastal Erosion: Causes and Control
5.4. Sustainable Management of Earth Resources and Environmental Ethics

EVS-103: BIODIVERSITY AND CONSERVATION (Theoretical- 50 marks/4 credits)

Unit 1: Concepts and Importance of Biodiversity

1.1. Definition and Scope of Biodiversity: Genetic, Species, and Ecosystem Levels
1.2. Values of Biodiversity: Ecological, Economic, Ethical, and Aesthetic
1.3. Global and Indian Biodiversity: Distribution Patterns and Gradients
1.4. Endemism, Keystone, Flagship, and Indicator Species

Unit 2: Biodiversity Assessment and Documentation

2.1. Biodiversity Inventories and Sampling Methods
2.2. Species Richness, Abundance, and Diversity Indices (Shannon, Simpson)
2.3. Traditional Knowledge and Indigenous Biodiversity Documentation
2.4. Tools and Techniques: Remote Sensing, GIS, DNA Barcoding, and Citizen Science

Unit 3: Threats to Biodiversity and Extinction

3.1. Natural and Anthropogenic Threats: Habitat Loss, Fragmentation, Pollution
3.2. Invasive Alien Species and Their Impact on Native Ecosystems
3.3. Climate Change and Biodiversity: Range Shifts, Coral Bleaching, Phenological Mismatches
3.4. Mass Extinctions: Past Events and Current Biodiversity Crisis (Sixth Extinction)

Unit 4: Conservation Strategies and Approaches

4.1. In-situ Conservation: Protected Areas, National Parks, Wildlife Sanctuaries, Biosphere Reserves
4.2. Ex-situ Conservation: Botanical Gardens, Zoos, Gene Banks, Seed Banks, Cryopreservation
4.3. Community-Based Conservation: Sacred Groves, Joint Forest Management, CBNRM
4.4. Role of Biocultural Diversity and Ecological Restoration in Conservation

Unit 5: Biodiversity Governance and Global Initiatives

5.1. International Conventions: CBD, Cartagena Protocol, Nagoya Protocol, CITES, Ramsar
5.2. National Biodiversity Strategies: Biodiversity Act (2002), NBA, SBBs, BMCs
5.3. Global Biodiversity Outlook, IPBES Reports, and SDG 15 (Life on Land)
5.4. Role of NGOs, Local Communities, Youth, and Citizen Science in Biodiversity Conservation

EVS-104: HYDROLOGY, WATER RESOURCES AND MANAGEMENT (Theoretical- 50 marks/4 credits)

Unit 1: Fundamentals of Water Resources

1.1. Hydrological Cycle and Global Water Budget
1.2. Surface and Groundwater Resources: Rivers, Lakes, Aquifers, Wetlands
1.3. Freshwater Availability: Global, Regional, and Indian Context
1.4. Water Demand across Sectors: Agriculture, Industry, Domestic, and Ecology

Unit 2: Assessment and Monitoring of Water Resources

2.1. Techniques for Water Resource Assessment: Hydrometry and Remote Sensing
2.2. Water Quality Parameters and Standards (WHO, BIS, CPCB)
2.3. Groundwater Monitoring and Aquifer Mapping Techniques
2.4. Water Budgeting, Watershed Delineation, and Modelling Tools (e.g., SWAT, WEAP)

Unit 3: Fundamentals of Hydrology and Water Pollution

3.1. Introduction to Hydrology: Scope and Content of Hydrology,Importance of Hydrology in Environmental Science, Role of Hydrology in Sustainable Development and Climate Resilience
3.2. Surface and Soil Water Processes: Infiltration, Runoff, Evaporation, Transpiration, Evapotranspiration and Soil moisture
3.3. Groundwater: Groundwater Occurrence and Movement (Aquifers, Water Table), Groundwater recharge and discharge processes, Human impacts on groundwater
3.4. Eutrophication, Salinization, and Arsenic/Fluoride Contamination

Unit 4: Water Resource Management and Conservation

4.1. Watershed Management: Principles, Practices, and Case Studies
4.2. Rainwater Harvesting, Groundwater Recharge, and Traditional Water Systems
4.3. Integrated Water Resource Management (IWRM): Concepts and Implementation
4.4. Urban Water Management: Smart Cities, Water-Sensitive Urban Design (WSUD)

Unit 5: Policies, Governance, and Global Perspectives

5.1. National Water Policy (2012) and River Basin Management in India
5.2. International Treaties and Frameworks: Helsinki Rules, UNECE Water Convention, SDG 6
5.3. Role of Institutions: Central Water Commission (CWC), CGWB, Jal Shakti Abhiyan
5.4. Community Participation, NGOs, and Gender in Water Governance

EVS-105: ENVIRONMENTAL CHEMISTRY (Practical- 50 marks/4 credits)

Unit 1: Gravimetric and Volumetric Analysis

1.1. Estimation of Sulphate as $BaSO_4$ by Gravimetric Method
1.2. Determination of Hardness of Water by EDTA Titration
1.3. Estimation of Chloride by Argentometric Titration (Mohr's Method)
1.4. Estimation of Total Alkalinity and Acidity of Water
1.5. Standardization of $KMnO_4$ and Estimation of Iron (Fe^{2+}) in Solution

Unit 2: Instrumental Techniques – Spectrophotometry and Colorimetry

2.1. Preparation of Calibration Curve using UV-Vis Spectrophotometer
2.2. Estimation of Phosphate or Nitrate in Water Samples Using Spectrophotometry
2.3. Colorimetric Determination of Heavy Metals (e.g., Chromium or Lead)
2.4. Estimation of Chemical Oxygen Demand (COD) using Colorimetric Method
2.5. Verification of Beer-Lambert Law Using Standard Dyes

Unit 3: Chromatography and Electrochemical Methods

3.1. Paper Chromatography: Separation of Amino Acids or Plant Pigments
3.2. Thin Layer Chromatography (TLC): Identification of Organic Pollutants
3.3. Demonstration of Column Chromatography: Separation of Dye Mixtures
3.4. pH Measurement and Buffer Preparation
3.5. Conductometric Titration of Strong Acid vs. Strong Base

Unit 4: Environmental Sample Analysis and Data Handling

4.1. Analysis of Ambient Air Quality (SO_2/NO_2) using Field Kits or Lab Setup
4.2. Analysis of Fluoride or Arsenic in Water using Colorimetric Kits
4.3. Estimation of Total Dissolved Solids (TDS), Electrical Conductivity, and Turbidity
4.4. Quality Control in Analytical Chemistry: Blanks, Standards,Detection limit, Duplicates
4.5. Field Sampling, Sample Preservation, and Report Writing Techniques

Unit 5: Laboratory Notebook and Viva Voice

SEMESTER II

EVS-201: Environment, Ecology, and Sustainable Development (Theoretical- 50 marks/4 credits)

UNIT 1: Fundamentals of Environment and Ecology

1.1. Concept and Scope of Environmental Science and Ecology
1.2. Components of Environment: Biotic and Abiotic; Levels of Ecological Organization
1.3. Energy Flow in Ecosystems: Food Chains, Food Webs, and Pyramids
1.4. Ecosystem Services and Human-Nature Interactions

UNIT 2: Biodiversity and Conservation

2.1. Definition and Levels of Biodiversity: Genetic, Species, and Ecosystem
2.2. Values of Biodiversity and Major Threats (Habitat Loss, Invasive Species, Pollution)
2.3. Conservation Approaches: In-situ and Ex-situ, Role of Communities and TEK
2.4. Global and National Biodiversity Frameworks (CBD, CITES, NBA)

UNIT 3: Environmental Geology and Natural Hazards

3.1. Earth Systems and Resources: Rocks, Minerals, and Soil
3.2. Natural Hazards: Earthquakes, Volcanoes, Floods, Landslides, Tropical Cyclones
3.3. Groundwater and Surface Water Geology; Aquifer Basics
3.4. Resource Extraction and Environmental Impacts (Mining, Fossil Fuels)

UNIT 4: Atmospheric Processes and Climate Change

4.1. Structure and Composition of the Atmosphere; Weather vs. Climate
4.2. Greenhouse Effect, Global Warming, and Climate Feedbacks
4.3. Climate Variability: ENSO, Monsoon, Indian Ocean Dipole
4.4. Air Pollution, Ozone Depletion, and International Agreements (Montreal, Paris)

UNIT 5: Sustainable Resource and Energy Management

5.1. Water Resources: Distribution, Scarcity, and Pollution Issues
5.2. Renewable and Non-renewable Energy: Sources, Use, and Environmental Impact
5.3. Sustainable Development, SDGs, and Environmental Ethics
5.4. Role of Policy, Community Participation, and Technological Interventions

EVS-202: MARINE ENVIRONMENT (Theoretical- 50 marks/4 credits)

Unit 1: Introduction to Marine Environmental Science

1.1. Scope, Evolution, and Importance of Marine Environmental Science

1.2. Properties and Composition of Seawater: Physical, Chemical, and Biological Aspects

1.3. Marine Provinces: Continental Shelf, Slope, Abyssal Plains, Trenches

1.4. Interdisciplinary Nature: Oceanography, Marine Ecology, Climate Science, and Policy

Unit 2: Marine Ecosystems and Biodiversity

2.1. Major Marine Ecosystems: Coral Reefs, Mangroves, Estuaries, Seagrass Beds, Deep Sea

2.2. Marine Biodiversity: Patterns, Hotspots, Endemism, and Ecosystem Services

2.3. Trophic Dynamics: Marine Food Chains and Webs, Ocean Productivity

2.4. Threatened Species and Marine Biodiversity Conservation

Unit 3: Ocean-Atmosphere Interactions and Climate Regulation

3.1. Ocean Circulation: Surface Currents, Thermohaline Circulation, and Upwelling

3.2. Ocean-Climate Linkages: ENSO, Monsoons, Ocean Acidification

3.3. Oceans and Carbon Cycling: Carbon Sinks, Biological Pump, Blue Carbon

3.4. Role of Oceans in Global Climate Change and IPCC Assessments

Unit 4: Marine Pollution and Environmental Degradation

4.1. Sources of Marine Pollution: Oil Spills, Plastic Debris, Nutrient Runoff, Noise, Ballast Water

4.2. Bioaccumulation, Biomagnification, and Ecotoxicology in Marine Systems

4.3. Dead Zones, Coral Bleaching, Ocean Eutrophication

4.4. Monitoring and Modeling Marine Pollution: Remote Sensing, Sensors, and Indicators

Unit 5: Marine Governance, Policies, and Sustainable Use

5.1. UNCLOS, MARPOL, and Other Global Conventions

5.2. Marine Protected Areas (MPAs), Coastal Zone Regulation (CRZ) Rules, Blue Economy

5.3. Integrated Coastal Zone Management (ICZM) and Ecosystem-Based Management

5.4. Role of International Bodies (IMO, UNEP, FAO) and Community-Based Conservation

EVS-203: ENERGY AND ENVIRONMENT (Theoretical- 50 marks/4 credits)

Unit 1: Fundamentals of Energy and Environment

1.1. Definition and Forms of Energy: Kinetic, Potential, Thermal, Chemical, Electrical
1.2. Energy Units and Conversions; Energy Demand and Consumption Patterns (Global & Indian Context)
1.3. Relationship between Energy Production, Use, and Environmental Degradation
1.4. Concept of Energy Efficiency, Energy Intensity, and Energy Return on Investment (EROI)

Unit 2: Non-Renewable Energy Sources and Their Impacts

2.1. Coal, Oil, and Natural Gas: Distribution, Reserves, and Mining Techniques
2.2. Thermal and Nuclear Power Generation: Process, Efficiency, and Emissions
2.3. Environmental Impacts: Air and Water Pollution, GHG Emissions, Fly Ash, and Nuclear Waste
2.4. Fossil Fuel Dependency, Energy Crisis, and Resource Depletion Concerns

Unit 3: Renewable and Alternate Energy Systems

3.1. Solar Energy: Photovoltaics, Solar Thermal Systems, CSP Technologies; Solar Pond
3.2. Wind, Hydropower, Tidal Energy and Ocean Thermal Energy: Principles, Potential, and Environmental Trade-offs
3.3. Biomass, Biofuels (1st, 2nd, and 3rd Gen), Biogas, and Waste-to-Energy Technologies
3.4. Hydrogen Energy, Fuel Cells, and Emerging Alternatives (e.g., Geothermal, Tidal)

Unit 4: Sustainable Energy Management and Technologies

4.1. Energy Conservation Strategies in Industry, Transport, Buildings, and Agriculture
4.2. Smart Grid, Net Metering, Decentralized and Off-Grid Energy Systems
4.3. Clean Development Mechanism (CDM), Carbon Footprinting, and Energy Audits
4.4. Lifecycle Assessment (LCA) of Energy Systems and Techno-Economic Feasibility

Unit 5: Energy Policy, Planning, and Global Initiatives

5.1. India's Energy Policy Frameworks: National Energy Policy (NEP), Integrated Energy Policy
5.2. International Energy Agencies and Agreements: IEA, IRENA, UNFCCC, SDG 7
5.3. Renewable Energy Missions in India: National Solar Mission, Wind Mission, Bio-Energy Mission
5.4. Energy Justice, Community Energy, and Role of NGOs and Civil Society in Energy Governance

EVS-204: ATMOSPHERIC PROCESSES (Theoretical- 50 marks/4 credits)

Unit 1: Structure and Composition of the Atmosphere

1.1. Origin and Evolution of the Atmosphere
1.2. Vertical Structure: Troposphere, Stratosphere, Mesosphere, Thermosphere
1.3. Atmospheric Composition: Major and Trace Gases, Aerosols, and Particulate Matter
1.4. Lapse Rate, Stability, and Temperature Inversions; Atmospheric Boundary Layer, Plume Behaviour

Unit 2: Solar Radiation and Energy Balance

2.1. Solar Constant, Albedo, Absorption, and Scattering of Solar Radiation
2.2. Earth's Energy Budget and Radiative Equilibrium
2.3. Heat Transfer Mechanisms: Conduction, Convection, and Radiation
2.4. Greenhouse Effect, Global Warming Potential (GWP), and Radiative Forcing

Unit 3: Atmospheric Dynamics and Circulation

3.1. Atmospheric Pressure Systems: Highs, Lows, and Pressure Gradient Force
3.2. Wind Systems: Geostrophic Wind, Trade Winds, Jet Streams, Monsoons
3.3. Cyclones and Anticyclones: Tropical and Temperate
3.4. General Circulation Models (GCMs) and Global Atmospheric Circulation

Unit 4: Weather Systems and Climate Patterns

4.1. Cloud Formation, Classification, and Precipitation Mechanisms
4.2. Thunderstorms, Tornadoes, and Extreme Weather Events
4.3. Climatic Classifications (Koppen, Thornthwaite) and Global Climatic Zones
4.4. ENSO, La Nina, Indian Ocean Dipole (IOD), and Monsoonal Variability

Unit 5: Atmospheric Chemistry and Human Impacts

5.1. Photochemical Reactions and Atmospheric Chemistry Basics
5.2. Ozone Layer Depletion: Causes, Effects, and Montreal Protocol
5.3. Applied Climatology: Radar and Satellite Meteorology, Application of Remote Sensing in Numerical Weather Prediction, Role of Meteorology in Aviation

5.4. Climate Change:Factors, IPCC Reports, Climate Feedbacks, and Mitigation Pathways

EVS-205: POLLUTION AND ITS MANAGEMENT (Theoretical- 50 marks/4 credits)

Unit 1: Introduction to Environmental Pollution

1.1. Definition, Classification, and Characteristics of Pollutants
1.2. Pathways and Fate of Pollutants in the Environment
1.3. Concept of Threshold Limit Values, Bioaccumulation, and Biomagnification
1.4. Global Pollution Scenarios and Trends (Air, Water, Land, Marine)

Unit 2: Air Pollution and Control

2.1. Types and Sources of Air Pollutants: Particulates, Gases, Aerosols, VOCs
2.2. Atmospheric Dispersion, Inversions, and Air Quality Index (AQI)
2.3. Health Effects: Respiratory, Cardiovascular, and Neurological Impacts
2.4. Air Pollution Control Devices: Scrubbers, Cyclones, ESPs, Filters, and Catalytic Converters

Unit 3: Water and Soil Pollution

3.1. Sources and Types of Water Pollutants: Nutrients, Pathogens, Heavy Metals, Pesticides
3.2. Eutrophication, Groundwater Contamination, and Industrial Effluents
3.3. Soil Pollution: Causes, Indicators, and Soil Quality Parameters
3.4. Treatment and Remediation: STPs, ETPs, Constructed Wetlands, Phytoremediation

Unit 4: Noise, Thermal, and Radiation Pollution

4.1. Noise Pollution: Sources, Measurement (dB scale),Noise indices, Percentile levels and Health Effects
4.2. Thermal Pollution: Sources, Impacts on Aquatic Ecosystems
4.3. Radiation Pollution: Ionizing and Non-ionizing Radiation, Sources, and Health Effects
4.4. Control Measures and Global Safety Standards (e.g., WHO, ICRP Guidelines)

Unit 5: Emerging Contaminants and Pollution Management

5.1. Emerging Pollutants: Microplastics, Pharmaceuticals, PFAS,Antibiotics, Nanoparticles
5.2. Waste Management: Municipal Solid Waste, Hazardous Waste, Biomedical and E-waste
5.3. Pollution Monitoring Tools: Biosensors, Remote Sensing, IoT-based Systems
5.4. Environmental Policies and Treaties: CPCB Guidelines, Basel Convention, Stockholm Convention, SDG 6 & 12

EVS-206: RS, GIS AND GNSS (Practical- 50 marks/4 credits)

Unit 1: Principles of Remote Sensing

1.1. Types and classification of RS platforms and sensors
1.2. Types of resolutions with reference to the IRS/Resourcesat/Cartosat and Landsat series.
1.3. Types and utility of Digital Elevation Models
1.4. Downloading and data stacking from ISRO and USGS websites

Unit 2: Techniques in Remote Sensing

2.1. Georeferencing of maps and images. Preparation of FCCs
2.2. Unsupervised and supervised classification of satellite data
2.3. Preparation of indices through band rationing: NDVI, NDWI, NDMI, and NDBI
2.4. Classification of elevation data

Unit 3: Principles of Geographical Information System

3.1. GIS data structures types: Spatial and non-spatial, raster and vector
3.2. Principles of preparing attribute tables, data manipulation, and query
3.3. Principles and utilities of buffer generation
3.4. Principles and utilities of overlay analysis

Unit 4: Techniques in Geographical Information System

4.1. Digitization of earth features: points, lines, and polygons
4.2. Preparation and linking of exported data tables
4.3. Spatial analysis: Generation of buffers and overlays
4.4. Change detection using maps and images

Unit 5: Global Navigation Satellite System– Principles and Techniques

5.1. Principles of GNSS positioning with reference to GPS and IRNSS
5.2. Principles of DGNSS positioning and the utility of SoI CORS network
5.3. Collection and representation of GNSS waypoints
5.4. Area and line measurement from GNSS waypoints

SEMESTER III

EVS-301: Environmental Pollution, Chemistry, and Management (Theoretical- 50 marks/4 credits)

Unit 1: Understanding the Environment

1.1. Components and Functions of the Environment (Atmosphere, Hydrosphere, Lithosphere, Biosphere)
1.2. Environmental Pollution: Types, Causes, and Global Trends (Air, Water, Soil, Noise)
1.3. Ecosystem Concepts: Food Chains, Biogeochemical Cycles, and Energy Flow
1.4. Sustainable Development Goals (SDGs) and Environmental Relevance (SDG 6, 12, 13)

Unit 2: Pollution and Control Technologies

2.1. Air and Water Pollutants: Types, Sources, and Effects on Health and Environment
2.2. Soil and Noise Pollution: Sources, Indicators, and Effects
2.3. Pollution Control Technologies: Filters, Scrubbers, Bioreactors, ETPs, STPs
2.4. Waste Management: Solid, Hazardous, Biomedical, and E-waste Management Approaches

Unit 3: Environmental Chemistry and Microbiology

3.1. Basic Environmental Chemistry: pH, Redox, COD, BOD, Nutrients, and Contaminants
3.2. Chemical Reactions in Air and Water: Smog, Acid Rain, and Eutrophication
3.3. Role of Microorganisms in the Environment: Decomposition, Nitrogen Fixation, Bioremediation
3.4. Emerging Contaminants: Microplastics, Heavy Metals, Pharmaceuticals, and Nanomaterials

Unit 4: Environmental Data and Statistical Tools

4.1. Introduction to Environmental Data: Qualitative vs. Quantitative, Scales, and Sampling
4.2. Data Presentation and Summary: Tables, Graphs, Mean, Median, SD
4.3. Environmental Monitoring Tools: Sensors, Remote Sensing, GIS, IoT Applications
4.4. Basic Statistical Techniques in Environmental Science: Correlation, Regression, and PCA

Unit 5: Environmental Management, Law, and Governance

5.1. Environmental Management Systems (EMS) and Life Cycle Assessment (LCA)
5.2. Environmental Laws in India: EPA 1986, Air and Water Acts, NGT, CPCB
5.3. Global Environmental Agreements: Stockholm, Basel, Kyoto, Paris, and CBD
5.4. Public Participation and Environmental Movements: Role of NGOs, CER, and ESG

EVS-302: ENVIRONMENTAL MICROBIOLOGY AND BIOTECHNOLOGY (Theoretical- 50 marks/4 credits)

Unit 1: Fundamentals of Environmental Microbiology

1.1. Introduction to Microbiology: Scope and History
1.2. General Microbiology: Microbiology of air, water and soil; general idea about bacterial morphology -- shape, size; structure and function of capsule, pilus, flagella, cell wall, membrane, nucleoid and plasmid. Distinctive properties of virus, types of viral nucleic acids, replication of viral DNA and RNA, lytic, lysogeny, control of lysogeny, induction, lysogenic conversion, significance of lysogeny, Viroids and prions.
1.3. Microbial Culture Techniques: Culture media and types, Isolation and characterization, microbial growth and growth factors; environmental factors regulating microbial growth, preservation of microorganisms
1.4. Control of Microbial Growth: Physical and chemical methods of sterilization

1.5. Microbial Interactions: Symbiosis, Competition, Antagonism, and Pathogenesis

Unit 2: Microbial Processes and Environmental Applications

2.1. Microbial Metabolism: Aerobic and Anaerobic Respiration, Fermentation
2.2. Biogeochemical Roles of Microbes: Carbon, Nitrogen, Sulfur, and Phosphorus Cycles
2.3. Microbial Indicators of Environmental Quality: Pathogens and Biomonitors, MPN test
2.4. Microbial Degradation of Pollutants: Hydrocarbons, Pesticides, Heavy Metals, and Plastics2.5. Food Microbiology: Microbial spoilage of fresh food and its preservation, fermented food, food poisoning, microbiology of milk, milk sources, types of microorganisms used, pasteurization

Unit 3: Environmental Biotechnology – Principles and Tools

3.1. Introduction to Environmental Biotechnology: Scope and Emerging Trends
3.2. Bioreactors and Fermentation Technology: Types and Environmental Applications
3.3. Molecular Tools in Biotechnology: PCR, DNA Probes, Electrophoresis, and DNA Sequencing
3.4. Microbial Genomics and Metagenomics: Concepts and Environmental Relevance

Unit 4: Applied Environmental Biotechnology

4.1. Bioremediation Techniques: In Situ and Ex Situ Approaches (Bioaugmentation, Bioventing, etc.)
4.2. Phytoremediation and Mycoremediation: Mechanisms and Case Studies
4.3. Bioleaching and Biosorption of Heavy Metals: Industrial and Environmental Relevance
4.4. Microbial Fuel Cells and Bioenergy Production: Microbial Role in Renewable Energy

Unit 5: Microbial Risk, Regulation, and Sustainable Use

5.1. Biosafety and Bioethics in Environmental Microbiology and Biotechnology
5.2. Genetically Modified Microorganisms (GMMs): Environmental Applications and Risks
5.3. Wastewater Treatment and Microbial Management in STPs/ETPs
5.4. Policy Frameworks and Regulatory Guidelines: Cartagena Protocol, Indian Biosafety Rules, and Global Practices

EVS-303: SOLID AND HAZARDOUS WASTE MANAGEMENT (Theoretical- 50 marks/4 credits)

Unit 1: Introduction to Waste Management

1.1. Definition, Types, and Characteristics of Waste: Solid, Liquid, Hazardous, E-waste, and Biomedical Waste
1.2. Waste Generation Patterns and Factors Influencing Waste Production
1.3. Waste Hierarchy: Avoidance, Minimization, Reuse, Recycling, and Disposal
1.4. Integrated Waste Management System (IWMS) and Sustainable Development Goals (SDG 12)

Unit 2: Solid Waste: Sources, Composition, and Disposal Methods

2.1. Sources and Classification of Solid Waste: Municipal, Industrial, Agricultural, and Construction Waste
2.2. Composition of Municipal Solid Waste (MSW) and Waste Characterization
2.3. Collection, Segregation, Transportation, and Disposal Methods (Landfilling, Incineration, Composting)
2.4. Waste-to-Energy Technologies and Challenges in Landfill Management

Unit 3: Hazardous Waste Management

3.1. Definition, Sources, and Classification of Hazardous Waste (Chemical, Radioactive, Biomedical)
3.2. Physical, Chemical, and Toxicological Properties of Hazardous Waste
3.3. Hazardous Waste Treatment Methods: Incineration, Stabilization, Solidification, Landfilling
3.4. Regulatory Frameworks: Basel Convention, RCRA, Local Hazardous Waste Guidelines

Unit 4: Waste Minimization and Recycling Technologies

4.1. Principles of Waste Minimization and Source Reduction Techniques
4.2. Recycling and Reuse of Materials: Metals, Plastics, Paper, Glass, and Organic Waste
4.3. Innovative Recycling Technologies: Chemical Recycling, Biodegradable Plastics, and Circular Economy
4.4. Extended Producer Responsibility (EPR) and Product Stewardship Initiatives

Unit 5: Global Waste Management Practices and Policies

5.1. Global Waste Generation Trends and Regional Disparities (Developed vs. Developing Countries)
5.2. National and International Regulations and Standards (EPA, CPCB, UN Environment)
5.3. Policy Frameworks for Waste Management: Extended Producer Responsibility (EPR), Polluter Pays Principle
5.4. Case Studies of Successful Waste Management Programs: Sweden’s Recycling Model, Zero Waste Cities

EVS-304: ENVIRONMENTAL MANAGEMENT, LAW AND POLICIES (Theoretical- 50 marks/ 4 credits)

Unit 1: Foundations of Environmental Management

1.1. Concept and Scope of Environmental Management
1.2. Principles of Environmental Planning and Sustainable Development
1.3. Environmental Impact Assessment (EIA): Process, Methods, and Limitations
1.4. Environmental Management Systems (EMS): ISO 14000 Series and Auditing

Unit 2: Natural Resource and Disaster Risk Management

2.1. Integrated Natural Resource Management (INRM): Concepts and Tools
2.2. Watershed and River Basin Management: Case Studies
2.3. Environmental Risk Assessment and Life Cycle Assessment (LCA)
2.4. Disaster Risk Reduction (DRR) and Management: Climate Resilience and Early Warning Systems

2.5 Sendai Framework for Disaster Risk Reduction, 2015-30

Unit 3: Environmental Laws and Regulatory Frameworks – National

3.1. Constitutional Provisions Related to Environment in India
3.2. Key Environmental Legislations: EPA 1986, Air Act 1981, Water Act 1974
3.3. Forest Conservation Act 1980, Wildlife Protection Act 1972, and Biological Diversity Act 2002
3.4. Role of National Green Tribunal (NGT), Central and State Pollution Control Boards (CPCB &SPCB)

Unit 4: International Environmental Law and Agreements

4.1. Principles of International Environmental Law: Precautionary Principle, Polluter Pays, Intergenerational Equity
4.2. Key Multilateral Environmental Agreements (MEAs): Stockholm, Rio, Kyoto, Paris
4.3. Convention on Biological Diversity (CBD), CITES, Basel and Montreal Protocols
4.4. Global Environmental Governance: UNEP, IPCC, and Environmental Justice

Unit 5: Environmental Policy and Governance

5.1. Environmental Policy Formulation: Stakeholders, Instruments, and Policy Cycles
5.2. National Environmental Policy (NEP) and Five-Year Plans
5.3. Public Participation, Environmental Movements, and Role of NGOs and Civil Society
5.4. Corporate Environmental Responsibility (CER), ESG Criteria, and Green Economy

EVS-305: STATISTICAL APPLICATIONS IN ENVIRONMENTAL SCIENCES (Theoretical- 50 marks/4 credits)

Unit – 1: Univariate Statistical Analysis

1.1 Data: nature, types, and scales of measurement (SoM); Choice of Techniques based on SoM; Likert Data and Techniques of Scaling.

1.2 Data Acquisition: Sample and population; Nature and characteristics of Samples; Types of Sampling with salient features; Sampling Error; Estimates of Population from Sample characteristics.

1.3 Data Description: central tendency, dispersion (absolute and relative), standard error of estimate, data distribution (dot plot, stem-and-leaf diagram, box-and-whisker plot, histogram, frequency curve, cumulative frequency polygons, and curves).

1.4 Data Distribution: Shape of Frequency Curves – skewness and kurtosis.

Unit – 2: Bivariate Statistical Analysis

2.1 Correlation Analysis: Pearson's Product Moment Correlation Coefficient, and Spearman's Rank Correlation Coefficient; Test of Significance; Scatter Plot of Bivariate Data

2.2 Regression Analysis: Linear Regression Parameters; Residual Analysis; Coefficient of Determination and Goodness-of-Fit. ANOVA, Scatter Plot of Bivariate Data

2.3 Regression Analysis: Non-linear Regression (Exponential, Power, Semi-logarithmic, Logarithmic, Polynomial – 2nd Degree and 3rd Degree, Residual Analysis); Coefficient of Determination and Goodness-of-Fit. Scatter Plot of Bivariate Data

2.4 Time Series Analysis: types of trend; measurement of trend (free-hand method, semi-average method, moving average method, and curve-fitting method).

Unit – 3: Multivariate Statistical Analysis and Spatial Statistics

3.1 Multivariate Statistical Analysis: multivariate data - nature and characteristics; Choice of multivariate Techniques.

3.2 Analysis of Dependence: correlation matrix, partial correlation, multiple correlation, multivariate linear regression.

3.3 Analysis of Interdependence: Principal component analysis (PCA), Factor Analysis (FA), Discriminant Analysis (DA), and Cluster Analysis (CA).

3.4 Spatial Analysis: mean, median, mode, standard distance, standard deviational ellipse, point pattern analysis, directional analysis – nature of data, frequency distribution, mean direction, and test of significance.

Unit – 4: Inferential Statistics

4.1 Hypothesis Building and Testing: Null Hypothesis and Alternate Hypothesis; Type- and Type-2 Error; Parametric and Non-parametric Tests; t-tests, ANOVA, Mann-Whitney U Test, Kruskal-Wallis Test.

4.2 Test of Uniformity: Chi-Square Test; Test of Randomness: Quadrat Analysis; Test of Clustering and Regularity: NNA;

4.3 Test of System Organisation: Entropy Analysis; Join Count statistics.

4.4 Spatial Auto Correlation, Test of Normality and Randomness; Spatial Regression.

EVS- 306: Advanced Environmental Monitoring and Analytical Techniques (Practical – 50 Marks / 4 Credits)

Unit 1: Geo-Spatial and Geological Data Interpretation

1.1. Interpretation of Relief Features: Hills, Valleys, Watersheds, and Drainage Patterns from Topographical Maps
1.2. Calculation of Average Slope (Wentworth Method), Drainage Frequency, and Drainage Density
1.3. Identification of Structural Features: Folds, Faults, and Uniclinal Structures from Geological Maps
1.4. Construction of Geological Cross-Sections and Application in Hazard Assessment (Landslides, Fault Zones)

Unit 2: Climate, Air Quality, and Environmental Monitoring

2.1. Measurement of Climatic Parameters: Max-Min Temperature, Atmospheric Pressure, Relative Humidity
2.2. Graphical Representation: Climographs, Wind Rose, Hydrographs for Climate Data Interpretation
2.3. Long-Term Climate Change Analysis: Temperature Trends, Rainfall Variability, Seasonality Indices
2.4. Ambient Air Quality Monitoring: PM2.5, PM10, SO_2, NO_2, and O_3 using Digital Instruments

Unit 3: Environmental Quality and Biogeochemical Assessments

3.1. Water & Soil Quality Monitoring: pH, DO, EC, Heavy Metals (As, Pb, Cd), Nutrients (NO_3^-, PO_4^{3-}, SO_4^{2-})
3.2. Noise Pollution Assessment: Measurement & Source Identification using Sound Level Meters
3.3. Water Treatment Techniques: Coagulation, Flocculation, and Disinfection Efficiency Testing
3.4. Estimation of Organic Carbon in Soil (Walkley-Black Method) and Basic Biomolecule Quantification (Protein, Carbohydrates, Lipids)

Unit 4: Microbial, Biotechnological, and Ecological Techniques

4.1. Isolation and Enumeration of Microorganisms: Total Plate Count (TPC) and Coliform Testing
4.2. Biochemical Oxygen Demand (BOD) Estimation and Respirometry-Based Biodegradation Assessment
4.3. Molecular Detection of Pathogens (PCR) & Antibiotic Sensitivity Testing (Agar Diffusion)
4.4. Biodiversity Assessment: Species Richness, Shannon-Wiener Index, and Bioassays (Daphnia Mortality, Algal Inhibition)

5. Viva Voice and Laboratory Note book

SEMESTER IV

EVS-401: ENVIRONMENTAL CHEMISTRY (Theoretical- 50 marks/4 credits)

Unit 1: Fundamentals of Environmental Chemistry

1.1. Definition, Scope, and Significance of Environmental Chemistry
1.2. Concepts of Chemical Speciation and Bioavailability in the Environment
1.3. Principles of Chemical Thermodynamics and Kinetics in Environmental Systems
1.4. Acid-Base Chemistry, Redox Reactions, and Buffer Systems in Natural Waters

Unit 2: Chemistry of Air and Atmospheric Reactions

2.1. Composition and Structure of the Atmosphere
2.2. Photochemical Reactions in the Troposphere and Stratosphere
2.3. Air Pollutants: Chemistry of NO_x, SO_x, CO, O_3, and VOCs, PMs (PM2.5, PM10)

2.4. Acid Rain, Photochemical Smog, and Ozone Layer Depletion: Chemical Perspectives

Unit 3: Aquatic Chemistry and Water Pollution

3.1. Physical and Chemical Properties of Water and Aquatic Systems
3.2. Chemical Oxygen Demand (COD), Biological Oxygen Demand (BOD), and DO
3.3. Hydrolysis, Precipitation, Complexation, and Redox Reactions in Water Bodies
3.4. Heavy Metals, Nutrients (N, P), and Organic Contaminants in Water Pollution

Unit 4: Soil and Sediment Chemistry

4.1. Composition and Chemical Characteristics of Soils
4.2. Ion Exchange, Adsorption–Desorption, and Soil pH Chemistry
4.3. Persistence and Degradation of Pesticides and Agrochemicals
4.4. Soil Contamination by Heavy Metals and Remediation Approaches

Unit 5: Environmental Analytical Chemistry and Toxicology

5.1. Sampling Techniques and Sample Preparation for Environmental Matrices
5.2. Principles of Spectroscopy (UV-Vis, AAS), Chromatography (GC, HPLC)
5.3. Environmental Toxicology: Dose-Response, LD_{50}, Bioaccumulation and Biomagnification
5.4. Chemistry of Emerging Contaminants: Microplastics, PPCPs, and Nanomaterials

EVS-402: MOLECULAR BIOLOGY AND IMMUNOLOGY FOR ENVIRONMENTAL SCIENCE

(Theoretical – 50 Marks / 4 Credits)

Unit 1: Fundamentals of Molecular Biology

1.1 Structure and Function of DNA, RNA, and Proteins: Central Dogma, Gene Structure, Types of RNA, and Genetic Code

1.2. DNA Replication, Transcription, and Translation: Mechanisms in Prokaryotes and Eukaryotes, Enzymes Involved

1.3. Gene Regulation and Epigenetics: Operon Models, Transcription Factors, DNA Methylation, Histone Modification

1.4. Mutations and DNA Repair Mechanisms: Types of Mutations, Repair Pathways, Environmental Mutagens

Unit 2: Molecular Techniques in Environmental Analysis

2.1. DNA Extraction, PCR, and Gel Electrophoresis: Techniques for Environmental Samples: Soil, Water, Air Microbiome

2.2. Quantitative PCR (qPCR) and RT-PCR: Gene Expression Analysis, Pathogen Detection in Ecosystems

2.3. Molecular Cloning and Gene Editing Tools: Plasmid Vectors, CRISPR-Cas System, and Applications in Bioremediation

2.4. Metagenomics and Environmental DNA (eDNA): Microbial Diversity Analysis, Species Monitoring, and Ecosystem Health

Unit 3: Principles of Immunology

3.1. Components of the Immune System: Innate and Adaptive Immunity, Immune Cells, Organs, and Receptors

3.2. Antigen Recognition and Immune Response: Antigens, Antibodies, MHC Complex, Cytokines, and T-cell/B-cell Activation, Immune Response to Environmental Pollutants: Heavy Metals, Pesticides, Endocrine Disruptors and Immune Modulation

3.3. Vaccines and Immunization Strategies: Traditional and Next-Generation Vaccines (DNA, mRNA, Subunit)

3.4. Immune Disorders and Environmental Triggers: Allergies, Autoimmune Diseases, and Immunotoxicology

Unit 4: Disease Ecology and Disease Biology

4.1. Arthropods of medical importance and Vector-borne diseases: Mode of transmission, pathogenesis and control of Dengue, Malaria, Kala-azar and Lymphatic Filariasis.Medical importance of fleas, ticks and mites on health.

4.2. Mode of transmission, pathogenesis and control of air-borne respiratory diseases (Bacterial: Tuberculosis, Viral: Measles and Influenza), Water-borne diseases (Bacterial: Cholera, Protozoan: Amoebiasis)

4.3. Epidemiology and Management of Viral Diseases (COVID19 and AIDS), Bacterial diseases (Gastric and Duodenal Ulcers, Hospital-borne infections)

Unit 5: Environmental Biotechnology, Epidemiology and Public Health

5.1. Bioremediation Using Genetically Modified Organisms (GMOs): Engineered Microbes for Pollutant Degradation and Detoxification

5.2. Molecular Diagnostics for Environmental Pathogens: LAMP, Microarrays, ELISA, and Nanotech-based Biosensors

5.3. Role of Microbes as Biopesticides. Mode of action and application of Bt and Bs toxin

5.4. Principles of Epidemiology and Public Health: Basic Concept of communicable and non-communicable Diseases, Rate of Disease in a population, Reservoirs of Infectious Agents, Prevalence and Incidence of a Disease, Pathogenicity and Virulence, Factors that Influence the Epidemiology of Disease, Characteristics of Infectious Disease, Distribution of the Pathogen, Koch's Postulates,Establishment of Infection, Epidemiological Studies: Descriptive and Analytical, Factors affecting the Emergence and Re-emergence of diseases, Basic concept of Surveillance, Reduction and Eradication of a Disease

SPECIAL PAPER

EVS- 403A: ENVIRONMENTAL HYDROLOGY (Theoretical – 50 Marks / 4 Credits)

Unit 1: Advanced Hydrological Processes and Measurement Techniques

1.1. Concepts and Evolution of Hydrological Science; Quantification of the Global Water Cycle
1.2. High-Resolution Hydrometeorological Observations: Satellite Products (TRMM, GPM), Remote Sensing, and In-situ Sensors
1.3. Coupled Earth System–Hydrology Models and Climate-Hydrology Interactions
1.4. Precipitation and Soil Moisture Dynamics: Radar Estimation, Unsaturated Zone Processes, and Ground-Based Validation

Unit 2: Surface and Subsurface Water Systems

2.1. Watershed Hydrology: Hydrograph Analysis, Baseflow Separation, Unit Hydrograph Theory
2.2. River Basin Hydraulics and Sediment Transport: Energy Gradient, Manning's Equation
2.3. Groundwater Flow and Aquifer Dynamics: Darcy's Law, Theis Solution, MODFLOW Modeling
2.4. River–Aquifer Interactions and Managed Aquifer Recharge (MAR), Aquifer Storage Recovery (ASR)

Unit 3: Hydrological Hazards and Environmental Risk Management

3.1. Flood Hazard Modeling: FFA, Return Period Estimation, Inundation Mapping (HEC-RAS)
3.2. Drought Assessment: SPI, PDSI, NDVI Anomalies, and Drought Resilience Frameworks
3.3. Urban Hydrology and Pluvial Flooding: Heat-Hydro Coupling, Imperviousness and Runoff Generation
3.4. Nature-Based Solutions for River Basin Risk Management: Wetlands, Floodplains, and Eco-Engineering

Unit 4: Water Quality, Monitoring, and Emerging Technologies

4.1. Water Pollution Sources and Pathways: Geogenic vs. Anthropogenic Contaminants
4.2. Real-Time Water Quality Surveillance: IoT Sensors, Remote Sensing (MODIS, Sentinel, GRACE)
4.3. Process-Based Hydrological and Water Quality Models: SWAT+, HEC-HMS, MIKE SHE, SWMM
4.4. AI/ML Applications in Hydrology: Forecasting Floods/Droughts, Water Quality Predictions, DSS Integration

Unit 5: Water Governance, Policy, and Global Sustainability

5.1. IWRM Principles, SDG 6 Monitoring, and the Water-Energy-Food-Carbon Nexus
5.2. Transboundary Water Management and Hydrodiplomacy: Ganges-Brahmaputra-Meghna, Nile, Colorado Case Studies
5.3. National and International Water Institutions: CWC, CGWB, IWMI, River Basin Organizations (RBOs)
5.4. Participatory Governance and Indigenous Knowledge: Citizen Science, Blockchain in Water Rights, and Climate-Resilient Traditions

EVS- 404A: Hydrological Techniques and Watershed Analytics (Practical – 50 Marks / 4 Credits)

Unit 1: Advanced Field Methods

1.1. Stream Discharge by ADCP, Salt Dilution, and Velocity-Area Techniques
1.2. Automated Rain Gauge Data Collection and Analysis (TBRG, ARG)
1.3. Groundwater Level Monitoring: Piezometers, Observation Wells, Data Loggers

Unit 2: Hydrochemical Laboratory Techniques

2.1. Measurement of BOD, COD, TDS, Hardness using Advanced Lab Kits
2.2. Spectrophotometric Estimation of Arsenic, Fluoride, and Nitrate
2.3. Computation and Classification using Water Quality Index (WQI) Framework

Unit 3: Spatial and Modeling Applications

3.1. Watershed Delineation using High-Resolution DEMs in QGIS/ArcGIS
3.2. SWAT+, MIKE-SHE, and HEC-HMS Modeling: Setup, Calibration, Validation
3.3. HEC-RAS 2D and Flood Hazard Mapping: Terrain Pre-processing and Model Simulation

Unit 4: Research Projects and Analytical Reporting

4.1. Water Budget Analysis for Multi-Use Catchments (ET, Recharge, Withdrawals)
4.2. Design of Urban Hydrological Monitoring and Early Warning System
4.3. Report Writing, Thematic Mapping, and Presentation (Oral + Written)

MODULE-405: DISSERTATION (Practical – 50 Marks/4 credits)

MODULE-406: FIELD REPORT/INTERNSHIP (Practical – 50 Marks/4 credits)