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(Accredited by NAAC with Grade A+)

GU/Acad –PG/BoS -NEP/2026-27/185 Date: 01.07.2026

CIRCULAR

Ref. No.: GU/Acad –PG/BoS -NEP/2025-26/253 dated 17.07.2025

In supersession to the above referred Circular, the structure and syllabus of Semester III and IV of the **Master of Science in Environmental Science** Programme approved by the Standing Committee of the Academic Council in its meeting held 24th & 25th November 2025, is attached.

The Syllabus of Semester I and II approved earlier by the Academic Council in its meeting held on 13th & 14th June 2025 is also attached.

The Dean & Vice-Dean (Academic) of the School of Earth, Ocean and Atmospheric Sciences and Principals of the affiliated Colleges offering the **Master of Science in Environmental Science** Programme are requested to take note of the above and bring the contents of the Circular to the notice of all concerned.

(Ashwin V. Lawande)
Deputy Registrar – Academic

To,

1. The Dean, School of Earth, Ocean and Atmospheric Sciences, Goa University.
2. The Vice-Dean (Academic), School of Earth, Ocean and Atmospheric Sciences, Goa University.
3. The Principals of Affiliated Colleges offering the Master of Science in Environmental Science Programme.

Copy to:

1. Chairperson, BoS in Environmental Science, Goa University.
2. Programme Director, M.Sc. Environmental Science, Goa University.
3. Controller of Examinations, Goa University.
4. Assistant Registrar Examinations (PG), Goa University.
5. Directorate of Internal Quality Assurance, Goa University for uploading the Syllabus on the University website.

GOA UNIVERSITY

MASTER OF SCIENCE IN ENVIRONMENTAL SCIENCE PROGRAMME

(Effective from the Academic Year 2025-2026)

ABOUT THE PROGRAMME

Environmental science has conventionally studied physical, chemical and biological processes in the Earth system (Lithosphere, hydrosphere, atmosphere, biosphere and cryosphere). Increasingly, it now incorporates nature-human interactions and the social, political and cultural processes which impact the planet. The anthropogenic pressures on the ecological processes have forced disciplinary boundaries to merge and a student of environmental science must understand the complex relationships that drive nature-human interactions. Sustainability is one of the grand challenges that human survival faces on planet Earth.

Goa University has designed a unique two-year postgraduate programme in Environmental Science keeping the above grand challenge in mind. The programme is hosted by the School of Earth Ocean and Atmospheric Sciences (SEOAS) in collaboration with other schools across the University such as School of Biological Sciences and Biotechnology, School of Chemical Sciences, Goa Business School, School of Physical and Applied Sciences, D.D. Kosambi School of Social Sciences and Behavioural Studies and Manohar Parrikar School of Law, Governance and Public Policy. This multidisciplinary programme will teach students how to combine skills and knowledge from a variety of domains. It will allow students to explore courses from a large number of disciplines and skill themselves in a manner that they feel best suits them for their knowledge pursuits.

Eligibility: Graduate in any science subject including Medicine and B. Tech.

OBJECTIVES OF THE PROGRAMME

- The programme aims to provide a holistic approach to understand environmental issues and undertake environmental impact assessment studies with diverse perspectives, frameworks and using multiple data sources.
- Field and laboratory-based work will help students to experience conservation and management of varied habitats, understand response of biotic components to a changing climate, and gain insights on land formations and social structures.

PROGRAMME SPECIFIC OUTCOMES (PSO)	
PSO 1.	To provide a holistic view of the environment, multi-disciplinary understanding on the causes, impacts of environmental issues, their management and conservation.
PSO 2.	To monitor environmental quality through advanced analytical techniques for providing baseline information on the effect of land-based activities on groundwater source and coastal ecosystems.
PSO 3.	To acquaint/train the students for Environmental Impact Assessment studies as per the Ministry of Environment, Forest and Climate Change (MoEFCC) guidelines from time to time.
PSO 4.	To generate awareness among the student community about the linkages between the environment and ecosystem services to support livelihood that enable upliftment of socio-economic status.
PSO 5.	To enable an understanding of spatial data integration and interpretation for environmental conservation.
PSO 6.	To apply theoretical insights to real-world environmental challenges, foster critical thinking, ethical reasoning, and informed action for sustainable environmental futures.

PROGRAMME STRUCTURE

Master of Science in Environmental Science

Effective from Academic Year 2025-2026

Bridge Course			
Sr. No.	**Course Code**	**Title of the Course**	**Credits**
1	**ENV-1000**	Fundamentals of Environmental Science	2T

Note: The bridge course will be offered to students coming from diverse academic backgrounds to gain foundational knowledge in Environmental Science.

SEMESTER I				
Discipline Specific Core (DSC) Courses (16 credits)				
Sr. No.	**Course Code**	**Title of the Course**	**Credits**	**Level**
1	**ENV-5000**	Environmental Chemistry	3T	400
2	**ENV-5001**	Environmental Chemistry Practical	1P	400
3	**ENV-5002**	Environmental Biology and Ecology	3T	400
4	**ENV-5003**	Environmental Biology and Ecology Practical	1P	400
5	**ENV-5004**	Environmental Geology and Soil Science	3T	400
6	**ENV-5005**	Environmental Geology and Soil Science Practical	1P	400
7	**ENV-5006**	Atmospheric Science and Climate Change	3T	400
8	**ENV-5007**	Atmospheric Science and Climate Change Practical	1P	400
Total Credits for DSC Courses in Semester I			**16**	
Discipline Specific Elective (DSE) Course (4 credits)				
Sr. No.	**Course Code**	**Title of the Course**	**Credits**	**Level**
1	**ENV-5201**	Coastal Habitats and Processes	3T	400
2	**ENV-5202**	Coastal Habitats and Processes Practical	1P	400
3	**ENV-5203**	Mangrove Ecosystem and Biodiversity	3T	400
4	**ENV-5204**	Mangrove Ecosystem and Biodiversity Practical	1P	400
5	**ENV-5205**	Remote Sensing Techniques and GIS	3T	400

6	**ENV-5206**	Remote Sensing Techniques and GIS Practical	1P	400
		Total Credits for DSE Courses in Semester I	**4**	
		Total Credits in Semester I	**20**	

Note: Students opting for a 3-credit DSE theory course are required to take the corresponding 1-credit practical course.

SEMESTER II				
Discipline Specific Core (DSC) Courses				
Sr. No.	**Course Code**	**Title of the Course**	**Credits**	**Level**
1	**ENV-5008**	Analytical Techniques	3T	500
2	**ENV-5009**	Analytical Techniques Practical	1P	500
3	**ENV-5010**	Environmental Microbiology	3T	500
4	**ENV-5011**	Environmental Microbiology Practical	1P	500
5	**ENV-5012**	Environmental Toxicology and Risk Assessment	3T	500
6	**ENV-5013**	Environmental Toxicology and Risk Assessment Practical	1P	500
7	**ENV-5014**	Waste Management	3T	500
8	**ENV-5015**	Waste Management Practical	1P	500
Total Credits for DSC Courses in Semester II			**16**	
Discipline Specific Elective (DSE) Courses (4 credits)				
Sr. No.	**Course Code**	**Title of the Course**	**Credits**	**Level**
1	**ENV-5207**	Environment Ethics	4T	400
2	**ENV-5208**	Environmental Issues and Perspectives	4T	400
3	**ENV-5209**	Sustainable Development and Resource Management	3T	400
4	**ENV-5210**	Sustainable Development and Resource Management Practical	1P	400
Total Credits for DSE Courses in Semester II			**4**	
Total Credits in Semester II			**20**	

Note: Students opting for the 3-credit DSE theory course are required to take the corresponding 1-credit practical course.

SEMESTER III				
Research Specific Elective (RSE) Courses (12 credits)				
Sr. No.	**Course Code**	**Title of the Course**	**Credits**	**Level**
1	**ENV-6000**	Environmental Impact Assessment	3T	500
2	**ENV-6001**	Environmental Policy & Law	3T	500
3	**ENV-6002**	Biodiversity and Conservation	3T	500
4	**ENV-6003**	Biodiversity and Conservation Practical	1P	500
5	**ENV-6004**	Mining Geology and Stratigraphy	3T	500
6	**ENV-6005**	Mining Geology and Stratigraphy Practical	1P	500
7	**ENV-6006**	Marine Pollution	3T	500
8	**ENV-6007**	Microplastics in Environment	4T	500
9	**ENV-6008**	Renewable Energy System	3T	500
10	**ENV-6009**	Research Methodology	4T	500
Total Credits for RSE Courses in Semester III			**12**	
Discipline Specific Vocational Elective (DSVE) Courses (8 credits)				
Sr. No.	**Course Code**	**Title of the Course**	**Credits**	**Level**
1	**ENV-6401**	Environmental Pollution Practical I	2P	500
2	**ENV-6402**	Environmental Pollution Practical II	2P	500
3	**ENV-6403**	Field work and Environmental Sampling Practical	2P	500
4	**ENV-6404**	Environmental Data Analysis Practical	2P	500
5	**ENV-6405**	Analysis of Environmental Impact Assessment	1T+1P	500
Total Credits for DSVE Courses in Semester III			**8**	
Total Credits in Semester III			**20**	

Note: Students are required to complete 12 credits of RSE courses in Semester III listed from Sr. no. 1 to 9. Students taking course ENV-6002 and ENV-6004 are also required to take the corresponding practical course. Additionally, the course Research Methodology is mandatory to be undertaken by students, eligible/opting for the Dissertation in Semester III. However, the marks obtained will be accounted for in Semester IV. Also, the course Advanced Theory of 04 credits has to be completed by students opting for a 40 credits dissertation.

Discipline Specific Dissertation (DSD) (40 Credit Dissertation)				
Sr. No.	**Course Code**	**Title of the Course**	**Credits**	**Level**
1	**ENV-6501**	Dissertation	40	500
Discipline Specific Dissertation (DSD) (40 Credit Dissertation)				

SEMESTER IV				
Generic Elective (GE) Courses (20 credits)				
Sr. No.	**Course Code**	**Title of the Course**	**Credits**	**Level**
1	**ENV-6201**	Coral Ecosystem and Threats	3T	500
2	**ENV-6202**	Disaster Management	3T	500
3	**ENV-6203**	Environmental Economics	3T	500
4	**ENV-6204**	Environmental Implication of Marine Productivity	3T	500
5	**ENV-6205**	Green Chemistry	3T	500
6	**ENV-6206**	Marine Biodiversity and Conservation Practices	3T	500
7	**ENV-6207**	Polar Sciences	3T	500
8	**ENV-6208**	Water Resource Management	3T	500
9	**ENV-6209**	Ecological significance of symbiosis	2T	500
10	**ENV-6210**	Ecology and Society	2T	500
11	**ENV-6211**	Gender Sensitivity and Rights Awareness	2T	500
12	**ENV-6212**	Mineral Resource Management	2T	500
13	**ENV-6213**	Nitrogen and Climate Change	2T	500
14	**ENV-6214**	Coastal Geohazards	1T	500
15	**ENV-6215**	Environmental Externalities and Policy	1T	500
16	**ENV-6216**	Gender and Ecology in Goan Society	1T	500
17	**ENV-6217**	Concepts in Environmental Valuation	1T	500
18	**ENV-6218**	Marine Habitat Conservation and Restoration	1T	500
19	**ENV-6219**	Spatial Economic Analysis	1T	500
Total Credits for GE Courses in Semester IV			**20**	

Discipline Specific Dissertation (DSD) / Internship (20 Credit Dissertation)				
Sr. No.	**Course Code**	**Title of the Course**	**Credits**	**Level**
1	**ENV-6502**	Dissertation	20	500
		Total Credits in Semester IV	**20**	

Blooms Taxonomy Cognitive Levels	
Cognitive Level	**Notations**
K1	Remembering
K2	Understanding
K3	Applying
K4	Analyzing
K5	Evaluating
K6	Create

BRIDGE COURSE

Title of the Course	Fundamentals of Environmental Science
Course Code	ENV-1000
Number of Credits	02
Theory/Practical	Theory
Level	100
Effective from AY	2025-2026
New Course	Yes
Bridge Course/ Value added Course	Yes (Bridge Course)
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	• Understand and evaluate key environmental issues. • Analyze ecological systems and biodiversity. • Integrate fundamental principles of chemistry, physics, and biology. • Examine environmental pollution and control methods.	
Course Outcomes:		**Mapped to PSO**
	CO 1. Describe the scope, importance, and interdisciplinary nature of environmental science.	PSO 1

	CO 2. Identify and describe key environmental issues.		PSO 1	
	CO 3. Explain the structure and functioning of ecosystems and ecological interactions.		PSO 1	
	CO 4. Identify major global biomes and biodiversity hotspots.		PSO 1	
	CO 5. Apply basic chemical principles relevant to environmental systems.		PSO 1	
	CO 6. Identify sources, types, and impacts of various types of pollutants and evaluate practical solutions to address contemporary environmental problems.		PSO 1	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	*Introduction to Environmental Science* Definition, scope, and importance; Interdisciplinary nature; Key environmental issues such as climate change, ozone depletion, global warming, loss of biodiversity, pollution, deforestation, sea level rise, ocean acidification, resource depletion, waste management, and overpopulation; Sustainable development goals (SDGs).	**15**	CO1, CO2	K2
	Basics of Ecology and Biodiversity: Ecosystem structure and function; Food chains, webs, and ecological pyramids; Biomes and biodiversity hotspots; Conservation strategies.		CO3, CO4	K2
Module 2:	*Fundamentals of Chemistry, Physics & Biology* Chemistry: pH, organic/inorganic chemistry, redox, water and soil chemistry; Physics: energy, radiation, thermodynamics; Biology: cell structure, genetics, evolution, microbiology relevant to the environment.	**15**	CO5	K3
	Environmental Pollution & Control Air, water, soil, and noise pollution: sources, effects, mitigation; Solid and hazardous waste management; Case studies of major environmental disasters; Solutions to environmental issues.		CO6	K2, K5

Pedagogy:	Lectures/ tutorials/ assignments / case study analysis/ group discussions
References/ Readings:	1. Botkin, D. B., & Keller, E. A. (2014). *Environmental science: Earth as a living planet* (9th ed.). Wiley, Hoboken, NJ. 2. Cunningham, W. P., & Cunningham, M. A. (2017). *Principles of environmental science: Inquiry and applications* (8th ed.). McGraw-Hill Education. New York, NY, USA. 3. Dash, M. C. (2010). *Fundamentals of ecology*. Tata McGraw-Hill. New Delhi, India. 4. De, A. K. (2006). *Environmental studies* (2nd ed.). New Age International. New Delhi, India. 5. Manahan, S. E. (2017). *Environmental chemistry* (10th ed.). CRC Press. Boca Raton, FL 6. Miller, G. T., & Spoolman, S. (2018). *Living in the environment* (19th ed.). Cengage Learning. Boston, MA, USA. 7. Misra, S. P., & Pandey, S. N. (2010). *Essential environmental studies*. Ane Books. New Delhi 8. Primack, R. B. (2014). *Essentials of conservation biology* (6th ed.). Sinauer Associates/Oxford University Press, Sunderland, MA, USA. 9. Rajan, S. D. (2019). *Environmental studies* (2nd ed.). Pearson India, Chennai, India. 10. Sharma, B. K. (2016). *Environmental chemistry and pollution control* (Rev. ed.). Krishna Prakashan Media, Meerut, India. 11. Smith, R. L., & Smith, T. M. (2015). *Elements of ecology* (9th ed.). Pearson, Boston, MA, USA. 12. Solomon, E. P., Berg, L. R., & Martin, D. W. (2015). *Biology* (10th ed.). Cengage Learning, Boston, MA, USA.
Web Resources:	1. IPCC Reports (https://www.ipcc.ch/) 2. NASA Earth Observatory (https://earthobservatory.nasa.gov/) 3. UNEP Publications (https://www.unep.org/)

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SEMESTER I

Discipline Specific Core Courses

Title of the Course	Environmental Chemistry
Course Code	ENV-5000
Number of Credits	03
Theory/Practical	Theory
Level	400
Effective from AY	2025-2026
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	To study the properties of air/water/soil pollutants, and familiarize with different methods to control air/water/soil pollution in the environment.	
Course Outcomes:		**Mapped to PSO**
	CO 1. Classify air, water, and soil pollutants based on their sources, composition, and their environmental impacts	PSO 1

	CO 2. Apply appropriate techniques for sampling, measurement, and analysis of major air pollutants.		PSO 1	
	CO 3. Evaluate types of water pollutants, and to monitor, control pollution, and implement water treatment strategies.		PSO 1	
	CO 4. Summarize solid waste management principles, methods of collection, segregation, disposal, and environmentally sustainable solutions.		PSO 1	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	Classification and properties of air pollutants, emission sources- natural and anthropogenic, photochemical smog and its effects on environment. Air pollution: sampling and measurement, ambient air, collection of gaseous air pollutants, collection of particulate pollutants-stack sampling, analysis of air pollutants-sulphur dioxide, carbon monoxide, nitrogen dioxide, ozone, hydrocarbons and particulate matter.	**15**	CO1 CO2	K2, K4
Module 2:	Types of water pollutants: sewage and domestic wastes, industrial wastes, agriculture discharges, toxic wastes. Basic process of water treatment- primary treatment, pre-treatment, sedimentation, floatation secondary (biological) treatment, active sludge process, advance filteration technique, trickling filters, sludge treatment and disposal. Advanced waste water treatment- removal of suspended solids, removal of dissolved solids, nitrogen and phosphorous removal, advanced biological systems, chemical oxidation.	**15**	CO1 CO3	K2, K5
Module 3:	Sources of soil pollution: industrial wastes, domestic wastes, radioactive pollutants, pesticides and agricultural waste. Detrimental effects of soil pollutants-industrial wastes, domestic wastes, radioactive wastes and agricultural wastes to the environment. Solid waste management: sources and classification, public health aspects, methods of collection, disposal methods.	**15**	CO1 CO4	K2, K5

Pedagogy:	Lectures/ tutorials/ assignments
References/ Readings:	1. Bakour, I., Isaure, M.-P., Barrouilhet, S., Goni-Urriza, M., & Monperrus, M. (2025). Mercury interaction with S-containing molecules: Implications for methylation and demethylation processes in sulfate-reducing bacteria. *Frontiers in Environmental Chemistry, 6,* Article 123456. 2. Chiras, D. D. (1994). *Environmental science* (4th ed.). Jones & Bartlett Publishers, Sudbury, MA, USA. 3. Clark, R. B. (1986). *Marine pollution*. Oxford Science Publications, Oxford, United Kingdom. 4. Hussain, S. (2024). Recent trends in chitosan-based hydrogels for water treatment applications: A bibliometric analysis. *International Journal of Environmental Analytical Chemistry*,1-23. 5. Kudesia, V. P. (1985). *Water pollution*. Pragati Prakashan, Meerut, India. 6. Lodge, J. P. (Ed.). (1994). *Methods of air sampling and analysis* (3rd ed.). CRC Press. Boca Raton, Florida, USA. 7. Manahan, S. E. (2017). *Environmental chemistry* (10th ed.). CRC Press. Boca Raton, FL, USA. 8. Seinfeld, J. H., & Pandis, S. N. (2006). *Atmospheric chemistry and physics: From air pollution to climate change* (2nd ed.). John Wiley & Sons. Hoboken, NJ, USA. 9. Stumm, W., & Morgan, J. J. (1996). *Aquatic chemistry: Chemical equilibria and rates in natural waters* (3rd ed.). John Wiley & Sons. Hoboken, NJ, USA. 10. Turekian, K. K. (2010). *Marine chemistry and geochemistry*. Academic Press, Cambridge, MA, USA.

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Title of the Course	Environmental Chemistry Practical
Course Code	ENV-5001
Number of Credits	01
Theory/Practical	Practical
Level	400
Effective from AY	2025-2026
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	To understand the concentration of various pollutants in natural waters and their influence in biota.	
Course Outcomes:		**Mapped to PSO**
	CO 1. Analyze the dissolved oxygen, chemical and biochemical oxygen demand data to assess the quality of coastal waters.	PSO 1, PSO 2
	CO 2. Estimate hydrogen sulphide levels in coastal waters and interpret the results to assess water quality.	PSO 1, PSO 2
	CO 3. Apply spectrophotometric method to determine phosphorus concentration in polluted water and evaluate its environmental impact	PSO 1, PSO 2

	CO 4. Perform fluoride estimation in drinking water, to understand the implications for public health		PSO 1, PSO 2	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	1. Determination of chemical oxygen demand in coastal waters. 2. Determination of dissolved oxygen in coastal waters. 3. Determination of biochemical oxygen demand in coastal waters. 4. Estimation of hydrogen sulphide in coastal waters. 5. Estimation of phosphorus in polluted water. 6. Determination of fluoride in drinking water.	**30**	CO1 CO1 CO1 CO2 CO3 CO4	K4 K4 K4 K4 K5 K3
Pedagogy:	Demonstrations / lab experiments/ operation of different instruments.			
References/ Readings:	1. Allen, S. E., Grimshaw, H. M., Parkinson, J. A., Quarmby, C., & Roberts, J. D. (1976). Chemical analysis. In S. B. Chapman (Ed.), *Methods in plant ecology* (Chap. 8). Blackwell Scientific Publications, Oxford, United Kingdom. 2. Ewing, G. W. (1981). *Instrumental methods of chemical analysis*. McGraw-Hill, New York, NY, USA. 3. Grasshoff, K., Ehrhardt, M., & Kremling, K. (1983). *Methods of seawater analysis*. Verlag Chemie, Weinheim, Germany. 4. Khopkar, S. M. (2008). *A laboratory manual for environmental chemistry*. I. K. International Publishing House, New Delhi, India. 5. Murphy, R. A. (2022). *Environmental chemistry in the lab* (1st ed.). CRC Press, Boca Raton, FL, USA. 6. Parsons, T. R., Maita, Y., & Lalli, C. M. (1984). *A manual of chemical and biological methods for seawater analysis*. Pergamon Press, Oxford, United Kingdom. 7. Rice, E. W., & Bridgewater, L. (2012). *Standard methods for the examination of water and wastewater analysis* (22nd ed.). American Public Health Association, Washington D.C, USA.			

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Title of the Course	Environmental Biology and Ecology
Course Code	ENV-5002
Number of Credits	03
Theory/Practical	Theory
Level	400
Effective from AY	2025-2026
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	• Develop advanced understanding of ecosystem dynamics and biodiversity. • Apply scientific methods in environmental assessment and conservation practices. • Analyze and address global environmental challenges through policy and management.	
Course Outcomes:		**Mapped to PSO**
	CO 1. Apply knowledge of ecological principles and biodiversity to assess ecosystem health and environmental issues.	PSO 1
	CO 2. Analyze and interpret data on biodiversity, pollution, and ecosystem functions using advanced ecological methods and tools.	PSO 1, PSO 2
	CO 3. Critically evaluate global environmental challenges and propose sustainable solutions using research and policy analysis.	PSO 1, PSO 6

	CO 4. Design and implement ecological restoration projects and assess their effectiveness in real-world environments.		PSO 1, PSO 6	
	CO 5. Demonstrate proficiency in conducting field-based environmental assessments, including biodiversity surveys and environmental impact assessments (EIA).		PSO 1	
	CO 6. Communicate complex environmental issues and research findings effectively through scientific reports, presentations, and policy briefs.		PSO 1, PSO 4	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module I:	***Fundamentals of Environmental Biology and Ecology***			
	Introduction to Environmental Science and Ecology	**15**	CO1	K3
	Physico-Chemical and Biological Factors Affecting the Environment		CO2	K4
	Concept and Principles of Ecosystems		CO1	K3
	Ecological Pyramids and Disruption of Food Chains		CO1	K3
	Ecological Succession		CO2	K4
	Ecosystem Classification: Terrestrial and Aquatic		CO1	K3
	Types of Major Biomes		CO1	K3
	Population Ecology Fundamentals		CO2	K4
	Community Ecology		CO2	K4
	Human Impact on Ecosystems and Biodiversity		CO3	K5
	Climate Regulation and the Role of Forests		CO3	K5
	Hydrology and Green Belt in Urban Environments		CO2	K4
	Aquatic Ecology: Species-Specific Interactions		CO1	K3
	Terrestrial and Aquatic Ecosystems: Ecological Functions		CO2	K4

	Global Environmental Issues: Climate Change and Biodiversity Loss		CO3	K5
Module II:	***Biodiversity and Conservation***			
	Concept of Biodiversity	**15**	CO1	K3
	Taxonomic, Genetic, and Phylogenetic Biodiversity		CO2	K4
	Measurement of Biodiversity		CO2	K4
	Western Ghats as Biodiversity Hotspots in India		CO1	K3
	National Parks and Sanctuaries in India		CO5	K3
	Biosphere Reserves and Marine Protected Areas		CO5	
	Keystone, Umbrella and flagship Species and Their Role in Ecosystems		CO1	K3
	IUCN Red List: Threatened and Endemic Species		CO3	K5
	Eco-Restoration Techniques		CO4	K6
	Sustainable Development and Biodiversity Conservation		CO3	K5
	Habitat Degradation and Fragmentation		CO3	K5
	Endangered Species and Conservation Efforts		CO3	K5
	Advanced Technologies in Conservation		CO2	K4
	International Conservation Policies and Treaties		CO3	K5
	Conservation and Sustainable Management of Marine Ecosystems		CO4	K6
Module III:	***Environmental Management and Policy***			
	Introduction to Environmental Management	**15**	CO3	K5
	Environmental Sustainability and Development		CO3	K5
	Environmental Ethics and Philosophy		CO3	K5
	Environmental Governance and Legal Frameworks		CO3	K5

	Pollution Control and Waste Management		CO2	K4
	Environmental Impact Assessment (EIA)		CO5	K6
	Ecological Restoration and Habitat Conservation		CO4	K6
	Climate Change Mitigation and Adaptation		CO3	K5
	Corporate Social Responsibility (CSR) and the Environment		CO3	K5
	Environmental Education and Advocacy		CO6	K1
	International Environmental Policy and Agreements		CO3	K5
	Biodiversity Conservation and Policy (Biodiversity Protection Act 1972, 2003)		CO3	K5
	Sustainable Resource Management		CO4	K6
	Environmental Risk Assessment and Disaster Management		CO5	K6
	Future Directions in Environmental Management		CO3	K5
Pedagogy:	Use of conventional, online and ICT methods. Lecture/ tutorials/ assignments, field-based learning, discussions, and project work			
References/ Readings:	1. Bhatt, S., Kohli, K., & Kothari, A. (2006). *Process documentation of the National Biodiversity Strategy and Action Plan-India*. Kalpavriksh Environmental Action Group. Pune, India. 2. Dey, S. (2004). *Bioresources and genepool conservation*. Pointer Publishers, New Delhi, India. 3. Odum, E. P. (2004) Kemp, D., & Parto, S. (2005). *Fundamentals of ecology* (5th ed.). Saunders Belmont, CA, USA. 4. Grimmett, R., Inskipp, C., & Inskipp, T. (2016). *Birds of the Indian Subcontinent: India, Pakistan, Sri Lanka, Nepal, Bhutan, Bangladesh and the Maldives*. Bloomsbury Publishing, London, United Kingdom. 5. Whitaker, R., Captain, A., & Ahmed, F. (2004). *Snakes of India*. Draco Books. Chennai, India. 6. Sawaiker, R. U. (2021). Conservation of biodiversity through scientifically validated and well-participated people's biodiversity registers (PBRs) in Goa, India. *Asian Journal of Conservation Biology*, 10(1), 159–161.			

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Title of the Course	Environmental Biology and Ecology Practical
Course Code	ENV-5003
Number of Credits	01
Theory/Practical	Practical
Level	400
Effective from AY	2025-2026
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	1. To equip students with practical skills for ecological assessment through field-based surveys, mapping, and data collection in both terrestrial and aquatic ecosystems. 2. To develop an understanding of biodiversity and its role in ecosystem functioning. 3. To provide hands-on experience in evaluating and mitigating environmental impacts through pollution monitoring, ecosystem health assessments, and the application of Environmental Impact Assessment (EIA) for local development projects.	
Course Outcomes:		**Mapped to PSO**
	CO 1. Demonstrate proficiency in field-based ecological data collection	PSO 1
	CO 2. Apply biodiversity indices for assessing ecosystem health and biodiversity	PSO 1
	CO 3. Analyze the ecological impact of urban green spaces on biodiversity and ecosystem	PSO 1, PSO 4

	services			
	CO 4. Conduct environmental impact assessments (EIA) to evaluate ecosystem health and inform conservation strategies		PSO 1, PSO 6	
	CO 5. Implement ecological restoration techniques, including invasive species removal and native species reintroduction		PSO 1	
	CO 6. Evaluate conservation practices and biodiversity monitoring strategies in protected areas		PSO 1, PSO 4	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	1. Field Survey Techniques: Mapping, and ecosystem data collection in terrestrial and aquatic ecosystems for ecological assessment.	**30**	CO1	K2, K3
	2. Sampling for organisms: Transect, point count, quadrat.		CO1	K2, K3
	3. Biodiversity Assessment in Terrestrial & Aquatic Ecosystems: Identification and documentation of biodiversity using biodiversity indices to evaluate ecosystem health.		CO2	K3
	4. Pollution Monitoring in Urban Green Spaces: Conducting field-based evaluation of urban green spaces, focusing on biodiversity, ecosystem services, and their role in enhancing urban environmental quality.		CO3	K3, K4
	5. Ecosystem Health Assessment & EIA Field Assessment: Evaluating ecosystem health through field-based assessments and conducting Environmental Impact Assessment (EIA) for local development projects.		CO4	K3, K4
	6. Restoration Ecology Techniques: Practical exposure to ecological restoration through invasive species removal, habitat restoration, and native species reintroduction.		CO5	K3
	7. Field Trip to Protected Area: Observation and evaluation of conservation practices, wildlife management, and biodiversity monitoring in protected areas.		CO6	K5

Pedagogy:	Hands-on practicals/ demonstrations/ field visit
References/ Readings:	1. Bhatt, S., Kohli, K., & Kothari, A. (2006). *Process documentation of the National Biodiversity Strategy and Action Plan-India*. Kalpavriksh Environmental Action Group. Pune, Maharashtra, India. 2. Dey, S. (2004). *Bioresources and genepool conservation*. Daya Books. New Delhi, India. 3. Grimmett, R., Inskipp, C., & Inskipp, T. (2016). *Birds of the Indian Subcontinent: India, Pakistan, Sri Lanka, Nepal, Bhutan, Bangladesh and the Maldives*. Bloomsbury Publishing. London, United Kingdom. 4. Kemp, D., & Parto, S. (2005). *The International Handbook of Environmental and Resource Economics*. Edward Elgar Publishing. Cheltenham, United Kingdom. 5. Krebs, C. J. (2014). *Ecological methodology* (3rd ed.). Pearson. Boston, MA, USA. 6. Odum, E. P. (2004). *Fundamentals of ecology* (5th ed.). Saunders. Belmont, California, USA. 7. Whitaker, R., Captain, A., & Ahmed, F. (2004). *Snakes of India*. Draco Books. Chennai, India. 8. Sawaiker, R. U. (2021). Conservation of biodiversity through scientifically validated and well-participated people's biodiversity registers (PBRs) in Goa, India. *Asian Journal of Conservation Biology*, 10(1), 159–161.

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Title of the Course	Environmental Geology and Soil Science
Course Code	ENV-5004
Number of Credits	03
Theory/Practical	Theory
Level	400
Effective from AY	2025-2026
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	To provide knowledge on the interaction of humans with the geological environment, mechanism behind natural hazards and different geological resources and their management.	
Course Outcomes:		**Mapped to PSO**
	CO 1. Explain principles of geological processes and describe the impact of natural hazards	PSO 1, PSO 6
	CO 2. Classify different rock types and minerals based on physical properties.	PSO 1
	CO 3. Evaluate various mineral exploration and mining techniques and environmental impact.	PSO 1, PSO 6

	CO 4. Analyse soil forming processes and classify soil types of India.	PSO 1		
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	Introduction and scope of environmental geology. Geological time scale, internal structure and composition of the earth. Concept of plate tectonics – types of lithospheric plates, continental drift and sea floor spreading. Catastrophic natural hazards – volcanoes, earthquake, tsunami. Coastal erosion – protection and restoration.	**15**	CO1	K2
Module 2:	Important rock forming minerals. Composition, physical properties and distribution of important economic mineral deposits. Rock cycle – classification, properties and distribution of rocks. Minerals and human use. Mineral exploration techniques – opencast mining, underground mining. Mine gases and mine diseases, environmental impact and mitigation.	**15**	CO2, CO3	K2, K5
Module 3:	Introduction to soil science - Soil forming processes – chemical, physical and biological weathering, development of horizons and soil profile. Physical and chemical properties of soil, soil mineralogy. Soil classifications and soil types of India. Soil as a resource. Soil erosion, strategies to reduce soil erosion. Soil contamination and desertification.	**15**	CO4	K4, K2
Pedagogy:	Lectures, case studies, discussions and assignments			
References/ Readings:	1. Keller, E. A. (2012). *Introduction to environmental geology* (5th ed.). Prentice Hall, New Jersey, USA. 2. Montgomery, C. W. (2006). *Environmental geology* (p. 540). McGraw-Hill. Boston, MA, USA. 3. Pipkin, B. W., Trent, D. D., Hazlett, R., & Bierman, P. (2013). *Geology and the environment*. Cengage Learning. Belmont, CA, USA. 4. Valdiya, K. S. (1987). *Environmental geology: Indian context*. Tata McGraw-Hill Publishing Company. New Delhi, India.			

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Title of the Course	Environmental Geology and Soil Science Practical
Course Code	ENV-5005
Number of Credits	01
Theory/Practical	Practical
Level	400
Effective from AY	2025-2026
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	To develop ability to identify economic minerals and rocks and demonstrate basic methods for analysis of soil samples, its characteristics and recognition.	
Course Outcomes:		**Mapped to PSO**
	CO 1. Describe common economic minerals and igneous, sedimentary and metamorphic rocks.	PSO 1
	CO 2. Prepare maps of plate boundaries, volcanoes and earthquakes.	PSO 1
	CO 3. Prepare soil distribution maps of Goa using NBSS data source.	PSO 1
	CO 4. Measure grain size in soil samples.	PSO 1

Content:		No of hours	Mapped to CO	Cognitive Level
Module 1:	1. Megascopic study of common economic minerals.	**30**	CO1	K2
	2. Megascopic study of common Igneous, sedimentary and metamorphic rocks.		CO1	K2
	3. Marking of plate boundaries, volcanoes and earthquakes on world map and preparation of informative report.		CO2	K3
	4. Preparation of soil distribution maps of Goa using NBSS data source.		CO3	K3
	5. Collection of soil sample and grain size distribution analysis.		CO4	K5
Pedagogy:	Hands-on practical / demonstrations, discussions.			
References/ Readings:	1. Best, M. G. (2002). *Igneous and metamorphic petrology*. John Wiley & Sons. Hoboken, NJ, USA. 2. Condie, K. C. (1989). Plate tectonics and crustal evolution (3rd ed.). Pergamon Press, Oxford, UK. 3. Deer, W. A., Howie, R. A., & Zussman, J. (2013). *An introduction to the rock-forming minerals*. Mineralogical Society of Great Britain and Ireland. London, United Kingdom. 4. Lindholm, R. (2012). *A practical approach to sedimentology*. Springer Science & Business Media. London, United Kingdom.			

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Title of the Course	Atmospheric Science and Climate Change
Course Code	ENV-5006
Number of Credits	03
Theory/ Practical	Theory
Level	400
Effective from AY	2025-2026
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	To provide a basic understanding of atmospheric science and climate change	
Course Outcomes:		**Mapped to PSO**
	CO 1. Describe and explain the basic processes in the atmosphere, gas laws, solar and infra-red radiation and thermodynamics.	PSO 1
	CO 2. Discuss and explain water vapour, and precipitation processes.	PSO 1
	CO 3. Describe and explain atmospheric forces, wind, fronts and air masses and thunder storms.	PSO 1
	CO 4. Classify basic clouds types	PSO 1

	CO 5. Illustrate and explain circulation in the atmosphere, tropical cyclones and related aspects		PSO 1, PSO 6	
	CO 6. Evaluate aspects of Climate Change		PSO 1, PSO 6	
Content:		**No. of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	Atmospheric Basics: Overview of the Earth's Atmosphere; Equation of State; Ideal Gas Law; Hydrostatic Balance; Layers of the Atmosphere; The Difference of Weather and Climate. Solar and Infrared Radiation: Radiation; Blackbody Laws; Application to the Earth-Sun System Thermodynamics: Introduction; Energy Transfer; Lapse Rates; Potential Temperature; Heat Budget at the Earth's Surface	**15**	CO1	K2
Module 2:	Water Vapour: Humidity Variables Atmospheric Stability: Introduction; Atmospheric Stability and Lapse Rates Clouds: Introduction and Formation of Clouds; Cloud Naming Convention Precipitation Processes: Cloud Droplets; Collision-Coalescence Process; Ice Phase Process; Types of Precipitation	**15**	CO2 CO4	K2 K4
Module 3:	Atmospheric Forces and Wind: Main Forces; Force Balances General Circulation: Three-Cell Model; Monsoons; El Niño-Southern Oscillation; Madden-Julian Oscillation Fronts and Air-masses: Air Masses; Surface Fronts Thunderstorm Fundamentals: Thunderstorms Tropical Cyclones: Structure; Evolution Climate Change: Causes; Effects; Examples; Mitigation; Intergovernmental Panel on Climate Change (IPCC) Reports	**15**	CO3 CO5 CO6	K2 K3 K5
Pedagogy:	Lectures/ Tutorials/ Assignments			
References/	1. Ahrens, C. D., Jackson, P. L., & Jackson, C. E. J. (2012). *Meteorology today: An introduction to weather, climate,*			

Readings:	*and the environment* (1st Canadian ed.). Nelson Education. Ontario, Canada. 2. Berdin, V., Dobrolyubova, Y., Gracheva, E., Konstantinov, P., Ryzhova, N., Smirnova, E., & Zamolodchikov, D. (2018). *Climate box: An interactive learning toolkit on climate change*. United Nations Development Programme. https://www.undp.org/sites/g/files/zskgke326/files/migration/eurasia/Climatebox_textbook_EN.pdfIstanbul,Turkey. 3. Houghton, J. T. (2002). *The physics of atmospheres* (3rd ed.). Cambridge University Press, Cambridge, United Kingdom. 4. Intergovernmental Panel on Climate Change. (2021). *Climate change 2021: The physical science basis*. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom. 5. Intergovernmental Panel on Climate Change. (2022). *Climate change 2022: Impacts, adaptation, and vulnerability*. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom. 6. Intergovernmental Panel on Climate Change. (2022). *Climate change 2022: Mitigation of climate change*. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom. 7. Nugent, A., DeCou, D., Russell, S., & Karamperidou, C. (2019). *Atmospheric processes and phenomena*. University of Hawai‘i at Mānoa, Hawaii, USA. 8. Schmittner, A. (2019). *Introduction to climate change*. Oregon State University, Oregon, USA. 9. Stull, R. (2017). *Practical meteorology: An algebra-based survey of atmospheric science*. University of British Columbia, Vancouver, Canada. 10. Wallace, J. M., & Hobbs, P. V. (2006). *Atmospheric science: An introductory survey* (2nd ed.). Elsevier Academic Press, Amsterdam, Netherlands.
Web Resources:	1. http://pressbooks-dev.oer.hawaii.edu/atmo/ 2. https://www.eoas.ubc.ca/books/Practical_Meteorology/ 3. https://www.undp.org/sites/g/files/zskgke326/files/migration/eurasia/Climatebox_textbook_EN.pdf 4. https://open.oregonstate.education/climatechange/ 5. https://www.ipcc.ch/

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Title of the Course	Atmospheric Science and Climate Change Practical
Course Code	ENV-5007
Number of Credits	01
Theory/Practical	Practical
Level	400
Effective from AY	2025-2026
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	To provide some practical skills in analyses of some datasets, and also measurement of some variables, for obtaining a better understanding of the atmosphere and Climate Change.	
Course Outcomes:		**Mapped to PSO**
	CO 1. Analyse temperatures, extent of sea-ice and radio-sonde data	PSO 1, PSO 6
	CO 2. Deduce links between sea surface temperature and rainfall	PSO 1, PSO 5, PSO 6
	CO 3. Measure atmospheric temperature and humidity	PSO 1
	CO 4. Distinguish between basic cloud types	PSO 1
	CO 5. Estimate cloud cover	PSO 1

Content:		No. of hours	Mapped to CO	Cognitive Level
Module 1:	1. Analyses of Temperatures and its trends.	**30**	CO1	K4
	2. Linkages between Sea Surface Temperature and Rainfall.		CO2	K4
	3. Measurement of Atmospheric Temperature and Humidity.		CO3	K5
	4. Analysis of the Extent of Sea-Ice.		CO1	K4
	5. Analysis of Radiosonde Data		CO1	K4
	6. Observations of Cloud Cover and Type		CO4, CO5	K4, K5
Pedagogy:	Tutorials/assignments/practicals/ field-study			
References/ Readings:	1. Karnauskas, K. (2020). *Physical oceanography and climate*. Cambridge University Press, Cambridge, United Kingdom. 2. Stocker, T. F., Clarke, G. K. C., Le Treut, H., Lindzen, R. S., Meleshko, V. P., Mugara, R. K., Palmer, T. N., et al. (2001). Physical climate processes and feedbacks. In J. T. Houghton, Y. Ding, D. J. Griggs, M. Noguer, P. J. van der Linden, X. Dai, K. Maskell, & C. A. Johnson (Eds.), *Climate change 2001: The scientific basis* (pp. 417–470). Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press. Cambridge, United Kingdom. 3. World Meteorological Organization. (2021). *Guide to instruments and methods of observation* (WMO-No. 8) (2018 ed.). https://community.wmo.int/en/activity-areas/imop/wmo-no_8 Geneva, Switzerland. 4. Intergovernmental Panel on Climate Change. (2019). *Special report on the ocean and cryosphere in a changing climate*. Cambridge, United Kingdom. 5. Wallace, J. M., & Hobbs, P. V. (2006). *Atmospheric science: An introductory survey* (2nd ed.). Elsevier Academic Press, Amsterdam, Netherlands. 6. World Meteorological Organization. (2020). *Cloud identification guide*. World Meteorological Organization, Geneva, Switzerland.			
Web Resources:	1. https://www.ipcc.ch/site/assets/uploads/2018/03/TAR-07.pdf 2. https://community.wmo.int/en/activity-areas/imop/wmo-no_8			

	3. https://www.ipcc.ch/srocc/ 4. https://cloudatlas.wmo.int/en/cloud-identification-guide.html

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Discipline Specific Elective (DSE) Courses

Title of the Course	Coastal Habitats and Processes
Course Code	ENV-5201
Number of Credits	03
Theory/Practical	Theory
Level	400
Effective from AY	2025-2026
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	• To introduce to the marine environment with special emphasis on coastal habitats and processes. • To elucidate impact of anthropogenic effects on water quality degradation and fish exploitation in coastal habitats.	
Course Outcomes:		**Mapped to PSO**
	CO 1. Explain the structure and function of marine ecosystems, productivity, nutrient dynamics, and marine food web processes.	PSO 1
	CO 2. Explain the dynamics of marine communities and resources, including ecological niches,	PSO 1

	population processes, migrations, larval ecology, and oceanographic features.			
	CO 3. Describe key coastal habitats, focusing on species, adaptations, productivity, energy flow, and the ecological role of blue carbon.		PSO 1, PSO 6	
	CO 4. Analyze human impacts on coastal ecosystems and evaluate strategies for sustainable fishing, algal bloom control, and coastal resource management.		PSO 1, PSO 4, PSO 6	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	Marine Environment – Divisions of marine ecosystem, coastal and open ocean habitats, productivity, nutrient dynamics, MLD, and associated processes. Marine food webs, standing crop and carrying capacity. Living and non-living resources, marine communities, ecological niche, pyramid, population processes, upwelling, sub-surface chlorophyll maxima (SCM) and migrations (diurnal and ontogenic), larval ecology and bi-phased life cycle of benthic communities. Oxygen Minimum Zone (OMZ).	**15**	CO1, CO2	K2
Module 2:	Coastal habitats - inter-tidal ecosystem - rocky shore - zonation pattern - physical and biological factors, sandy shores and protected sand flats - physical and biological factors, faunal composition and adaptations. Salt marsh ecosystem – species composition, distribution, nutrient dynamics, primary productivity and ecological processes and fate of salt marsh plant; Mangrove ecosystem species composition, distribution, adaptations, primary productivity, heterotrophic production, secondary communities and energy flow. Blue carbon, key functions, threats and conservation.	**15**	CO3	K2
Module 3:	Human impact and coastal zone – primary productivity, Biological pump, Industrial, agriculture, sewage and other effluents, effect on water quality and marine life. Blooming events - bloom initiation, formation, propagation, decomposition, prevention and control - Chemical, biological, flocculants, role of zooplankton, viruses, parasites, bacteria. Potential Fishing Zones (PFZ), overexploitation and habitat destruction, Sediment dredging, Responsible fishing and sustainable management.	**15**	CO4	K4

Pedagogy:	Lectures/ tutorials/ assignments/ self-study
References/ Readings:	1. Nybakken, J. W., & Bertness, M. D. (2005). *Marine biology: An ecological approach* (6th ed.). Pearson/Benjamin Cummings. San Francisco, CA, USA. 2. Levinton, J. S. (1982). *Marine ecology*. Prentice-Hall. Englewood Cliffs, NJ, USA. 3. Mann, K. H. (2000). *Ecology of coastal waters: With implications for management* (2nd ed.). Blackwell Science, Oxford, United Kingdom. 4. Parsons, T. R., Takahashi, M., & Habgrave, B. (1984). *Biological oceanographic processes* (3rd ed.). Pergamon Press, Oxford, United Kingdom. 5. Valiela, E. (1995). *Marine ecological processes*. Springer Verlag, New York, USA.

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Title of the Course	Coastal Habitats and Processes Practical
Course Code	ENV-5202
Number of Credits	01
Theory/Practical	Practical
Level	400
Effective from AY	2025-2026
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	To identify commonly occurring marine organisms using morphological features.	
Course Outcomes:		**Mapped to PSO**
	CO 1. Apply standard methods to analyze and preserve biological communities from seawater and sediment.	PSO 1, PSO 5, PSO 6
	CO 2. Identify key mangrove species and describe their life cycles and biological characteristics.	PSO 1
	CO 3. Identify hard corals, teleost fishes, and brachyuran crabs using morphological features and explain their biological roles.	PSO 1

	CO 4. Distinguish prawns and shrimps based on external morphology and sex characteristics, and interpret their biological significance.		PSO 1	
Module 1:		**No of hours**	**Mapped to CO**	**Cognitive Level**
	1. Analysis of biological communities (water and sediment), their preservation and storage techniques using standard methods.	**30**	CO1	K3
	2. Identification of mangroves, their lifecycle and few biological characteristics.		CO2	K2
	3. Identification of hard corals and a few biological characteristics.		CO3	K2
	4. Identification of few commonly occurring teleosts (ray-finned fishes) and their biological characteristics.		CO3	K2
	5. Identification of brachyuran crabs using morphology and gonopod characteristics, sex determination and their biological importance.		CO3	K5
	6. Identification of prawns and shrimps using external characteristics, sex determination biological aspects.		CO4	K5
Pedagogy:	Demonstrations/ practical/ identification of marine flora and fauna/ field studies.			
References/ Readings:	1. Intergovernmental Oceanographic Commission. (1994). *Protocols for the Joint Global Ocean Flux Study (JGOFS) core measurements*. UNESCO-IOC. https://doi.org/10.25607/OBP-1409 Paris, France. 2. Untawale, A. G. (1985). *Mangroves of India: Present status and multiple use practices*. UNDP/UNESCO Regional Mangrove Project. Paris, France. 3. Dhargalkar, V. K., D'Souza, R., Kavlekar, D. P., & Untawale, A. G. (2014). *Mangroves of Goa*. Forest Department, Government of Goa, & Mangroves Society of India, Goa, India. 4. Hogarth, P. J. (2015). *The biology of mangroves and seagrasses*. Oxford University Press, Oxford, United Kingdom. 5. Venkataraman, K., Satyanarayana, Ch., Alfred, J. R. B., & Wolstenholme, J. (2003). *Handbook on hard corals of*			

	India. Zoological Survey of India, Kolkata, India. 6. Carpenter, K. E., & Niem, V. H. (1999). *FAO species identification guide for fishery purposes: The living marine resources of the Western Central Pacific (Vol. 4, Bony Fishes Part 2, Mugilidae to Carangidae)*. Food and Agricultural Organization, Rome, Italy. 7. Carpenter, K. E., & Niem, V. H. (2001). *FAO species identification guide for fishery purposes: The living marine resources of the Western Central Pacific (Vol. 5, Bony Fishes Part 3, Menidae to Pomacentridae)*. Food and Agricultural Organization, Rome, Italy. 8. Carpenter, K. E., & Niem, V. H. (1988). *FAO species identification guide for fishery purposes: The living marine resources of the Western Central Pacific (Vol. 2, Cephalopods, crustaceans, holothurians, and sharks)*. Food and Agricultural Organization, Rome, Italy.

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Title of the Course	Mangrove Ecosystem, Biodiversity and Conservation
Course Code	ENV-5203
Number of Credits	03
Theory/Practical	Theory
Level	400
Effective from AY	2025-2026
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	To introduce the students to the dynamic mangrove ecosystem, its composition – abiotic and biotic, benefits, threats and need for conservation.	
Course Outcomes:		**Mapped to PSO**
	CO 1. Gain knowledge about mangrove ecosystem, its floral and faunal biodiversity	PSO1
	CO 2. Imprint the importance of mangroves in maintaining the global climate and balance in the nutritional as well as biogeochemical cycles.	PSO1
	CO 3. Study the flora and fauna of the mangrove ecosystem	PSO1, PSO4
	CO 4. Highlight the need to conserve and protect the mangroves	PSO3, PSO4, PSO5,

			PSO6	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	*Structure and function of mangrove ecosystem:* Mangroves; global distribution; economic importance; current status; threats; ecology and environment; relation with other ecosystems; uses of mangroves; physical mangrove environment; forest types: overwashed, fringe, dwarf, riverine, basin, hammock; true mangroves: red, white, green, black; mangrove associates; adaptations in mangroves; patterns and processes in mangrove ecosystem; environmental factors; climate and habitats. Biodiversity in mangrove ecosystem: flora and fauna.	**15**	CO 1	K1, K2
Module 2:	*Ecological importance of mangrove ecosystem and the impact of anthropogenic activities:* Functional aspects: biomass, productivity, litter and its decomposition, carbon sink and organic carbon productivity; nitrogen and sulfur cycling; nutrient status; nurseries; biofilters for toxic pollutants; breeding grounds – fish, birds; mitigation of climate change; coastal defence mechanism; Indigenous people of mangroves: livelihood dependency; Case study mangroves of Sunderban and Goa. Anthropogenic destruction: deforestation; landfills; land reclamation; waste disposal sites; pollution: water quality and persistent chemicals; loss of mangrove biodiversity.	**15**	CO 2	K2, K4
Module 3:	*Restoration and conservation:* Restoration and afforestation projects; ecosystem based management; protected areas; restoration tools; monitoring methods: remote sensing and GIS; awareness programmes; training programmes; community based management; role of institutions; NGOs; national and global conservation strategies and policies; conservation and mangrove protection laws; economic valuation (cost benefit analysis); international agreements – Ramsar convention; case study – mangroves of	**15**	CO 3	K2, K3, K4

	Goa.			
Pedagogy:	Lectures/ case studies/ tutorials/ videos/ assignments/ self-study/ visits to mangrove conservation sites			
References/ Readings:	1. FAO. (2007). *The world's mangroves: 1980–2005*. Food and Agriculture Organization, Rome, Italy. 2. First International Training Course on Mangrove Ecosystems in the Western Indian Ocean Region. (2013, December 2–9). *Mangrove ecosystems in the Western Indian Ocean region*. UNU-INWEH-UNESCO, Ontario, Canada. 3. Kathiresan, K., & Ajmal Khan, S. (2005). *UNU-INWEH-UNESCO international training course on coastal biodiversity in mangrove ecosystem—Course manual* (p. 410). Annamalai University, Tamil Nadu, India. 4. Nagelkerken, I., Blaber, S. J. M., Bouillon, S., et al. (2008). The habitat function of mangroves for terrestrial and marine fauna: A review. *Aquatic Botany*, *89*, 155–185. 5. Nanjo, K., Kohno, H., Nakamura, Y., Horinouchi, M., & Sano, M. (2014). Effects of mangrove structure on fish distribution patterns and predation risks. *Journal of Experimental Marine Biology and Ecology, 461*, 216–225. 6. Sandilyan, S., & Kathiresan, K. (2012). Mangrove conservation: A global perspective. *Biodiversity Conservation, 21*, 3523–3542. 7. Singh, V. P., & Odaki, K. (2004). *Mangrove ecosystem: Structure and function*. Scientific Publishers, Jodhpur, India. 8. Shinnaka, T., Sano, M., Ikejima, K., Tongnunui, P., Horinouchi, M., & Kurokura, H. (2007). Effects of mangrove deforestation on fish assemblage at Pak Phanang Bay, Southern Thailand. *Fisheries Science, 73*, 862–870.			
Web Resources:	1. www.lifegate.com/sundarbans-beekeeping 2. https://youtu.be/svvYyljtcTk 3. https://www.youtube.com/watch?v=0ehUoK7xyvg 4. https://www.youtube.com/watch?v=6VHBJdTGH9k&t=7s 5. https://www.facebook.com/godrejlawkimmotors/videos/godrej-mangroves-world-nature-conservation-day-2020/305862404099765/ 6. https://www.youtube.com/watch?v=BFORURgz38I 7. https://www.youtube.com/watch?v=cwTZhyA57mA			

	8. https://www.youtube.com/watch?v=NOA-Al0RLKk 9. https://www.youtube.com/watch?v=0bsnP1B6-nE 10. https://www.youtube.com/watch?v=BzU0sJ6eZ7I 11. https://www.youtube.com/watch?v=s4br-wCS5ds 12. https://www.youtube.com/watch?v=hOKjrN2yRts 13. https://www.youtube.com/watch?v=mzn0z30nyJM 14. https://www.youtube.com/watch?v=t9qlVvEqP5U 15. https://www.youtube.com/watch?v=aI1u0YZWT-w 16. https://www.youtube.com/watch?v=nbN6zWUnm18 17. https://www.youtube.com/watch?v=YzzwGS0BijY&t=11s 18. https://www.littledayout.com/mangroves-and-marshlands-in-singapore-to-visit-on-your-next-nature-walk/ 19. https://www.youtube.com/watch?v=csq5XYCtZ9g 20. https://www.youtube.com/watch?v=NOA-Al0RLKk 21. https://edition.cnn.com/2019/07/15/middleeast/abu-dhabi-mangroves-scn-intl/index.html

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Title of the Course	Mangrove Ecosystem, Biodiversity and Conservation Practical
Course Code	ENV-5204
Number of Credits	01
Theory/Practical	Practical
Level	400
Effective from AY	2025-2026
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	To introduce the students to practical knowledge of mangrove ecosystem and its biodiversity studies	
Course Outcomes:		**Mapped to PSO**
	CO 1. Acquaint with types and species of mangroves in the state	PSO 1
	CO 2. Analyze physico-chemical parameters and their correlation with mangrove speciation	PSO 2
	CO 3. Evaluate the threats to mangroves	PSO 4, PSO 6
	CO 4. Create herbarium for preservation of mangroves	PSO 1, PSO 6

Content:		No of hours	Mapped to CO	Cognitive Level
Module 1	1. Field visit to evaluate current status of mangrove cover in Goa.	**30**	CO1, CO2	K1, K2
	2. Mangrove flora and associated fauna found in Goa.		CO1, CO2	K2, K4
	3. Physico-chemical parameters of mangrove ecosystem: pH, salinity, temperature, BOD, nutrients.		CO2	K4, K5
	4. Impact of anthropogenic activity on mangrove ecosystem.		CO3	K2, K4, K5
	5. Preparation of herbarium.		CO4	K1-K5
Pedagogy:	Site visits, field work, laboratory experiments			
References/ Readings:	1. Goa Forest Department. (n.d.). *Threat to mangrove ecosystem*. In *Mangroves of Goa* (Chap. 6, pp. 79–83). Goa Forest Department, Goa, India. 2. Kothari, M. J., & Rao, K. M. (2002). *Mangroves of Goa*. In N. P. Singh & P. S. N. Rao (Eds.), Botanical Survey of India, Kolkata, India. 3. Kathiresan, K., & Ajmal Khan, S. (2005). *UNU-INWEH-UNESCO international training course on coastal biodiversity in mangrove ecosystem—Course manual* (p. 410). Annamalai University, Tamil Nadu, India. 4. Pawar, G. M., & Salgaokar, B. B. (2023). *The biodiversity and ecology of fragile ecosystems of Goa: The mangroves and the saltpans*. Project report. Goa Forest Department, Goa, India.			

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Title of the Course	Remote Sensing Techniques and GIS
Course Code	ENV-5205
Number of Credits	03
Theory/Practical	Theory
Level	400
Effective from AY	2025-2026
New Course	Yes
Bridge Course/ Value-added Course	No
Course for advanced learners	Yes

Pre-requisites for the Course:	Nil	
Course Objectives:	This course provides a foundational understanding of remote sensing principles, technologies, and applications, with a focus on data acquisition, sensor types, and practical uses in environmental and resource management.	
Course Outcomes:		**Mapped to PSO**
	CO 1. Define the basic concepts and components of remote sensing.	PSO 5
	CO 2. Understand the principles of EMR and its interaction with Earth and the atmosphere	PSO 5
	CO 3. Identify types of remote sensing platforms, sensors, and resolutions.	PSO 5
	CO 4. Explain the fundamentals, components, and applications of GIS	PSO 5

Content:		No of hours	Mapped to CO	Cognitive Level
Module 1:	Introduction to Remote Sensing: Definition, Scope, and Historical Evolution. Principles of Remote Sensing and Electromagnetic Radiation. Components of Remote Sensing. Transmission of Electromagnetic Radiation and its Interaction with Earth's Surface. Propagation of Reflected/Emitted Energy through Atmosphere.	**15**	CO 1, CO 2	K1, K2
Module 2:	Types of Remote Sensing Platforms. Types of Sensors. Concepts of Spatial, Spectral, Temporal, and Radiometric Resolution. Data Acquisition in Remote Sensing. Applications of Remote Sensing. Resources and limitations of Remote Sensing. In-situ and Remote Sensor Technologies and UAV Applications.	**15**	CO 3	K2, K3
Module 3:	Introduction to GIS: Definitions, Components, History and Evolution, Need and Scope; Interdisciplinary Relations, Application Areas, Current Issues, Trends and Future. GIS software packages: proprietary & open source. Introduction to GIS software framework. Data types: spatial data, non-spatial data; data structures and data models (Raster & Vector); ESRI Shapefile.	**15**	CO 4	K2
Pedagogy:	Use of Conventional, Online and ICT Methods. Lecture / Tutorials / Assignments			
Texts:	1. Campbell, J. B., & Wynne, R. H. (2011). *Introduction to Remote Sensing.* Guilford Press. 2. Chuvieco, E. (2016). *Fundamentals of Satellite Remote Sensing.* CRC Press. 3. Jensen, J. R. (2015). *Remote Sensing of the Environment: An Earth Resource Perspective.* Pearson, Boston, MA, USA. 4. Lillesand, T. M., Kiefer, R. W., & Chipman, J. W. (2014). *Remote Sensing and Image Interpretation.* Wiley, Hoboken, NJ, USA. 5. Mobley, C. D. (1994). *Light and Water: Radiative Transfer in Natural Waters.* Academic Press, San Diego, CA, USA. 6. Richards, J. A. (2022). *Remote Sensing Digital Image Analysis.* Springer, Cham, Switzerland.			

References/ Readings:	1. Goodchild, M. F. (2009). Geographic information systems and science: Today and tomorrow. *Annals of GIS*, *15*(1), 3–9. 2. Longley, P. A., Goodchild, M. F., Maguire, D. J., & Rhind, D. W. (2005). GIS and science: On the influence of geography and geographic information science. *Geographical Analysis*, *37*(1), 1–8. 3. Mulla, D. J. (2013). Twenty-five years of remote sensing in precision agriculture: Key advances and remaining knowledge gaps. *Biosystems Engineering*, *114*(4), 358–371. 4. Pinter Jr., P. J., Hatfield, J. L., Schepers, J. S., Barnes, E. M., Moran, M. S., Daughtry, C. S. T., & Upchurch, D. R. (2003). Remote sensing for crop management. *Photogrammetric Engineering & Remote Sensing*, *69*(6), 647–664. 5. Rogan, J., & Chen, D. (2004). Remote sensing technology for mapping and monitoring land-cover and land-use change. *Progress in Planning*, *61*(4), 301–325.
Web Resources:	1. Indian Space Research Organisation. (n.d.). Space Applications Centre: Earth observation, atmospheric studies, and remote sensing programs. https://www.sac.gov.in 2. IOCCG Reports on Ocean Colour Remote Sensing (https://ioccg.org/what-we-do/ioccg-publications/ioccg-reports/). 3. ISRO's Remote Sensing Handbooks (https://www.isro.gov.in/Miscellaneous.html). 4. LearnOSM. (n.d.). Beginner's Guide to OpenStreetMap (OSM) https://learnosm.org/en/beginner/ 5. NASA and ESA Satellite Data Portals (https://www.earthdata.nasa.gov/) 6. QGIS Documentation – Introduction to GIS Concepts (https://docs.qgis.org/latest/en/docs/gentle_gis_introduction/) 7. VEDAS (Visualisation of Earth observation Data and Archival System) https://vedas.sac.gov.in

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Title of the Course	Remote Sensing Techniques and GIS Practical
Course Code	ENV-5206
Number of Credits	01
Theory/Practical	Practical
Level	400
Effective from AY	2025-2026
New Course	Yes
Bridge Course/ Value-added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	This course provides hands-on experience in Geographic Information Systems (GIS) and remote sensing, emphasizing practical skills in spatial data analysis and visualization. Students will learn core techniques such as georeferencing, vector and raster data creation, error identification, topology building, and data conversion between formats. The course also introduces remote sensing concepts, including satellite image processing and interpretation, enabling students to extract and analyze geospatial information for diverse real-world applications.	
Course Outcomes:		**Mapped to PSO**
	CO 1. Understand satellite data and its sources for remote sensing analysis	PSO 5
	CO 2. Evaluate and integrate remote sensing data for analysis and interpretation	PSO 5
	CO 3. Apply geospatial tools for data handling and visualization	PSO 5

	CO 4. Apply data conversion and mapping techniques in digital cartography		PSO 5	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	1. Familiarisation with Panoply/QGIS/ERDAS/ArcGIS/Python/ MATLAB.	**30**	CO1	K1
	2. Familiarity with remote sensors, their data sources, and portals.		CO1	K1, K2
	3. Layer Stacking of Multispectral Imagery.		CO2	K2, K3
	4. Creating a subset of the image		CO2, CO3	K2, K3
	5. Band Combination and Colour Composites.		CO2, CO3	K2, K3
	6. Georeferencing, Vector data Creation, Working with Attributes.		CO2, CO3	K2, K3
	7. Conversion of existing data (Rasterise / vectorise).		CO2, CO3	K2, K3
	8. Digital Cartography: Layout Generation, Using Multiple Data Frames.		CO4	K3
Pedagogy:	Use of Conventional, Online and ICT Methods. Hands-on Practical			
Texts:	1. Campbell, J. B., & Wynne, R. H. (2011). *Introduction to Remote Sensing.* Guilford Press. 2. Chuvieco, E. (2016). *Fundamentals of Satellite Remote Sensing.* CRC Press. 3. Jensen, J. R. (2015). *Remote Sensing of the Environment: An Earth Resource Perspective.* Pearson, Boston, MA, USA. 4. Lillesand, T. M., Kiefer, R. W., & Chipman, J. W. (2014). *Remote Sensing and Image Interpretation.* Wiley, Hoboken, NJ, USA. 5. Mobley, C. D. (1994). *Light and Water: Radiative Transfer in Natural Waters.* Academic Press, San Diego, CA, USA. 6. Richards, J. A. (2022). *Remote Sensing Digital Image Analysis.* Springer, Cham, Switzerland.			
References/	1. Goodchild, M. F. (2009). Geographic information systems and science: Today and tomorrow. *Annals of GIS, 15*(1),			

Readings:	3–9. 2. Longley, P. A., Goodchild, M. F., Maguire, D. J., & Rhind, D. W. (2005). GIS and science: On the influence of geography and geographic information science. *Geographical Analysis, 37*(1), 1–8. 3. Mulla, D. J. (2013). Twenty-five years of remote sensing in precision agriculture: Key advances and remaining knowledge gaps. *Biosystems Engineering, 114*(4), 358–371. 4. Pinter, Jr., P. J., Hatfield, J. L., Schepers, J. S., Barnes, E. M., Moran, M. S., Daughtry, C. S. T., & Upchurch, D. R. (2003). Remote sensing for crop management. *Photogrammetric Engineering & Remote Sensing, 69*(6), 647–664. 5. Rogan, J., & Chen, D. (2004). Remote sensing technology for mapping and monitoring land-cover and land-use change. *Progress in Planning, 61*(4), 301–325.
Web Resources:	1. Indian Space Research Organisation. (n.d.). Space Applications Centre: Earth observation, atmospheric studies, and remote sensing programs. https://www.sac.gov.in 2. IOCCG Reports on Ocean Colour Remote Sensing (https://ioccg.org/what-we-do/ioccg-publications/ioccg-reports/). 3. ISRO's Remote Sensing Handbooks (https://www.isro.gov.in/Miscellaneous.html). 4. LearnOSM. (n.d.). Beginner's Guide to OpenStreetMap (OSM) https://learnosm.org/en/beginner/ 5. NASA and ESA Satellite Data Portals (https://www.earthdata.nasa.gov/) 6. QGIS Documentation – Introduction to GIS Concepts https://docs.qgis.org/latest/en/docs/gentle_gis_introduction/ 7. VEDAS (Visualisation of Earth observation Data and Archival System) https://vedas.sac.gov.in

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SEMESTER II

Discipline Specific Core (DSC) Courses

Title of the Course	Analytical Techniques
Course Code	ENV-5008
Number of Credits	03
Theory/Practical	Theory
Level	500
Effective from AY	2025-2026
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Basic knowledge of chemistry and biology.	
Course Objectives:	• Understand various instrumental methods used for environmental monitoring. • Understand the principles, and working of the various basic and advanced instruments used in environmental analysis.	
Course Outcomes:		**Mapped to PSO**

	CO 1. Understand the use of various analytical methods in environmental analysis.		PSO 1, PSO 2	
	CO 2. Describe different types of microscopy, radioisotopes.		PSO 1, PSO 2	
	CO 3. Explain the use of spectrometric assays in environmental analysis.		PSO 1, PSO 2	
	CO 4. Apply knowledge of environmental analysis of samples using the principles of chromatography, centrifugation and electrophoresis.		PSO 1, PSO 2	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	Chromatographic techniques: GC, HPLC, Ion-exchange, affinity and molecular exclusion; Centrifugation: Density gradient centrifugation, Ultracentrifugation; Spectrophotometry: Atomic Absorption Spectrophotometry (AAS), AES, UV-Visible, fluorimetry Spectroscopy: Fourier transformation infra-red spectroscopy (FTIR), NMR, IRMS, ICP MS, MALDI-TOF, Circular dichroism, Optical rotatory dispersion.	**15**	CO1, CO3, CO4	K3
Module 2:	Microscopy: Epifluorescence, SEM, TEM, Confocal microscopy; Radio-isotope and tracer techniques: Radio-activity counters, Autoradiography, Radiorespirometry. Sorting: Flow cytometry, Fluorescence activated cell sorter (FACS), Biosafety: Biosafety levels of laboratories, Biohazards and Biosafety cabinets.	**15**	CO1, CO2	K2
Module 3:	Electrophoretic techniques: PAGE, IEF, PFGE, DGGE, TGGE. X-ray diffraction: Energy Dispersive X-Ray Fluorescence, Wavelength Dispersive X-Ray Fluorescence. CNS analyser, Oxygen analyser, Particle size analyser, TOC analyser, Turbidimetry, Nephelometry.	**15**	CO1, CO3	K3

Pedagogy:	Lectures/ tutorials/ assignments/ self-study/ Videos
References/ Readings:	1. Cooper, T. G. (2011). *The tools of biochemistry* (1st ed.). Wiley India Pvt. Ltd., New Delhi, India. 2. Ewing, G. W. (1995). *Instrumental methods of chemical analysis* (5th ed.). McGraw-Hill, New York, USA. 3. Goswami, C., Paintal, A., & Narain, R. (2011). *Handbook of bioinstrumentation*. Wisdom Press, New Delhi, India. 4. Jayaraman, J. (2011). *Laboratory manual in biochemistry*. New Age International Publishers, New Delhi, India. 5. Parakhia, M. V., Tomar, R. S., Patel, S., & Golakiya, B. A. (2010). *Molecular biology and biotechnology: Microbial methods*. NIPA, New Delhi, India. 6. Reeve, R. N. (2002). *Introduction to environmental analysis* (1st ed.). John Wiley & Sons Ltd., Chichester, West Sussex, England. 7. Skoog, D. A., West, D. M., & Holler, F. J. (2001). *Fundamentals of analytical chemistry* (7th ed.). Harcourt Asia PTE Ltd., Singapore. 8. Willard, H., Merritt, L., Dean, D. A., & Settle, F. A. (1998). *Instrumentation methods of analysis* (7th ed.). Wordsworth, Belmont, California. 9. Wilson, K., & Walker, J. (2013). *Principles and techniques of biochemistry and molecular biology*. Cambridge University Press, Cambridge, United Kingdom.

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Title of the Course	Analytical Techniques Practical
Course Code	ENV-5009
Number of Credits	01
Theory/Practical	Practical
Level	500
Effective from AY	2025-2026
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Basic knowledge of chemistry and biology.	
Course Objectives:	• This course develops the skills for techniques and instrumentation. • To understand the principles and working of various instruments used in environmental analysis.	
Course Outcomes:		**Mapped to PSO**
	CO 1. Understand the use of various analytical methods in environmental analysis.	PSO 1, PSO 2
	CO 2. Apply knowledge of environmental analysis of samples using the principles of chromatography, centrifugation.	PSO 1, PSO 2
	CO 3. Explain the use of spectroscopic assays in environmental analysis.	PSO 1, PSO 2
	CO 4. Interpret the results of environmental sample analysis.	PSO 1, PSO 2

Content:		No of hours	Mapped to CO	Cognitive Level
Module 1:	1. Demonstration of cell structure and components by SEM.	**30**	CO1	K2
	2. Demonstration of GC/ FTIR/ NMR/ MALDI-TOF.		CO2, CO3	K2, K3
	3. Demonstration of LC-MS.		CO3	K2
	4. Demonstration of TOC analyser.		CO1	K2
	5. Elucidation of the structure of cellular metabolites using IR, NMR and Mass profiles.		CO3, CO4	K2, K3
Pedagogy:	Practicals/ Tutorials/ Research papers/ assignments/ presentations/ self-study/ Videos			
References/ Readings:	1. Cooper, T. G. (2011). *The tools of biochemistry* (1st ed.). Wiley India Pvt. Ltd. New Delhi, India 2. Goswami, C., Paintal, A., & Narain, R. (2011). *Handbook of bioinstrumentation*. Wisdom Press, New Delhi, India. 3. Jayaraman, J. (2011). *Laboratory manual in biochemistry*. New Age International Publishers, New Delhi, India 4. Parakhia, M. V., Tomar, R. S., Patel, S., & Golakiya, B. A. (2010). *Molecular biology and biotechnology: Microbial methods*. NIPA. New Delhi, India. 5. Wilson, K., & Walker, J. (2013). *Principles and techniques of biochemistry and molecular biology*. Cambridge University Press, Cambridge, United Kingdom.			

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Title of the Course	Environmental Microbiology
Course Code	ENV-5010
Number of Credits	03
Theory/Practical	Theory
Level	500
Effective from AY	2025-2026
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	To equip students with a thorough understanding of the microbial world, focusing on the diversity, ecology, and physiological roles of microorganisms in various environments, and explore their impacts on ecosystem functioning, human health, and sustainable development.	
Course Outcomes:		**Mapped to PSO**
	CO 1. Understand classification systems and microbial diversity from diverse environments.	PSO 1, PSO 4
	CO 2. Review techniques to study microbial communities and interpret their ecological interactions.	PSO 1, PSO 4
	CO 3. Assess the roles of microorganisms in ecological processes and their impact on	PSO 1, PSO 4, PSO 6

	biodiversity, environmental stability, and public health.			
	CO 4. Evaluate microbial solutions for sustainability in agriculture, energy, environment, and industry.		PSO 1, PSO 4, PSO 6	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	Introduction to the microbial world and a brief history of microbiology; microbial groups (Archaea, bacteria, protists, fungi, viruses) from diverse terrestrial and aquatic environments; Aim and principles of classification, systematics and taxonomy, concept of species, taxa, strain; concepts of extremophilic microorganism (Thermophiles, halophiles, acidophiles, alkaliphiles, piezophiles, and psychrophiles). Culture-dependent and culture-independent approaches for understanding microbial diversity in the environment; microbial associations (plant-microbe, animal-microbe): mutualism, protocooperation, commensalism, syntrophism, predation, competition, amensalism and parasitism.	**15**	CO1, CO2	K2, K5
Module 2:	Impacts of microorganisms on the environment and humans: role of microorganisms in food web, biogeochemical cycling of carbon, nitrogen and phosphorus. microorganisms and climate change, range extension of species; disease outbreaks and epizootics; Microorganisms in Global Biodiversity and Conservation: Keystone Microbial Species, Microbiomes in Conservation, Extinction Risks Due to Pathogens; antibiotic-resistant bacteria and their implications; Microbial Threats and Bioterrorism; ballast water and bio-invasion: concept, implications and preventive measures, ballast water management convention, biofilms, bio-fouling and corrosion associated with shipping industry-progression, impacts and preventive measures.	**15**	CO3	K5
Module 3:	Environmental microbiology in sustainable development, microorganisms in agriculture: nitrogen-fixing bacteria, Mycorrhizae, phosphate-solubilizing bacteria, plant growth-promoting Rhizobia, biocontrol agents, Genetically Modified Organisms. Microorganisms for food security, clean energy, water quality, bioactive compounds for therapeutics, bioenzymes (Lignocellulolytic microorganisms,	**15**	CO4	K6

	enzymes and their biotechnological applications in: (i) biopulping, (ii) biobleaching, (iii) textiles (iv) animal feed production); mineral recovery (Bioleaching of copper, gold and uranium) bioremediation of environmental pollutants (Petroleum hydrocarbons and pesticides heavy metal and xenobiotics)**.**			
Pedagogy:	Lectures/ tutorials/ assignments/ case study/ self-study.			
References/ Readings:	1. Bertrand, J. C., & Coumette, P. (2015). *Environmental microbiology: Fundamentals and applications*. Springer. Dordrecht, Netherlands. 2. Medigan, M. T., Bender, K. S., Bukley, D. H., Sattley, W. M., & Stahl, D. A. (2019). *Brock biology of microorganisms* (15th ed.). Pearson. Boston, MA, USA. 3. Munn, C. (2020). *Marine microbiology: Ecology and applications* (3rd ed.). Garland Science. Boca Raton, FL, USA. 4. Naik, M. M., & Dubey, S. K. (2017). *Marine pollution and microbial remediation*. Springer. Singapore. 5. Satyanarayana, T., Johri, B., & Anil, T. (2012). *Microorganisms in environmental management*. Springer. Dordrecht, Netherlands. 6. Willey, J. M., Sherwood, L. M., & Woolverton, C. J. (2017). *Prescott's microbiology* (10th ed.). McGraw-Hill Education. New York, USA.			

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Title of the Course	Environmental Microbiology Practical
Course Code	ENV-5011
Number of Credits	01
Theory/Practical	Practical
Level	500
Effective from AY	2025-2026
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	To equip students with hands-on skills and a comprehensive understanding of microbiological techniques applied in environmental monitoring, microbial isolation, and the assessment of microbial interactions in various ecosystems.	
Course Outcomes:		**Mapped to PSO**
	CO 1. Demonstrate the ability to assess and evaluate the microbiological quality of air and water.	PSO 1, PSO 2, PSO 4
	CO 2. Gain proficiency in isolating symbiotic and environmentally significant microorganisms.	PSO 1, PSO 4
	CO 3. Perform culture-independent analysis of microbial communities by extracting genomic	PSO 1, PSO 4

	DNA from environmental samples and identifying microorganisms using sequence data.			
	CO 4. Develop the ability to isolate and screen bacteria capable of metal and hydrocarbon transformations to be used for bioremediation.		PSO 1, PSO 4, PSO 6	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	**1. Assessment of microbiological quality of air.**	30	CO1	K3, K4, K5, K6
	2. Isolation of symbiotic nitrogen-fixing rhizobacteria from the root nodules.		CO2	K3, K4, K5
	3. Isolation of bioluminescent bacteria from marine organisms.		CO2	K3, K4, K5
	4. Detection and enumeration of coliforms in water samples using the Most Probable Number (MPN) method.		CO1	K3, K4, K5
	5. Isolation of microbial genomic DNA from environmental sample (Sediment/Water) and identification of select microorganisms using provided sequence data.		CO3	K3, K4, K5
	6. Isolation and screening of bacteria capable of metal and hydrocarbon transformation.		CO4	K3, K4, K5
Pedagogy:	Laboratory experiments/ field trips.			
References/ Readings:	1. Amaresan, N., Patel, P., & Amin, D. (Eds.). (2022). *Practical handbook on agricultural microbiology*. Springer, New York, USA. 2. Davis, L. G., Dibner, M. D., & Battey, J. F. (1986). *Basic methods in molecular biology*. Elsevier, New York, USA. 3. Kamlage, B. (1996). *Methods for general and molecular bacteriology*. In P. Gerhardt, R. G. E. Murray, W. A. Wood, & N. R. Krieg (Eds.), American Society for Microbiology, Washington, D.C., USA. 4. Naik, M. M., & Dubey, S. K. (2017). *Marine pollution and microbial remediation*. Singapore			

	5. Pepper, I. L., Gerba, C. P., & Brendecke, J. W. (1995). Environmental microbiology: A laboratory manual. Academic Press, San Diego, CA, USA. 6. Parmar, P., Shukla, A., Saraf, M., & Patel, B. (2020). Isolation of bioluminescent bacteria from marine organisms. Indian Journal of Geo Marine Sciences 49(03), 471-476.

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Title of the Course	Environmental Toxicology and Risk Assessment
Course Code	ENV-5012
Number of Credits	03
Theory/Practical	Theory
Level	500
Effective from AY	2025-2026
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	To equip students with foundational knowledge in environmental toxicology and risk assessment for evaluating the impact of pollutants on human and ecological health.	
Course Outcomes:		Mapped to PSO
	CO 1. Define key concepts in toxicology, including dose-response relationships, exposure pathways, and toxicity mechanisms.	PSO 1, PSO 4
	CO 2. Distinguish between different types of toxic effects and analyse their implications for human and ecological health.	PSO 1, PSO 4
	CO 3. Explain the mechanism of environmental contaminants.	PSO 1, PSO 4

	CO 4. Use basic toxicological data to perform exposure assessments and calculate risk estimates.		PSO 1, PSO 4	
	CO 5. Critically assess risk assessment methodologies and regulatory guidelines used in environmental health decision-making.		PSO 1, PSO 4	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	Definition and importance; historical incidents of environmental toxicology; types/classification of toxicants: natural and anthropogenic; pathways of toxicant: air, water, soil, and food; dose and response relationship; toxicity; toxicokinetic and toxicodynamic; antimicrobial resistance; toxicant uptake	**15**	CO 1	K1
Module 2:	**Mechanisms of toxic action: oxidative stress, neurotoxicity, immunotoxicity, and endocrine disruption; Biomarkers of exposure, effect, and susceptibility; biomarkers of exposure, effect, and susceptibility; bioaccumulation, bioconcentration, and biomagnification; effects of pollutants on aquatic and terrestrial ecosystems; methods in ecotoxicology: acute and chronic toxicity tests; biotransformation and elimination; environmental forensics; teratogenesis, carcinogenesis, mutagenesis**	**15**	CO 2, CO 3	K2, K4
Module 3:	Risk assessment: Definition, scope, and importance; steps in risk assessment; risk characterization; risk management and communication; case studies; tools and techniques in risk assessment; regulatory frameworks; application of risk assessment in industrial and environmental contexts	**15**	CO 4, CO 5	K3, K5
Pedagogy:	Lectures/assignments/self-study/field trip			
References/ Readings:	1. Cockerham, L. G., & Shane, B. S. (2019). *Basic environmental toxicology*. CRC Press. Boca Raton, FL, USA. 2. Hughes, W. (1996). *Essentials of environmental toxicology*. CRC Press, London, United Kingdom. 3. Newman, M. C. (2019). *Fundamentals of ecotoxicology: The science of pollution* (5th ed.). CRC Press. Boca Raton, FL, USA. 4. Rand, G. M. (2020). *Fundamentals of aquatic toxicology: Effects, environmental fate, and risk assessment*. CRC			

	Press, Boca Raton, FL, USA. 5. Torres, J. A., & Bobst, S. (2015). *Toxicological risk assessment for beginners*. Springer, Cham, Switzerland. 6. Wright, D. A., & Welbourne, P. (2002). *Environmental toxicology*. Cambridge University Press, Cambridge, United Kingdom.

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Title of the Course	Environmental Toxicology and Risk Assessment Practical
Course Code	ENV-5013
Number of Credits	01
Theory/Practical	Practical
Level	500
Effective from AY	2025-2026
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	To provide hands-on experience in toxicity testing, pollutant impact assessment, and risk analysis using biological and environmental indicators for evaluating ecological and human health risks.	
Course Outcomes:		**Mapped to PSO**
	CO 1. Understand the experimental procedures used in environmental toxicity testing.	PSO 1, PSO 4
	CO 2. Describe the principles behind LC_{50} determination, dose-response relationships, and pollutant impact assessment.	PSO 1, PSO 4
	CO 3. Devise laboratory experiments to evaluate toxicity and the effects of pollutants on biological systems.	PSO 1, PSO 4

	CO 4. Prepare dose-response curves and formulate basic environmental risk assessments based on experimental outcomes.		PSO 1, PSO 4	
	CO 5. Classify marine debris/plastics by size and analyze patterns to assess potential environmental impacts.		PSO 1, PSO 4	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	1. Determine impact of heavy metals of the growth of test organism/plankton.	**30**	CO1, CO3	K2, K5
	2. Determination of LC_{50} using a test organism/plankton.		CO2	K1
	3. Determine the effect of pesticide/heavy metal on seed germination.		CO3	K5
	4. Preparation of dose-response curves, risk assessment and data interpretation.		CO4	K2
	5. Size classification of marine debris/plastic.		CO 5	K3, K5
Pedagogy:	Laboratory experiments/field trips			
References/ Readings:	1. Goh, B.P.L., Tong, J.J.L., Tan, L.T., Lim, K. & Tun, K.P.P. (2020). Marine Ecotoxicology Biomonitoring Made Easy – Six Biomarker Assays for the Citizen Scientist. National Institute of Education, Nanyang Technological University, National Parks Board, Singapore. 2. Goh, B.P.L., Lai, C.H., Tan, L.T., Yap, N.W.L. & Dissanayake, A. (2014). Handbook of Marine Ecotoxicology Techniques. National Institute of Education, Nanyang Technological University. National Parks Board, Singapore. 3. Kroon, F. J., Motti, C. E., Jensen, L. H., & Berry, K. L. (2018). Classification of marine microdebris: A review and case study on fish from the Great Barrier Reef, Australia. Science Reports, 8(1), 1-15. London, United Kingdom.			

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Title of the Course	Waste Management
Course Code	ENV-5014
Number of Credits	03
Theory/Practical	Theory
Level	500
Effective from AY	2025-2026
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	To understand the concept of waste, its types, classification, and characterization, recognize the importance of waste management and its environmental and public health implications, learn strategies and methods for waste disposal and treatment, and be aware of the role of individual and central laws in managing waste.	
Course Outcomes:		**Mapped to PSO**
	CO 1. Identify and classify different types of wastes and analyze their environmental, social, and economic impacts.	PSO 1, PSO 4
	CO 2. Evaluate various waste treatment methods in terms of efficiency, cost, and environmental sustainability.	PSO 1, PSO 4

	CO 3. Differentiate types and management of hazardous wastes.		PSO 1, PSO 4	
	CO 4. Analyze various policies, regulations, and guidelines for effective waste management and generate awareness among the general public.		PSO 1, PSO 4	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	Types of wastes, Classification of waste based on physical properties: Solid, liquid, gaseous, and semi-solid waste; Sources and categories of waste generation. Waste Generation and Its Environmental Impact, Principles of Waste Management- Waste Hierarchy, Sustainable Waste Management Principles, Integrated Waste Management Systems. Characteristics of municipal solid waste (physical, chemical and biological). waste prevention and waste reduction techniques; Factors affecting the solid waste generation; Storage, collection and transportation of municipal solid waste; Disposal of Municipal solid waste- Landfilling, Planning and design, construction and operational practices; quality check and control measures; Composting; biogas production from municipal solid waste; and Incineration of waste, Residues and its utilisation; co-combustion; Pyrolysis; Gasification; Refuse Derived Fuel; solid recovered fuel.	**15**	CO 1, CO 2	K1, K2, K3, K4, K5
Module 2:	Definition and types of liquid waste: Domestic sewage, industrial wastewater, agricultural runoff, leachate, and stormwater. Characteristics of liquid waste: Physical, chemical, and biological properties. Environmental impacts of untreated liquid waste. Sewage treatment processes: Single dwelling, Municipal waste treatment plants- Primary Treatment Techniques (Screening and grit chambers, Sedimentation tanks for settling suspended solids). Secondary Treatment Techniques: Biological treatment methods (Aerobic processes- Activated sludge process, trickling filters, oxidation ponds; Anaerobic processes- Upflow Anaerobic Sludge Blanket reactors, anaerobic lagoons). Tertiary and advanced Treatment techniques: (Chemical processes: Coagulation, flocculation, chlorination, and ozonation). Physical processes: Membrane filtration (microfiltration, ultrafiltration, reverse osmosis), constructed wetlands and bioreactors.	**15**	CO 1, CO 2	K1, K2, K3, K4 K5

Module 3:	Hazardous waste: Definition, sources, types (biomedical, nuclear and e-waste), effects and management. Principles of Industrial waste treatment: sources of pollution, physical-chemical and biological properties; characteristics and composition of wastes, including waste reduction, treatment of Dairy, Distillery, Sugar, and Antibiotic Industries; Use of SCADA systems for waste management; Biotechnological and Nanotechnological Advances in Waste Management. Environmental Regulation for Waste Management- Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016, E-Waste (Management) Rules, 2016 and 2022 Amendments, Plastic Waste Management Rules, 2016 and 2021 Amendments. Involvement of the public in waste management. Entrepreneurship in Waste Management.	**15**	CO 1, CO 2, CO 4	K1, K2, K3, K4, K5
Pedagogy:	Lectures/tutorials/assignments/case study/self-study.			
References/ Readings:	1. World Health Organization. (2024). Chapter 4: Solid waste. In *Compendium of WHO and other UN guidance in health and environment, 2024 update*. World Health Organization, Geneva. 2. Englande, A. J., & Jin, G. (2006). Application of biotechnology in waste management for sustainable development: An overview. *Management of Environmental Quality: An International Journal, 17*(4), 467–477. 3. Hammer, M. J. (1986). *Water and wastewater technology*. Englewood Cliffs, NJ, USA. 4. Lie, D. H., & Liptak, B. G. (2000). *Hazardous wastes and solid wastes*. Lewis Publishers, Boca Raton, FL, USA. 5. Pichtel, J. (2005). *Waste management practices: Municipal, hazardous, and industrial*. CRC Press, Boca Raton, FL, USA. 6. Vallero, D. A. (2022). Hazardous waste management (3rd ed.). Academic Press, Cambridge, MA, USA.			
Web Resources:	http://cpheeo.gov.in/cms/manual-on-municipal-solid-waste-management-2016.php			

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Title of the Course	Waste Management Practical
Course Code	ENV-5015
Number of Credits	01
Theory/Practical	Practical
Level	500
Effective from AY	2025-2026
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	To analyze waste generation patterns and management challenges in local communities, understand operational processes in wastewater and solid waste treatment facilities, and evaluate innovative treatment technologies while assessing wastewater quality through lab analysis.	
Course Outcomes:		**Mapped to PSO**
	CO 1. Conduct laboratory analyses of wastewater sample, measuring key chemical and biological parameters to evaluate water quality and treatment efficiency.	PSO 1, PSO 2, PSO 4, PO6
	CO 2. Prepare and analyze the bio-compost.	PSO 1, PSO 4, PO6
	CO 3. Perform the clarification of the dye-contaminated wastewater using nanoparticles.	PSO 1, PSO 4, PSO 6

	CO 4. Gain insights into the operational mechanisms and management strategies employed in wastewater, solid waste treatment and biomedical waste facilities through field observations.		PSO 1, PSO 4	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	1. To analyze key physicochemical and biological parameters specific to the wastewater sample.	**30**	CO1	K3, K4, K5, K6
	2. Perform bio-composting.		CO2	K3, K4, K5, K6
	3. Perform compost analysis- pH, Electrical Conductivity, determination of nitrate, phosphate, potassium etc.		CO2	K3, K4, K5, K6
	4. Use of nanoparticles (TiO_2/ ZnO/ Ag) for the clarification of dye-contaminated wastewater.		CO3	K3, K4, K5, K6
	5. Field visit to waste treatment facility to observe and understand the working processes and management mechanisms, and prepare a detailed report on the findings.		CO4	K3, K4, K5
Pedagogy:	Laboratory experiments / field trips/ field reports and presentations.			
References/ Readings:	1. Authority, E. P., & Victoria, A. (2000). *A guide to the sampling and analysis of waters, wastewaters, soils and wastes*. Environmental Protection Authority, Victoria, Australia. 2. Elbadawy, H. A., Elhusseiny, A. F., Hussein, S. M., & Sadik, W. A. (2023). Sustainable and energy-efficient photocatalytic degradation of textile dye assisted by ecofriendly synthesized silver nanoparticles. *Scientific Reports, 13*(1), 2302. 3. Iram, S., Kanwal, S., Ahmad, I., Tabassam, T., Suthar, V., & Mahmood-ul-Hassan, M. (2013). Assessment of physicochemical parameters of wastewater samples. *Environmental Monitoring and Assessment, 185*, 2503–2515. 4. Head, K. H., & Epps, R. (2014). *Manual of soil laboratory testing*. Whittles Publishing, Caithness, Scotland. 5. Hung, Y. T. (2014). *Handbook of environment & waste management* (Vol. 2). World Scientific, Singapore			

	6. Okafor, N. (2011). *Environmental microbiology of aquatic and waste systems*. Springer Science & Business Media. Dordrecht, Netherlands.
Web Resources:	https://www.vlab.co.in/

Discipline Specific Elective (DSE) Courses

Title of the Course	Environmental Ethics
Course Code	ENV-5207
Number of Credits	04
Theory/Practical	Theory
Level	400
Effective from AY	2025-2026
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	• To introduce students to the fundamental concepts, terminology, and historical developments in environmental ethics. • Analyze different value systems and moral theories pertaining to environmental decision-making. • Propose innovative, ethically sound solutions to environmental problems that integrate moral reasoning and sustainable technology.	
Course Outcomes:		**Mapped to PSO**
	CO 1. Analyze different theories of environmental ethics.	PSO 4, PSO 6

	CO 2. Develop and apply the essential forms of argumentation that can be offered for preserving natural entities and ensure the sustainable use of natural resources.		PSO 4, PSO 6	
	CO 3. Define and understand the key concepts, terminology, historical developments and ethical perspectives.		PSO 1, PSO 6	
	CO 4. Enhance the knowledge and abilities required to address complex environmental challenges by guiding students to critically examine how their choices and actions impact the environment.		PSO 1, PSO 6	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	Introduction to environmental ethics; Definition and Scope; Historical context; Philosophical challenges; Ethical framework and perspectives	**15**	CO3, CO4	K2, K 5
Module 2:	Value and Nature; Moral theories (Consequentialism, Virtue Ethics and Kantianism); Intrinsic value and Instrumental values; Anthropocentrism; Challenges to Anthropocentrism.	**15**	CO1, CO2	K3, K4, K6,
Module 3:	Ecology; Land ethics; Deep ecology & Shallow ecology; Bio centrism & Eco-centrism; Speciesism.	**15**	CO3	K1, K2
Module 4:	Technology and Environmental Impact; Ethics related to sustainable technology; Ethical issues in technological development; Environmental justice and technology; Contemporary issues (over-exploitation of natural resources, pollution, climate change), Technology and Environmental Ethics.	**15**	CO2, CO4	K3, K5, K6
Pedagogy:	Lectures/ assignments/ workshops/ campus walks/ documentaries/ discussions/ presentations			
References/ Readings:	1. Attfield, R. (2014). *Environmental philosophy*. Polity Press, Cambridge, United Kingdom 2. Bassey, S. (2020). Technology, environmental sustainability, and the ethics of anthropoholism. Przestrzeń Społeczna, 16(1), 45–58. 3. Epting, S. (2010). Questioning technology's role in environmental ethics: Weak anthropocentrism revisited.			

Interdisciplinary Environmental Review, 11(1). Geneva, Switzerland.

4. Gardiner, S. M., & Thompson, A. (2017). *The Oxford handbook of environmental ethics*. Oxford University Press, Oxford, United Kingdom.
5. Grim, J. A. (Ed.). (2001). *Indigenous traditions and ecology: The inter-being of cosmology and community*. Harvard University Press, MA, USA.
6. Jamieson, D. (2008). *Ethics and environment: An introduction*. Cambridge University Press, Cambridge, United Kingdom.
7. Jaquet, F. (2019). Is speciesism wrong by definition? *Journal of Agricultural and Environmental Ethics, 32*(3). Dordrecht, Netherlands.
8. Kaplan, D. M. (2017). *Philosophy, technology, and the environment*. MIT Press. Cambridge, MA, USA
9. Kopnina, H., Washington, H., Taylor, B., & Piccolo, J. J. (2018). Anthropocentrism: More than just a misunderstood problem. Journal of Agricultural and Environmental Ethics, 31(1), 109–127.
10. Passmore, J. (1974). *Man's responsibility for nature*. Charles Scribner's Sons, New York, USA.
11. Sandler, R. (2017). *Environmental ethics: Theory in practice*. Oxford University Press, Oxford, United Kingdom
12. Taylor, P. W. (1986). *Respect for nature: A theory of environmental ethics*. Princeton University Press, Princeton, NJ, USA.
13. Weaver, P., Jansen, L., Grootveld, G., Spiegel, E., & Vergragt, P. (2000). *Sustainable technology development*. Routledge, London, United Kingdom.

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Title of the Course	Environmental Issues and Perspectives
Course Code	ENV-5208
Number of Credits	04
Theory/Practical	Theory
Level	400
Effective from AY	2025-2026
New Course	Yes
Bridge Course/ Value-added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	• To provide a conceptual foundation for understanding contemporary environmental concerns • To foster the ability to apply theoretical knowledge to practical environmental problems • To develop critical thinking on sustainability and environmental futures	
Course Outcomes:		**Mapped to PSO**
	CO 1. Understand ecological concepts and interdisciplinary approaches to environmental studies to critically examine human-nature relationships.	PSO 1
	CO 2. Analyse the impacts of human population dynamics, urbanisation, and development on natural resources	PSO 1, PSO 4

	CO 3. Identify and evaluate contemporary environmental issues such as pollution, food security, and global warming through scientific and social perspectives.		PSO 1, PSO 3, PSO 6	
	CO 4. Examine the social dimensions of environmental issues		PSO1, PSO 4, PSO 6	
	CO 5. Apply principles of sustainability, environmental ethics, and ecological citizenship to propose community-based strategies for environmental conservation and livelihood security.		PSO 1, PSO 3, PSO 4, PSO 6	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	Understanding Environmental Thought: Environmental heritage and the human dimension of environmental science; Sociological perspectives on environment; Interdisciplinary and multidisciplinary approaches to environment studies; Biological, ecological, and social ecological orientations.	**15**	CO1	K1, K2
Module 2:	Environmental Issues and Concerns: Urbanisation and environmental stress; food systems, agriculture, and environment; Climate change and global warming; Consumerism, and ecological footprints	**15**	CO1, CO3, CO4,	K2, K4, K5
Module 3:	Social Issues and Environment**:** Development, displacement, and rehabilitation; Gender and the Environment**;** Environmental Movements; Social-Ecological Issues in Goa.	**15**	CO2, CO4	K2, K4, K5
Module 4:	Towards a Sustainable Environmental Future**:** Sustainable Development in the Indian Context; Indigenous Knowledge and Environmental Management; Environmental Technologies for a Sustainable Future**;** Role of education, community participation, and ecological citizenship.	**15**	CO4, CO5	K2, K3, K6
Pedagogy:	Lectures, assignments, interactive sessions, campus walks, Field Visits, documentaries, presentations, role plays.			
Texts:	1. Alvares, C. (2002). *Fish Curry and Rice: A Source Book on Goa, Its Ecology, and Lifestyle.* Goa Foundation, Panaji,			

	Goa. 2. Basu, M., & Xavier, S. (2016). *Fundamentals of environmental studies*. Cambridge University Press, Cambridge, United Kingdom. 3. Gadgil, M., & Guha, R. (2000). *Ecology and equity*. Oxford University Press, New Delhi, India. 4. Guha, R. (2000). Environmentalism: A global history. Oxford University Press, New York, USA. 5. Joseph, B. (2009). *Environmental studies* (2nd ed.). Tata McGraw-Hill, New York, USA. 6. Krishna, S. (1996*). Environmental politics*. Sage Publications, New Delhi, India. 7. Rangarajan, M. (Ed.). (2007). *Environmental issues in India: A reader*. Dorling Kindersley, New Delhi, India.
References/ Readings:	1. Carolyn, M. (Ed.). (1996). *Ecology*. Rawat Publications, Rajasthan, India. 2. Gadgil, M., & Guha, R. (2000). *Use and abuse of nature*. Oxford University Press, New Delhi, India. 3. Goudie, A. S. (2019). *Human impact on the natural environment: Past, present and future* (8th ed.). Wiley-Blackwell, Oxford, United Kingdom. 4. Rai, S. C., & Mishra, P. K. (Eds.). (2023). *Traditional ecological knowledge of resource management in Asia*. Springer, Cham, Switzerland. 5. Shiva, V. (1991). *Ecology and the politics of survival: Conflicts over natural resources in India*. Sage Publications, New Delhi, India. 6. Sonak, S. (2014). *Khazan ecosystems of Goa: Building on indigenous solutions to cope with global environmental change*. Springer Nature, Dordrecht, Netherlands. 7. Weeks, J. R. (2012). *Population: An introduction to concepts and issues* (10th ed.). Cengage Learning, Boston, MA, USA.
Web Resources:	1. Agarwal, B. (1992). The gender and environment debate: Lessons from India. *Feminist Studies*, *18*(1), 119–158. https://doi.org/10.2307/3178217 2. Basu, S. (2016). Consumerism of e-products and its global effect on climate change. In *Climate change: Issues and challenges to society, environment and development* (pp. 91–97). ISBN: 978-81-929776-1-4 3. Berkes, F. (2007). Community-based conservation in a globalized world. *Proceedings of the National Academy of*

Sciences of the United States of America, 104(39), 15188–15193. https://doi.org/10.1073/pnas.0702098104

4. Borthakur, A., Singh, P. (2022). Understanding consumers' perspectives of electronic waste in an emerging economy: a case study of New Delhi, India. *Energ. Ecol. Environ.* **7**, 199–212 https://doi.org/10.1007/s40974-022-00242-9
5. Guerra, J.B.S.O.A., Hoffmann, M., Bianchet, R.T. *et al.* (2022). Sustainable development goals and ethics: building "the future we want". *Environ Dev Sustain* 24, 9407–9428 https://doi.org/10.1007/s10668-021-01831-0
6. Ganguly, V. (2005). Displacement, Rehabilitation and Resettlement: The Case of Maldhari Families of Gir Forest. Sociological Bulletin, 54(1), 3-17. https://doi.org/10.1177/0038022920050101
7. Guha, D. (n.d). Consumerism's Heavy Burden: Impact of Bulky Waste Generation on Society and Environment. https://saahas.org/wp-content/uploads/2024/05/Blog-on-Consumerism.pdf
8. Patel, S.K., Sharma, A. & Singh, G.S. (2020). Traditional agricultural practices in India: an approach for environmental sustainability and food security. *Energ. Ecol. Environ.* 5, 253–271 https://doi.org/10.1007/s40974-020-00158-2
9. Shukla, S.R., Sinclair, A.J. (2010). Strategies for Self-organization: Learning from a Village-level Community-based Conservation Initiative in India. *Hum Ecol* 38, 205–215 https://doi.org/10.1007/s10745-010-9301-y

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Title of the Course	Sustainable Development and Resource Management
Course Code	ENV-5209
Number of Credits	03
Theory/Practical	Theory
Level	400
Effective from AY	2025-2026
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil
Course Objectives:	• Introduce the ideas of Sustainable Development and resource management for a developing world. • Explain the goals and targets of UN's Sustainable Development Goals • Teach how to measure the achievements of SDGs. • Explain the trade-offs involved in operationalizing sustainability planning. • Familiarise with the plural perspectives on the environment. • Examine the role of markets and policies in resource management.

Course Outcomes:			**Mapped to PSO**	
	CO 1. Explain and critically analyze the SDGs.		PSO 1	
	CO 2. Measure the achievements in the SDGs, especially in the Indian context.		PSO 1	
	CO 3. Critically evaluate the role of markets and policies in resource management.		PSO 1, PSO 6	
	CO 4. Apply the economic tools for the preliminary application of policies for sustainable resource use.		PSO 1, PSO 6	
	CO 5. Analyze the trade-offs in sustainability planning.		PSO 1	
	CO 6. Explain the plural perspectives on the environment.		PSO 1, PSO4, PSO 6	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	Introduction to Sustainable Development: Definition and concept of sustainable development, measures of sustainable development – the UN Sustainable Development Goals (SDGs); objectives of Sustainable development, Policy options for Sustainable growth. Role of Industry, Agriculture and Services in sustainability. Link between Sustainable Development and Climate Change, Implementation of Sustainable Development and Climate Change Policies.	**15**	CO1, CO2	K2, K5
Module 2:	Sustainable development in India: India's efforts at achieving SDGs; technology transformation, industrial development and environmental pollution, Sustainable management of land, water and air. Equity and resource management. Role of communities in environmental management. Environmental movements and community restoration.	**15**	CO2, CO3	K5
Module 3:	Resource Management: Management of environmental resources. Understanding the role of markets, government and communities. Meaning of externalities, environmental policy in the	**15**	CO3, CO4, CO5,	K2, K3, K4, K5

	presence of externalities. Missing Markets. Public Goods, Common Property Resources, Coase Theorem and Issues in Property Rights; Pigouvian Taxes, Subsidies, Tradable Permits, Price v/s Quantity tools		CO6	
Pedagogy:	Lectures/ assignments/ workshops/ campus walks/ documentaries/ discussion/ presentations			
References/ Readings:	1. Conrad, J. M., & Rondeau, D. (2020). *Natural resource economics: Analysis, theory, and applications*. Cambridge University Press, Cambridge, United Kingdom. 2. Gadgil, M., & Guha, R. (2000). *Use and abuse of nature*. Oxford University Press, New Delhi, India. 3. Gadgil, M., & Guha, R. (1995). *Ecology and equity*. Oxford University Press, New Delhi, India. 4. Haque, A. K. E., Mukhopadhyay, P., Nepal, M., & Shammin, M. R. (Eds.). (2021). Climate change and community resilience: Insights from South Asia. Springer, Cham, Switzerland. 5. Hardin, G. (1968). The tragedy of the commons. *Science, 162*(3859), 1243–1248. 6. Harris, J. M., & Roach, B. (2022). *Environmental and natural resource economics: A contemporary approach*. Routledge, New York, USA. 7. Leopold, A. (1972). *A Sand County almanac and sketches here and there*. Oxford University Press, New York, USA. 8. Prasad, R., Jhariya, M. K., & Banerjee, A. (Eds.). (2022). Advances in sustainable development and management of environmental and natural resources: Economic outlook and opinions (1st ed.). Apple Academic Press, Oakville, Canada. 9. Carson, R. (2012). *Silent spring* (50th anniversary ed.). Penguin Classics. London, United Kingdom 10. Rangarajan, M. (Ed.). (2007). *Environmental issues in India: A reader*. Dorling Kindersley. Noida, India.			

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Title of the Course	Sustainable Development and Resource Management Practical
Course Code	ENV-5210
Number of Credits	01
Theory/Practical	Practical
Level	400
Effective from AY	2025-2026
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	• Introduce simple computational models of resource management. • To understand resource allocation problems using numerical models. • To explore optimal depletion and optimal harvest of renewable and non-renewable resources.	
Course Outcomes:		**Mapped to PSO**
	CO 1. Create simple models of resource management.	PSO 1
	CO 2. Apply economic principles to forest management, including growth evaluation, optimal rotation analysis, and old-growth forest valuation.	PSO 1

	CO 3. Identify the role of different institutional rules in fostering sustainable development.		PSO 1, PSO 4, PSO 6	
	CO 4. Evaluate the transition paths for renewable and non-renewable resources.		PSO 1	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	1. Optimal Depletion Problem and Optimal Harvest Problem.	**30**	CO1	K6
	2. Economics of Fisheries, Fishery Production Functions, The Yield–Effort Function, Static and Dynamic Model of Open Access, Present Value Maximization.		CO1	K3, K6
	3. The Economics of Forestry, The Volume Function and Mean Annual Increment, The Optimal Single Rotation, The Faustmann Rotation, the Optimal Stock of Old-Growth Forest.		CO2	K3
	4. The Economics of non-renewable Resources, Solving a Simple Model, Hotelling's Rule, Estimating the Inverse Demand Curve, Extraction and Price Paths in the Competitive Industry, Extraction and Price Paths under Monopoly, Reserve-Dependent Costs, Exploration, The Economic Measure of Scarcity.		CO1, CO3, CO4	K2, K5
Pedagogy:	Lectures/ assignments/ workshops/ discussion/ presentations			
References/ Readings:	1. Conrad, J. M. (2006). *Resource economics* (Reprint ed.). Cambridge University Press, MA, USA. 2. Conrad, J. M., & Rondeau, D. (2020). Natural resource economics: Analysis, theory, and applications (1st ed.). Cambridge University Press, Cambridge, UK. 3. Dayal, V. (2014). The environment in economics and development: Pluralist extensions of core economic models. Springer, New Delhi, India.			

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SEMESTER III

Research Specific Elective (RSE) Courses

Title of the Course	Environmental Impact Assessment
Course Code	ENV-6000
Number of Credits	03
Theory/Practical	Theory
Level	500
Effective from AY	2025-2026
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil
Course Objectives:	• To introduce the principles, need, and significance of Environmental Impact Assessment (EIA) in sustainable development. • To provide an understanding of EIA processes, methods, and the regulatory framework in India and globally. • To familiarize students with the tools, procedures, and evaluation techniques used in environmental decision-making. • To build analytical and reporting skills required for preparing and assessing EIA reports.

Course Outcomes:	Student will learn to:		**Mapped to PSO**	
	CO 1: Explain the basic principles, scope, and stages of EIA and its role in environmental management.		PSO 1, PSO 3	
	CO 2: Apply EIA methodologies and impact prediction tools for specific development sectors.		PSO 3	
	CO 3: Analyze environmental components, project impacts, and mitigation measures using scientific and social parameters.		PSO 3	
	CO 4: Evaluate the national and international legal frameworks, institutions, and policies governing EIA.		PSO 3	
	CO 5: Design and recommend effective mitigation and monitoring plans through systematic EIA processes.		PSO 3	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	Introduction and Conceptual Framework: Origin, definition, and objectives of EIA; Importance of EIA in project planning and sustainable development; Key concepts: environment, impact, risk, mitigation, and sustainability. Stages in EIA: screening, scoping, baseline data collection, prediction, mitigation, and monitoring; Types of EIA: strategic, regional, cumulative, and sectoral.	**15**	CO 1	K2
Module 2:	Methods and Techniques of EIA: EIA methodologies: checklist, matrix (Leopold, Battelle), overlay, network, and ad hoc methods; Impact prediction techniques for air, water, soil, flora, fauna, and socio-economic environment; Risk assessment and cost–benefit analysis; Environmental Management Plan (EMP): structure, formulation, and monitoring; Case study: Industrial or mining project EIA analysis.	**15**	CO 2, CO 3	K3, K4
Module 3:	Legal framework of EIA in India: EIA Notification 2006, amendments, and 2020 draft. Institutional structure: MoEF & CC, SEAC, SEIAA, and NGT; Public participation and	**15**	CO 3, CO 4,	K4,

	stakeholder consultation in EIA process; - International EIA systems: UNEP, World Bank, and EU directives; Challenges, limitations, and ethical issues in EIA implementation. Case study: Coastal Zone Regulation (CRZ) and EIA in infrastructure development; Mining, Highway, Residential and commercial, Ports, Jetty project EIA.		CO 5	K5, K6
Pedagogy:	Interactive lectures with case-based learning and real EIA report evaluations; Demonstrations of EIA methods (matrices, overlays, GIS applications); Group assignments on baseline data collection and impact analysis; Workshops on preparation of Environmental Management Plans (EMP); Class seminars on EIA legislation, court cases, and best practices.			
Texts:	1. Canter, L. W. (1996). *Environmental Impact Assessment* (2nd ed.). McGraw-Hill. 2. Glasson, J., Therivel, R., & Chadwick, A. (2013). *Introduction to Environmental Impact Assessment* (4th ed.). Routledge. 3. Jain, R. K., Urban, L. V., & Stacey, G. S. (2004). *Environmental Impact Analysis: A New Dimension in Decision-Making.* CBS Publishers. 4. Noble, B. (2014). *Introduction to Environmental Impact Assessment: A Guide to Principles and Practice* (3rd ed.). Oxford University Press. 5. Petts, J. (Ed.). (1999). *Handbook of Environmental Impact Assessment* (Vols. 1 & 2). Blackwell Science.			
References/ Readings:	1. Biswas, A. K., & Agarwal, A. (1994). *Environmental Impact Assessment for Developing Countries.* Butterworth-Heinemann. Oxford, UK 2. Morgan, R. K. (2012). Environmental impact assessment: The state of the art. *Impact Assessment and Project Appraisal, 30*(1), 5–14. https://doi.org/10.1080/14615517.2012.661557 3. Morris, P., & Therivel, R. (2001). *Methods of Environmental Impact Assessment* (2nd ed.). Routledge. London, UK. 4. Sadler, B. (1996). *Environmental Assessment in a Changing World: Evaluating Practice to Improve Performance.* IAIA & CEAA. Winnipeg, MB, Canada.			
Web Resources:	1. Central Pollution Control Board (CPCB) – Environmental monitoring and compliance. https://cpcb.nic.in/ 2. EIA Resource and Response Centre (ERC India) – Indian EIA cases, analysis, and commentary. https://ercindia.org/ 3. Environmental Information System (ENVIS) – EIA manuals and reports. https://envis.nic.in/			

	4. IAIA (International Association for Impact Assessment) – Global EIA best practices and publications. https://www.iaia.org/ 5. Ministry of Environment, Forest and Climate Change (MoEFCC), India – EIA Notification, 2006 and guidelines. https://moef.gov.in/ 6. UNEP Global Environmental Outlook and Assessment Reports – EIA applications in global policy. https://www.unep.org/ 7. World Bank Environmental and Social Framework (ESF) – International EIA guidelines. https://www.worldbank.org/en/projects-operations/environmental-and-social-framework

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Title of the Course	Environmental Policy and Law
Course Code	ENV-6001
Number of Credits	03
Theory/Practical	Theory
Level	500
Effective from AY	2025-2026
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	• To understand the foundations and evolution of environmental policy and legal frameworks at both national and international levels. • To apply key legal concepts, institutional mechanisms, and policy instruments to real-world environmental issues and regulatory contexts. • To analyze the role of environmental law in addressing contemporary challenges such as climate change, biodiversity loss, and environmental justice.	
Course Outcomes	Student will learn to:	**Mapped to PSO**
	CO 1. Explain the evolution of environmental governance and identify the constitutional, statutory, and institutional frameworks in India.	PSO 1, PSO 4

	CO 2. Explain key international conventions and interpret their implications for national environmental law and policy.		PSO 1, PSO 4	
	CO 3. Apply principles of environmental law to emerging issues like ESG, climate litigation, and environmental justice.		PSO 1, PSO 3	
	CO 4. Apply principles of environmental law to emerging issues like ESG, climate litigation, and environmental justice.		PSO 1, PSO 3, PSO 4, PSO 6	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	Environmental Law and policies in India: Constitution and environment protection; The Wildlife Protection Act, 1972; The Water (Prevention and Control of Pollution) Act, 1974; The Air (Prevention and Control of Pollution) Act, 1981; The Forest Conservation Act, 1980; The Environment Protection Act, 1986; Hazardous Waste Management Rules, 1989; Municipal Solid Waste Management Rules, 2000; Coastal Zone Regulation Notification, 2019.	**15**	CO 1	K2
Module 2:	International Environmental Agreements and Frameworks: United Nations Framework Convention on Climate Change (UNFCCC); Intergovernmental Panel on Climate Change (IPCC) and Reports; Convention on Biological Diversity (CBD), 1992; United Nations Environment Programme (UNEP); Sustainable Development Goals (SDGs); Montreal Protocol on Substances that Deplete the Ozone Layer, 1987; Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal, 1989.	**15**	CO 2	K2
Module 3:	Contemporary Issues in Environmental Policy and Law: Climate Litigation; India's Climate Policy, National Action Plan on Climate Change (NAPCC); Carbon Markets and Net-Zero Commitments; Community-Led Governance in Goa; Corporate Social Responsibility and environment.	**15**	CO 3	K3
Pedagogy:	Lectures/ tutorials/ assignments/practical/moot court/debate.			

Texts:	1. Bhat, S. (2024). *Environmental law and policy in India*. Routledge. 2. Divan, S., & Rosencranz, A. (2022). *Environmental law and policy in India: Cases and materials* (3rd ed.). Oxford University Press. 3. Fitzmaurice, M., Ong, D. M., & Merkouris, P. (Eds.). (2010). *Research handbook on international environmental law*. Edward Elgar Publishing. 4. Leal Filho, W., Azul, A. M., Brandli, L., Lange Salvia, A., & Wall, T. (Eds.). (2020). *Climate action: Encyclopedia of the UN Sustainable Development Goals*. Springer. 5. Rajamani, L. (2021). *International climate change law and equity*. In *The Oxford Handbook of International Environmental Law* (2nd ed.). Oxford University Press 6. Sands, P., Peel, J., & Fabra, A. (2023). *International environmental law* (5th ed.). Springer.
References/ Readings:	1. MoEFCC. (2023). *Environmental Impact Assessment Notification and Amendments*. Ministry of Environment, Forest and Climate Change, Government of India. New Delhi, India. 2. Puthucherril, T. G. (2015). *Institutionalizing integrated coastal zone management and coastal climate change adaptation in South Asia*. Brill Nijhoff. Leiden, The Netherlands. 3. Sahu, G. (2014). *Environmental regulatory institutions in India: Policy implementation and environmental governance*. Sage Publications, New Delhi, India.
Web Resources:	1. https://cprindia.org/research/environment-and-climate-change/ 2. https://ejatlas.org/ 3. https://greentribunal.gov.in/ 4. https://moef.gov.in/ 5. https://treaties.un.org/ 6. https://unfccc.int/ 7. https://www.indiacode.nic.in/ 8. https://www.unep.org/

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Title of the Course	Biodiversity and Conservation
Course Code	ENV-6002
Number of Credits	03
Theory/Practical	Theory
Level	500
Effective from AY	2026-2027
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	• The course provides the fundamentals about ecosystems, their types, distribution, components, functioning, services and their role in biodiversity • Biotic components of ecosystems, fundamentally understood as Biodiversity, their measure, and factors that lead to enormous biodiversity, and essential components that maintain biodiversity.	
Course Outcomes:	Student will learn to:	**Mapped to PSO**
	CO 1. Understand the basic concepts of ecosystem services such as structural and functional components, endemism, keystone, umbrella, and flagship species.	PSO 1
	CO 2. Explain the importance of biodiversity conservation for ecosystem and human health and sustainable development.	PSO 1
	CO 3. Analyze and summarize the factors contributing to biodiversity loss.	PSO 1

	CO 4. Evaluate the effectiveness of different conservation strategies and policies.		PSO 1	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	Introduction to Ecosystems and its Diversity: Development of concept and the current understanding of ecosystem; Structural and Functional components of Ecosystems. Ecological complexity; Adaptive cycle view of ecosystem development and change; Ecosystem attributes and functioning; Thermodynamics and Information theory in ecosystems; Types of ecosystems, their distribution and composition; Biodiversity hotspots.	**15**	CO 1, CO 2	K2
Module 2:	Ecosystem Processes and Applications: Role of species in ecosystem functioning and productivity; Ecosystem services: types, valuation, and importance to human welfare; Measuring ecosystem health and resilience; Ecosystem processes and their controls; Human-induced ecosystem changes: degradation, resilience, and threshold shifts; Impact of land-use changes and anthropogenic pressures.	**15**	CO 2, CO 3	K3, K4
Module 3:	Biodiversity and Conservation: Definition and scope of biodiversity: past (diversity and extinction) and present patterns; Major groups of organisms and evolution of biodiversity; Drivers of biodiversity: geology, climate, and ecological interactions; Patterns in biodiversity: spatial, temporal, and taxonomic levels; Approaches to biodiversity studies: inventory, monitoring, and modeling; Loss of biodiversity and global biodiversity targets (Aichi, CBD, Post-2020 framework); Biodiversity Act 2002 and Biodiversity Strategic Action Plan; Biogeographical regions and forest types of India; Endemism, keystone, umbrella, and flagship species concepts; Case Studies: Western Ghats biodiversity hotspot, coral reef biodiversity, wetlands and endemic flora and fauna with special reference to Goa.	**15**	CO 3, CO 4,	K4, K5, K6
Pedagogy:	Lectures, assignments, workshops, campus biodiversity walks, documentaries, and interactive discussions; students will engage in group presentations, case study reviews, and ecosystem mapping exercises to build applied understanding of biodiversity conservation principles.			
Texts:	1. Begon, M., Howarth, R. W., & Townsend, C. R. (2014). *Essentials of ecology* (4th ed.). Wiley-Blackwell, Chichester, UK.			

	2. Bowman, W. D., Hacker, S. D., & Cain, M. L. (2020). *Ecology* (5th ed.). Oxford University Press, New York, NY, USA. 3. Chapin III, F. S., Matson, P. A., & Vitousek, P. M. (2011). *Principles of terrestrial ecosystem ecology* (2nd ed.). Springer, New York, NY, USA. 4. Chapman, J. L., & Reiss, M. J. (1999). *Ecology: Principles and applications* (2nd ed.). Cambridge University Press, Cambridge, UK. 5. Gaston, K. J., & Spicer, J. I. (2004). *Biodiversity: An introduction* (2nd ed.). Blackwell Science, Oxford, UK. 6. Groombridge, B., & Jenkins, M. D. (2002). *World atlas of biodiversity: Earth's living resources in the 21st century.* University of California Press, Berkeley, CA, USA. 7. Henderson, P. A., & Southwood, T. R. E. (2016). *Ecological methods* (4th ed.). John Wiley & Sons, Chichester, UK. 8. Jørgensen, S. E., Xu, L., & Costanza, R. (2016). *Handbook of ecological indicators for assessment of ecosystem health* (2nd ed.). CRC Press, Boca Raton, FL, USA. 9. Kormondy, E. J. (2017). *Concepts of ecology* (4th ed.). Pearson Education, Boston, MA, USA. 10. Krebs, C. J. (2013). *Ecology: The experimental analysis of distribution and abundance* (6th ed.). Pearson Education, Boston, MA, USA. 11. Raffaelli, D. G., & Frid, C. L. J. (2010). *Ecosystem ecology: A new synthesis.* Cambridge University Press, Cambridge, UK. 12. Singh, J. S., Singh, S. P., & Gupta, S. R. (2014). *Ecology, environmental science & conservation.* S. Chand Publishing, New Delhi, India.
References/ Readings:	1. Begon, M., Howarth, R. W., & Townsend, C. R. (2014). *Essentials of ecology* (4th ed.). Wiley-Blackwell, Chichester, UK. 2. Bowman, W. D., Hacker, S. D., & Cain, M. L. (2020). *Ecology* (5th ed.). Oxford University Press, New York, NY, USA. 3. Chapin III, F. S., Matson, P. A., & Vitousek, P. M. (2011). *Principles of terrestrial ecosystem ecology* (2nd ed.). Springer, New York, NY, USA. 4. Chapman, J. L., & Reiss, M. J. (1999). *Ecology: Principles and applications* (2nd ed.). Cambridge University Press, Cambridge, UK. 5. Gaston, K. J., & Spicer, J. I. (2004). *Biodiversity: An introduction* (2nd ed.). Blackwell Science, Oxford, UK. 6. Groombridge, B., & Jenkins, M. D. (2002). *World atlas of biodiversity: Earth's living resources in the 21st century.* University of California Press, Berkeley, CA, USA. 7. Henderson, P. A., & Southwood, T. R. E. (2016). *Ecological methods* (4th ed.). John Wiley & Sons, Chichester, UK. 8. Jørgensen, S. E., Xu, L., & Costanza, R. (2016). *Handbook of ecological indicators for assessment of ecosystem*

	health (2nd ed.). CRC Press, Boca Raton, FL, USA. 9. Kormondy, E. J. (2017). *Concepts of ecology* (4th ed.). Pearson Education, Boston, MA, USA. 10. Krebs, C. J. (2013). *Ecology: The experimental analysis of distribution and abundance* (6th ed.). Pearson Education, Boston, MA, USA. 11. Raffaelli, D. G., & Frid, C. L. J. (2010). *Ecosystem ecology: A new synthesis.* Cambridge University Press, Cambridge, UK. 12. Singh, J. S., Singh, S. P., & Gupta, S. R. (2014). *Ecology, environmental science & conservation.* S. Chand Publishing, New Delhi, India.
Web Resources:	1. Convention on Biological Diversity (CBD) – Global framework and biodiversity targets. https://www.cbd.int/ 2. Global Biodiversity Information Facility (GBIF) – Species occurrence and biodiversity data. https://www.gbif.org/ 3. India Biodiversity Portal – Open-access biodiversity data for India. https://indiabiodiversity.org/ 4. IPBES (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services) – Global biodiversity assessments and policy links. https://www.ipbes.net/ 5. IUCN Red List of Threatened Species – Conservation status of species worldwide. https://www.iucnredlist.org/ 6. Millennium Ecosystem Assessment – Reports on ecosystem services and human well-being. https://www.millenniumassessment.org/ 7. National Biodiversity Authority (NBA), India – Biodiversity management and access policies. https://nbaindia.org/ 8. NatureServe Explorer – Data on species and ecosystems of conservation concern. https://explorer.natureserve.org/ 9. UNEP World Conservation Monitoring Centre (UNEP-WCMC) – Global data on biodiversity and ecosystems. https://www.unep-wcmc.org/ 10. WWF Global and India Biodiversity Resources – Conservation projects and biodiversity assessments.

	https://www.worldwildlife.org/ https://www.wwfindia.org/

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Title of the Course	Biodiversity and Conservation Practical
Course Code	ENV-6003
Number of Credits	01
Theory/Practical	Practical
Level	500
Effective from AY	2026-2027
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	The course will impart an insight to the students about the basic objectives and tools used to assess biodiversity and its assessment.	
Course Outcomes:	Student will learn to:	**Mapped to PSO**
	CO 1. Understand biodiversity governance mechanisms such as People's Biodiversity Registers and Biodiversity Management Committees.	PSO 1
	CO 2. Apply field and analytical techniques for biodiversity estimation and habitat assessment.	PSO 1
	CO 3. Analyze population data and assess species diversity using quantitative approaches.	PSO 1
	CO 4. Identify and document floral and faunal biodiversity using standard ecological methods.	PSO 1
	CO 5. Design participatory conservation documentation strategies for local biodiversity management.	PSO 1

Content:		No of hours	Mapped to CO	Cognitive Level
Module 1:	1. Documentation of floral and faunal biodiversity in urban areas and on campus. 2. Estimation of population density of trees using quadrant method. 3. Field visit to aquatic, forest and other ecosystems for identification of biota. 4. People's Biodiversity Register (PBR) preparation. 5. Interaction with members of Biodiversity Management Committee (BMC) to understand its functioning. 6. Documentation of commercial bio-resource.	**30**	CO 1, CO 2, CO 3, CO 5	K2, K3, K4, K6
Pedagogy:	Field-based learning, community survey and continuous assessment via field records, practical notebooks and presentations.			
Texts:	1. Bhatt, S., Kohli, K., & Kothari, A. (2006). *Process Documentation of the National Biodiversity Strategy and Action Plan–India.* Kalpavriksh Environmental Action Group. 2. Dey, S. (2004). *Bioresources and Genepool Conservation.* Daya Books. 3. Grimmett, R., Inskipp, C., & Inskipp, T. (2016). *Birds of the Indian Subcontinent.* Bloomsbury Publishing. 4. Gupta, H. K. (2013). *Institutional Framework for Creating Biodiversity Commons through Biodiversity Management Committees in India.* 5. Sawaiker, R. U. (2021). *Conservation of Biodiversity through Scientifically Validated and Well Participated People's Biodiversity Registers (PBRs) in Goa, India. Asian Journal of Conservation Biology, 10*(1), 159–161. 6. *The Biological Diversity Act, 2002* and *Rules, 2004.* Government of India. 7. Whitaker, R., Captain, A., & Ahmed, F. (2004). *Snakes of India.* Draco Books.			
References/ Readings:	1. Bhatt, S., Kohli, K., & Kothari, A. (2006). *Process Documentation of the National Biodiversity Strategy and Action Plan–India.* Kalpavriksh Environmental Action Group. 2. Dey, S. (2004). *Bioresources and Genepool Conservation.* Daya Books. 3. Grimmett, R., Inskipp, C., & Inskipp, T. (2016). *Birds of the Indian Subcontinent.* Bloomsbury Publishing. 4. Gupta, H. K. (2013). *Institutional Framework for Creating Biodiversity Commons through Biodiversity*			

	Management Committees in India. 5. Sawaiker, R. U. (2021). *Conservation of Biodiversity through Scientifically Validated and Well Participated People's Biodiversity Registers (PBRs) in Goa, India. Asian Journal of Conservation Biology, 10*(1), 159–161. 6. *The Biological Diversity Act, 2002* and *Rules, 2004.* Government of India. 7. Whitaker, R., Captain, A., & Ahmed, F. (2004). *Snakes of India.* Draco Books.
Web Resources:	1. Convention on Biological Diversity (CBD) – Biodiversity policy and global frameworks. 🔗 https://www.cbd.int/ 2. Global Biodiversity Information Facility (GBIF) – Open-access global biodiversity data. 🔗 https://www.gbif.org/ 3. India Biodiversity Portal – Biodiversity information and species occurrence data. 🔗 https://indiabiodiversity.org/ 4. IUCN Red List of Threatened Species – Conservation status of species. 🔗 https://www.iucnredlist.org/ 5. National Biodiversity Authority (NBA), India – Biodiversity management and access policies. 🔗 https://nbaindia.org/ 6. People's Biodiversity Register (PBR) Portal – Tools and resources for PBR preparation. 🔗 https://pbr.keralabiodiversity.org/ 7. UNEP World Conservation Monitoring Centre (UNEP-WCMC) – Global biodiversity assessments. 🔗 https://www.unep-wcmc.org/

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Title of the Course	Mining Geology and Stratigraphy
Course Code	ENV-6004
Number of Credits	03
Theory/Practical	Theory
Level	500
Effective from AY	2026-2027
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	• Explain the role and functions of environmentalist and geologist in mining industry. • Examine the processes of mineral formation and its occurrence mineral exploration. • Evaluate the mineral exploration techniques and mining methods. • Sketching the stratigraphy of India and its correlation with the mineral resources.	
Course Outcomes:	Student will learn to:	**Mapped to PSO**
	CO 1. Explain the role and functions of geologist and environmentalist in mining industry.	PSO 1, PSO 2
	CO 2. Demonstrate the processes of mineral formation and its occurrence mineral exploration.	PSO 1, PSO 3
	CO 3. Critically analyze the mineral exploration techniques and mining methods.	PSO 1, PSO 2, PSO 4

	CO 4. Explain the stratigraphy of India and its correlation with the mineral resources, and mining operation.		PSO 3, PSO 5, PSO 6	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	Classification of Mineral deposits: Textures and structures of ore deposits; Overview on types and nature of ore bearing fluids: Physico-chemical controls of ore deposition; Distribution of ore deposits in its relation to plate tectonic settings; Distribution and genesis of ore deposits in India: Banded Iron Formations, Manganese ore deposits, Polymetallic ore deposits, Copper, Lead, Zinc, Chromite and Bauxite deposits; Occurrence of Gold in India, Diamond deposits. Offshore and deep sea deposits; Mineral resources and distribution in Goa.	**15**	CO 1, CO 2	K1, K2, K4
Module 2	Overview to Mining Geology; Role of environmentalist and geologists in mining industry; Mineral beneficiation techniques, Mining plan and mine closure plan; Drilling, type of core bits, casing and their applications; Estimation of ore reserves; Mine evaluation, National Mineral Policy, Mine Lease; Conservation and substitution, Mine reclamation; Key features from The Mine and Mineral Development and Regulation Act, 1957 including ammendments; Importance regulations of The Goa Minor Mineral Concession Rules, 1985.	**15**	CO 1, CO 3	K1, K2, K4, K5
Module 3:	Stratigraphic principles and their applications. Lithostratigrapic, Chronostratigraphic and Biostratigraphic. Palaeomagnetism and time correlation; Cratons and mobile belts of India: Dharwar craton, Bastar craton, Bundelkhand Craton; Proterozoic basins of India: Vindhyan basin, Kaladgi basin, Cuddapah basin. Archaean-Proterozoic boundary and its significance; Precambrian/Cambrian boundary, Palaeozoic rocks in Himalayas; Mesozoic of Peninsular and extra peninsular India. Dinosaurs fossils in India; K-T boundary; Cenozoic successions and its fossil records; Gondwana Supergroup and Deccan volcanic province; Geology of Goa.	**15**	CO 2, CO 4	K2, K3 K5, K6
Pedagogy:	Lectures, case studies, discussions and assignments.			
References/ Readings:	1. Arogyaswamy, R. N. P. (2017). *Courses in mining geology*. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, India.			

	2. Dessai, A. G. (2023). *Environment, resources and sustainable tourism: Goa as a case study*. Springer Nature, Singapore. 3. Dessai, A. G. (2018). *Geology and mineral resources of Goa.* New Delhi Publishers, New Delhi, India. 4. Krumbein, W. C. (2013). *Stratigraphy and sedimentation.* W. H. Freeman and Company, San Francisco, CA, USA. 5. McKinstry, H. E. (1980). *Mining geology.* Asia Publishing House, Mumbai, India. 6. Miall, A. D. (2010). *The geology of stratigraphic sequences.* Springer Science & Business Media, Dordrecht, The Netherlands. 7. Naqvi, S. M., & Rogers, J. J. W. (1987). *Precambrian geology of India.* Oxford University Press, New York, NY, USA. 8. Ramakrishnan, M., & Vaidyanadhan, R. (2010). *Geology of India* (Vols. 1–2). Geological Society of India (GSI) Publications, Kolkata, India. 9. Youn, G. J. (1984). *Elements of mining geology.* McGraw Hill, New York, NY, USA.

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Title of the Course	Mining Geology and Stratigraphy Practical
Course Code	ENV-6005
Number of Credits	01
Theory/Practical	Practical
Level	500
Effective from AY	2026-2027
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	This course aims to: • Provide comprehensive understanding about mining operation and mining plan. • Develop knowledge of important stratigraphic formations and mineral resources in India.	
Course Outcomes:	Student will learn to:	**Mapped to PSO**
	CO 1. Demonstrate the scientific methodology used in mining operation and mining plan.	PSO 1, PSO 4, PSO 6
	CO 2. Explain important stratigraphic formations and mineral resources in India.	PSO 1, PSO 2, PSO 6
	CO 3. Correlated lithological data from various stratigraphic formations	PSO 2
	CO 4. Tabulate important stratigraphic units and mineral resources.	PSO 1, PSO 2

Content:		No of hours	Mapped to CO	Cognitive Level
Module 1:	1. Preparation of mining plan for open cast and underground mine. 2. Preparation of borehole logs, geological sections, calculation of ore reserves, ore to overburden ratio from sections; Preparation of mine pit sections. 3. Exercises on stratigraphic classification and correlation. Preparation of Stratigraphic range charts. 4. Identification of major stratigraphic units and preparation of mineral resource maps of important Cratons and Proterozoic basins of India. 5. Mapping important mineral resources and stratigraphic units in Goa and India.	**30**	CO 1	K1, K2
Pedagogy:	Practical, case studies, discussions and assignments.			
References/ Readings:	1. Arogyaswamy, R. N. P. (2017). *Courses in mining geology.* Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, India. 2. Dessai, A. G. (2023). *Environment, resources and sustainable tourism: Goa as a case study.* Springer Nature, Singapore. 3. Dessai, A. G. (2018). *Geology and mineral resources of Goa.* New Delhi Publishers, New Delhi, India. 4. McKinstry, H. E. (1980). *Mining geology.* Asia Publishing House, Mumbai, India. 5. Miall, A. D. (2010). *The geology of stratigraphic sequences.* Springer Science & Business Media, Dordrecht, The Netherlands. 6. Youn, G. J. (1984). *Elements of mining geology.* McGraw Hill, New York, NY, USA.			

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Title of the Course	Marine Pollution
Course Code	ENV-6006
Number of Credits	03
Theory/Practical	Theory
Level	500
Effective from AY	2026-2027
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	• To provide an insight on the sources, types and impact of marine pollution. • To equip with, monitoring approaches, treatment and sustainable management of marine resources.	
Course Outcomes:	Student will learn to:	**Mapped to PSO**
	CO 1. To understand the types of pollutants and analyse their ecological impacts on marine environment.	PSO 1
	CO 2. To apply the different waste treatment methods, and evaluate its effectiveness.	PSO 1
	CO 3. To identify major sources of oil spills, pesticide contamination and analyse the ecological consequences.	PSO 1
	CO 4. To understand conservative pollutants and heavy metal pollution, and remediation strategies.	PSO 1

	CO 5. To understand the role of indicator organism and red tides in assessing and managing marine pollution.		PSO 1	
	CO 6. To apply the critical pathway and mass balance approach for monitoring marine pollution.		PSO 1	
Content:		**No. of Hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	Marine Pollution: definition, pollutant and its classification. Organic wastes: BOD, COD, dilution factor, fluctuations in DO, consequences of organic waste discharge to estuaries, Sources of pollutants and their treatment; Sewage - primary, secondary and tertiary treatment processes; Solid waste pollution: classification and disposal of solid wastes; Coastal industrial pollution: sources, nature and their treatment processes with reference to wastes from paper and pulp, soap manufacturing industries.	**15**	CO 1, CO 2	K4, K5
Module 2:	Oil spills and cleanup: sources, major accidental spills, fate of spilled oil on the sea, consequences of oil spills and treatment of oil spills; GMOs for treatment of oil spills; Pesticide pollution: inputs, fate in the sea, factors affecting the bioaccumulation of pesticides, impact of pesticides on the environment, methods to minimize pesticide pollution; Conservative pollutants: measures of contamination, toxicity, detoxification. metal pollution in coastal waters (Hg, Pb, Cd).	**15**	CO 3, CO 4	K4, K5
Module 3:	Indicator organisms: Criteria for selection of indicator organism: quantification of pollution load, basic pre-requisites, response to different pollution load and time integration capacity, macro algae, crustaceans and molluscs as indicator organisms for monitoring of trace metal pollution; Red tides: distribution, types of poisoning, effects and methods to minimize red tides in the sea; Monitoring strategies of marine pollution: Critical pathway approach and mass balance approach.	**15**	CO 5, CO 6	K2, K3
Pedagogy:	Lectures/ Tutorials/ Assignments.			
Texts: **References/ Readings:**	1. Chandler, K. A. (1985). *Marine offshore corrosion.* Butterworths, London, UK. 2. Clark, R. B. (1986). *Marine pollution.* Oxford Science Publications, Oxford, UK. 3. Goldberg, E. D. (1976). *The health of the oceans.* UNESCO Press, Paris, France. 4. Phillips, J. D. H. (1980). *Quantitative aquatic biological indicators.* Applied Science Publishers, London, UK.			

	5. Riley, J. P., & Skirrow, G. (1975). *Chemical oceanography.* Academic Press, London, UK. 6. Sharma, B. K., & Kaur, H. K. (1994). *Thermal and radioactive pollution.* Prakasham Mandir, Meerut, India. 7. Sharma, B. K., & Kaur, H. K. (1994). *Water pollution.* Sharma Prakasham Mandir, Meerut, India.

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Title of the Course	Microplastics in Environment
Course Code	ENV-6007
Number of Credits	04
Theory/Practical	Theory
Level	500
Effective from AY	2026-2027
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	To introduce the concept of microplastics as a pollutant and its impact on the environment and humans.	
Course Outcomes:		**Mapped to PSO**
	CO 1. Understanding the formation of microplastics and its impact on the environment.	PSO 1, PSO 6
	CO 2. Create awareness among students about microplastic pollution.	PSO 4, PSO 1
	CO 3. Learn instrument-based analysis.	PSO 2, PSO 5
	CO 4. Suggest mitigation strategies for overcoming such problems.	PSO 1, PSO 3, PSO 6
	CO 5. The student will get an overview of regulatory measures undertaken by international committees.	PSO 3, PSO 6

	CO 6. Critically evaluate microbial and enzymatic strategies for microplastic degradation, environmental safety concerns, and *in situ* monitoring of biodegradation efficiency.		PSO 1, PSO 6	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	Introduction to plastics and microplastics: Types of plastics: PET, HDPE, PVC, LDPE, PP, PS, Other; and microplastics types: fibres, microbeads, fragments, nurdles, foam; Primary and secondary microplastics and its formation; Distribution of microplastics: Global occurrence, sources of microplastics; Distribution and fate of plastic in the environment; Microplastics pollution in land, fresh water and marine waters, air, snow; Uptake and accumulation of microplastics in plants, animals, and humans. Interaction with sediment and soil particles; Vertical and horizontal transport in aquatic systems; Influence of particle size, shape, and density; Adsorption and desorption of contaminants (e.g., heavy metals, PAHs); Role of biofilms in mobility and fate;. Sources and Transport of Airborne Microplastics; Microplastic and association with climate change.	**15**	CO 1, CO 2	K1, K2, K3, K4, K5, K6
Module 2:	Ingestion by aquatic and terrestrial organisms; Trophic transfer and biomagnification; Potential health effects in humans; Pathways and mechanisms of microplastic exposure in ecological systems; Microplastics as carriers of trace and heavy metals and its role as pollutant; Microplastics as vectors for pathogens and toxic chemicals; Ecotoxicological impacts on aquatic and terrestrial organisms; Trophic transfer and biomagnification of microplastics and associated pollutants; Human exposure routes and assess potential health impacts based on emerging evidence. Sampling and characterization: Methods used for sampling, quantification of microplastics; Instrument for identification of microplastics- Fourier Transform Infrared Spectroscopy (FTIR) and Raman Spectroscopy. Scanning Electron Microscope (SEM).	**15**	CO 2, CO 3	K1, K2, K3, K4, K5, K6
Module 3:	Mitigation: Mitigation methods for microplastics and role of Blue Flag certification, international eco-level tag Foundation for Environmental Education. G20 and United	**15**	CO 3, CO 4,	K1, K2,

	Nations Environment Assembly resolution on marine litter and microplastics. Overview of global agreements (e.g., UN Plastics Treaty, MARPOL, Basel Convention). National policies (e.g., India's Plastic Waste Management Rules, 2016 & amendments). Role of CPCB, MoEFCC in microplastic monitoring Bans, EPR (Extended Producer Responsibility), recycling frameworks. Role of citizen science and NGOs Case studies: Microplastics pollution studies in India-Case studies with special reference to Goa.		CO 5	K3, K4, K5, K6
Module 4:	Biological basis of microplastic degradation, plastics as novel and co-metabolic substrates; Plastisphere: definition, structure, ecological significance & communities; Selective microbial colonization and succession patterns; Microbial diversity associated with microplastics, functional traits relevant to degradation; Key enzymes (hydrolases, esterases, cutinases, lipases, laccases, PETase, MHETase, alkane monooxygenases) and their interaction; Aerobic vs anaerobic degradation mechanisms; Synergistic and antagonistic effects on microbial activity; Formation of nanoplastics during biodegradation; Isolated enzymes vs whole-cell systems, Immobilized enzymes and bioreactors; Advances in protein engineering for plastic-degrading enzymes. Scale-up challenges in natural ecosystems; Environmental safety, gene transfer risks; Monitoring biodegradation efficiency *in situ*; Toxicity of degradation by-products – model organism studies.	**15**	CO 6	K3, K4, K5
Pedagogy:	Lectures/tutorials/assignments			
Texts:	1. Crawford, B. C., & Quinn, B. (2016). Microplastic pollutants (1st ed., pp. xviii–315). Elsevier Science, London, United Kingdom. https://doi.org/10.1016/C2015-0-06984-5. 2. La Nasa, J. (Ed.). (2022). Microplastics Degradation and Characterization. MDPI - Multidisciplinary Digital Publishing Institute. 3. Mishra, A. K., Raizada, P., T. Helmy, E., Arockiasamy, S., & Selvasembian, R. (Eds.). (2024). Microplastics: Environmental Pollution and Degradation Process. Springer Nature Singapore. 4. Rocha-Santos, T. A. P., & Duarte, A. C. (Eds.). (2017). Characterization and analysis of microplastics (1st ed., ~302 pp.). Elsevier Science, Amsterdam, Netherlands. https://doi.org/10.1016/C2016-0-04106-7			

	5. Rocha-Santos, T., Costa, M., & Mouneyrac, C. (Eds.). (2022). Handbook of microplastics in the environment (1st ed., 1397 pp.). Springer Nature Switzerland, Cham, Switzerland. https://doi.org/10.1007/978-3-030-81659-8 6. Suriyanarayanan, S., Shivaraju, H. P., & Pakeerathan, K. (Eds.). (2025). Combating plastic pollution in terrestrial environment: Challenges and strategies for a sustainable future. Springer Nature Singapore, Singapore. ISBN 978-981-96-2342-6
Web Resources:	https://www.epa.gov/water-research/microplastics-research

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Title of the Course	Renewable Energy System
Course Code	ENV-6008
Number of Credits	03
Theory/Practical	Theory
Level	500
Effective from AY	2026-2027
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	• Provide an understanding of the concept of energy, its form and conversion system. • Develop understanding towards energy management.	
Course Outcomes:	Student will learn to:	**Mapped to PSO**
	CO 1. Correlate various forms of energy especially renewable and non-renewable forms and its status worldwide.	PSO 1
	CO 2. Understand various energy conversion systems.	PSO 1
	CO 3. Understand use of renewable energy resources in local and regional level.	PSO 1
	CO 4. Understand energy transmission, efficiency, low-power management, and e-waste regulations.	PSO 1

Content:		No of hours	Mapped to CO	Cognitive Level
Module 1:	Introduction to renewable energy resources: Solar; Wind, Hydro Power and Nuclear Energy; Classification of energy: Energy chain and common forms of usable energy; present energy scenario; World energy status; Energy scenario in India.	**15**	CO 1	K4
Module 2:	Solar energy and systems: Introduction to Solar Energy-Energy from sun-Spectral distribution of Solar radiation; Instruments for measurement of solar radiation, Solar radiation data analysis. Thermal applications: Introduction to Solar thermal collectors, Types, Principle of operation of different collectors, Flat plate, Evacuated tube collectors, Compound parabolic collectors, Solar air heaters, Solar dryers-solar cookers, solar stills, Solar ponds, Solar parks, concentrating collectors, line type, point type; Methods of solar power generation; Power towers. Solar photovoltaics cells: Physics of solar cells; Cell and module; Manufacturing Process: Characteristics of cells and module, Performance parameters, BoS, PV System applications, Standalone, Grid connected systems.	**15**	CO 2	K2
Module 3:	Small hydro power, ocean and geothermal energy systems, wind energy: Introduction, types, system components, discharge curve and estimation of power potential, Turbines for SHP; Power generation through OTEC systems, various types, Energy through waves and tides, Energy generation through geothermal systems, types; Resource assessment, types of wind turbines, selection of components, blade materials, power regulation, various methods of control, wind farms, site selection, off shore wind farms, Solar Wind Hybrid energy systems. Electric vehicles and its roadmap: Electric Vehicles, Batteries design material, resources, specifications and EV roadmap. Energy Management: Transmission of Energy System AC and DC Forms, Relevant issues in Transmission and Transmission lines, Engine Efficiency, Low power designs and	**15**	CO 3, CO 4	K2, K2

	managements, E-Waste, Worldwide Scenario and Indian Context, Rules and Regulations.			
Pedagogy:	Lectures/ tutorials/assignments.			
References/ Readings:	1. Andrews, J., & Jelley, N. (2013). *Energy science: Principles, technologies and impacts, Oxford Universities press,* Oxford, UK. 2. Boyle, G. (2012). *Renewable energy, power for a sustainable future*. Oxford University Press Oxford, UK. 3. Duffie, J. A., & Beckman, W. A. (2013). *Solar engineering of thermal processes, Wiley,* Hoboken, NJ, USA. 4. Fang, L. Y., & Hong, Y. (2012). *Renewable energy systems, advanced conversion technologies and applications*. CRC Press, Boca Raton, FL, USA. 5. Hodgson, P. E. (2010). *Energy, the environment and climate change, Publisher*. Imperial College Press, London, UK. 6. Jha, A. R. (2010). *Wind turbine technology*. CRC Press. Boca Raton, FL, USA. 7. Solanki, C. S. (2011). *Solar photovoltaics, fundamentals, technologies and applications*. Prentice Hall. Upper Saddle River, NJ, USA. 8. TERI Energy Data Year Books Bureau of Energy Efficiency- Volume 1. New Delhi, India. 9. Wolfson, R. (2011). *Energy, environment, and climate, Publisher* (2nd ed). W. W. Norton, and Company. New York, NY, USA.			

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Title of the Course	Research Methodology
Course Code	ENV-6009
Number of Credits	04
Theory/Practical	Theory
Level	500
Effective from AY	2026-2027
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	• Apply research design principles to formulate hypotheses, select problems, and plan data collection in environmental sciences. • Evaluate sampling strategies and data compilation methods to ensure representative and high-quality datasets. • Employ descriptive, inferential, and multivariate statistical tools to analyze ecological and environmental data. • Design and execute air, soil, and water sampling protocols alongside chemical parameter measurements for environmental assessment.	
Course Outcomes:	Student will learn to:	**Mapped to PSO**
	CO 1. Develop robust research plans defining objectives, hypotheses, and design for environmental studies.	PSO 1, PSO 6
	CO 2. Implement and justify appropriate sampling designs, data collection instruments, and data-	PSO 2, PSO 5

	processing workflows.			
	CO 3. Analyze ecological datasets using univariate and multivariate statistics, interpreting results in the context of environmental hypotheses.		PSO 3, PSO 6	
	CO 4. Execute field sampling (air, soil, water and biodiversity) and laboratory analyses, and critically evaluate data quality.		PSO 2, PSO 6	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	Research and scientific methods, Types of research, Significance of research; Selecting a research problem, Research design, Formulation of hypothesis, Procedure for hypothesis testing; Sampling: Concepts of statistical population, sample, sampling frame, sampling error and bias, Sample size; Types of sampling designs: Non-probability sampling, probability sampling; Primary data, Secondary data, tools and methods of data collection, data compilation; Tools in data analysis, graphical representation of data, Processing of data	**15**	CO 1, CO 2, CO 3	K2, K3, K4
Module 2:	Air Sampling: Objective and criteria of air sampling, selection of sampling location, sampling methods (sedimentation, filtration, centrifugal and impingement method), instrumental techniques used in estimation of atmospheric air pollutant, dust fall jar, SPM and RSPM using respirable dust sample/High volume air sampler; Soil and solid waste sampling: Collection and preparation of soil; Soil testing kits, samples for analysis, physico-chemical parameters and their significance (quality and productivity). Water Sampling: Objectives, selection of sampling site, collection, handling and preservation, sampling equipment, classification of water quality parameters (inorganic, organic and nutrient), data interpretation, measurement and analysis of DO, BOD, COD, metals, pesticides and Polynuclear Aromatic Hydrocarbon (PAH) in water and wastewater. Biodiversity monitoring: Vegetation surveys- quadrat methods, belt and line transects, point-intercept sampling, faunal survey / collection methods (invertebrates, birds, mammals, aquatic organisms), diversity metrics: alpha, beta and gamma diversity.	**15**	CO 4	K3, K4

Module 3:	Measurement scales, sources of error in measurement, measures of central tendency; Measures of dispersion (range, standard deviation); Normal Probability Curve - Meaning, characteristics and applications, Confidence Intervals, Type I and Type II errors; statistical hypothesis testing and interpretations; parametric vs non-parametric tests: tests for normality and homogeneity of variances; Testing the Significance of difference between means (t test and Mann-Whitney test); Analysis of Variance and Kruskal-Wallis test; Correlation, regression; PCA, LDA, MDS, Cluster analyses using SPSS/R.	**15**	CO 3	K2, K3
Module 4:	Ethics in Environmental research; Importance of effective communication; Graphical representation of data; Tools for draft writing; Types of reports, Oral presentation, Research paper; Writing format and style, Literature review, Major findings, Discussion, Conclusions, Citation and styles of references and bibliography. Scientific misconduct: Plagiarism, fabrication and falsification in research. Importance of indexed, peer-reviewed journals: Web of Science, Scopus, PubMed, Journal Metrics; IPR and patents.	**15**	CO 1, CO 2	K2, K3
Pedagogy:	1. Lectures to review and introduce core concepts. 2. ICT-based learning using animations and illustrations to understand research and statistical concepts. 3. Case-based problems: real-world scenarios. 4. Collaborative learning and group projects. 5. Evaluation using quizzes and assignments.			
Texts:	1. Greenfield, T., & Greener, S. (2016). Research methods for postgraduates (3rd ed.). John Wiley & Sons Ltd., Chichester, United Kingdom. 2. Gupta, S. C. (1997). Statistical methods. S. Chand & Sons Publishers, New Delhi, India. 3. Gurumani, N. (2008). Research methodology for biological sciences. MJP Publishers, New Delhi, India. 4. Hawkins, D. M. (2009). Biomeasurement: A student's guide to biological statistics. Oxford University Press, New York, NY, USA. 5. Kothari, C. R., & Garg, G. (2023). Research methodology: Methods and techniques (5th ed.). New Age International Publishers, New Delhi, India. 6. Zhang, C. (2024). Fundamentals of environmental sampling and analysis (2nd ed.). John Wiley & Sons, Hoboken,			

	NJ, USA.
References/ Readings:	1. Caggiano, H., & Weber, E. U. (2023). Advances in qualitative methods in environmental research. Annual Review of Environment and Resources, 48(1), 793-811. Annual Reviews. Palo Alto, CA, USA. 2. Tomy L, Chesneau C, Madhav AK. Statistical Techniques for Environmental Sciences: A Review. Mathematical and Computational Applications. 2021; 26(4):74. MDPI. Basel, Switzerland. 3. Zhu, G., Wen, Y., Cao, K., He, S., & Wang, T. (2024). A review of common statistical methods for dealing with multiple pollutant mixtures and multiple exposures. Frontiers in public health, 12, 1377685. Frontiers Media. Lausanne, Switzerland.
Web Resources:	1. Best practices for statistical reporting in scientific manuscripts. https://www.esa.org/wp-content/uploads/2022/05/ESA-Statistical-Analysis-Guidelines.pdf 2. Comprehensive online guide covering research formulation, design, statistics, and reporting. https://evs.institute/research-methodology-for-environmental-science/ 3. US EPA guidance and tools for environmental data analysis and determining causes of impairment. https://www.epa.gov/caddis/getting-started-data-analysis

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Discipline Specific Vocational Elective (DSVE) Courses

Title of the Course	Environmental Pollution Practical I
Course Code	ENV-6401
Number of Credits	02
Theory/Practical	Practical
Level	500
Effective from AY	2026-2027
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	To analyse the pollutants in the water and sediments and evaluate their impact on the environment.	
Course Outcomes:	Student will learn to:	**Mapped to PSO**
	CO 1. To determine the nutrient concentration (nitrite, nitrate, ammonia & silicate) in coastal waters to assess water quality	PSO 1, PSO 2
	CO 2. To estimate and compare bacterial and fungal loads in the air samples using standard microbiological methods to evaluate airborne microbial distribution.	PSO 1, PSO 2
	CO 3. To apply sediment digestion techniques and analyse trace (Cu, Co, Zn, Fe) metals using AAS.	PSO1, PSO2

	CO 4. To perform pre-concentration of seawater samples using solvent extraction method and analyse the trace metals (Cu, Co, Zn, Fe) metals using AAS.		PSO 1, PSO 2	
Content:		**No. of Hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	1. To determine the concentration of nitrite in the coastal waters using spectrophotometric technique. 2. To determine the concentration of nitrate in the coastal waters using spectrophotometric technique. 3. To determine the concentration of ammonia in the coastal waters using spectrophotometric technique. 4. To determine the concentration of chlorine in the coastal waters using spectrophotometric technique. 5. To estimate the bacterial load in the air. 6. To estimate the fungal load in the air.	**30**	CO 1, CO 2	K5
Module 2:	1. Sediment digestion. 2. Pre-concentration of seawater by solvent extraction method for analysis of trace metals by AAS. 3. Estimation of Cu in coastal waters/sediments by AAS method. 4. Estimation of Co in coastal waters/sediments by AAS method. 5. Determination of Zn in polluted water by AAS method. 6. Determination of Fe in seawater by AAS method. 7. To prepare consultancy reports, with structured presentations, recommendation and conclusions.	**30**	CO 3, CO 4, CO 5	K5
Pedagogy:	Practical/ Tutorials/ Assignments.			
Texts: **References/ Readings:**	1. Christian, G. D. (2013). *Analytical chemistry* (6th ed.). Wiley, Hoboken, NJ, USA. 2. Dey, A. K. (2010). *Environmental chemistry* (7th ed.). New Age International Publishers, New Delhi, India. 3. Grasshoff, K., Kremling, K., & Ehrhardt, M. (Eds.). (1999). *Methods of seawater analysis* (3rd ed.). Wiley-VCH, Weinheim, Germany. 4. Hota, R. N. (2021). *Geochemical analysis* (2nd ed.). CBS Publishers & Distributors Pvt. Ltd., New Delhi, India.			

	5. Rice, E. W., Baird, R. B., Eaton, A. D., & Clesceri, L. S. (2012). *Standard methods for the examination of water and wastewater* (22nd ed.). American Public Health Association, Washington, DC, USA.

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Title of the Course	Environmental Pollution Practical II
Course Code	ENV-6402
Number of Credits	02
Theory/Practical	Practical
Level	500
Effective from AY	2026-2027
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	Understand the concentration of various pollutants in natural waters and their influence on environment.	
Course Outcomes:	Student will learn to:	**Mapped to PSO**
	CO 1. Understand practical skills in the analysis of water and soil samples using classical and instrumental techniques.	PSO 1, PSO 2
	CO 2. Estimate pollution level of water, wastewater, and soil samples—through collection, preservation, and instrumental analysis techniques.	PSO 1, PSO 2
	CO 3. Apply spectrophotometric method to determine contaminant concentration in polluted water and evaluate its environmental impact.	PSO 1, PSO 2
	CO 4. Perform adsorption experiments for pollutant removal in drinking water and understand the implications for public health.	PSO 1, PSO 2

Content:		No of hours	Mapped to CO	Cognitive Level
Module 1:	1. Separation of amino acid by Thin Layer Chromatography. 2. Calibration of glass electrode and determination of pH of different water samples (surface water, ground water and sea water). 3. Calibration of conductivity meter and determination of conductivity of different water samples (surface water, ground water and sea water). 4. Determination of alkalinity of surface, ground and sea water sample using titrimetric analysis. 5. Determination of acidity of surface, ground and sea water sample using titrimetric analysis. 6. Estimation of total solids, dissolved solids, suspended solids of surface, ground and sea water samples.	**30**	CO 1, CO 2	K2, K3, K4
Module 2:	1. To determine the optimum coagulant dosage for clarifying the given sample of water by using alum as the coagulant and performing the jar test experiment. 2. Estimation of Sodium/ Potassium in soil samples using Flame Emission Spectroscopy. 3. Determination of chromium in water sample by UV-Visible spectrophotometry. 4. Determination of adsorption capacity of activated charcoal for various coloured water samples. 5. Estimation of Iron from water sample by thiocyanate method. 6. Infrared Spectral Analysis of soil samples.	**30**	CO 3, CO 4	K2, K3, K4, K5, K6
Pedagogy:	Pre-lab and post-lab assignments or a combination of some of these; Sessions shall be interactive in nature to enable peer group learning.			
Texts:	1. Christian, G. D. (2013). *Analytical chemistry* (6th ed.). Wiley. Hoboken, NJ, USA. 2. Dey, A. K. (2010). *Environmental chemistry* (7th ed.). New Age International Publishers. New Delhi, India. 3. Rice, E. W., Baird, R. B., Eaton, A. D., & Clesceri, L. S. (2012). *Standard methods for the examination of water and*			

	wastewater (22nd ed.). American Public Health Association. Washington, DC, USA.
References/ Readings:	1. Jeffery, G. H., Bassett, J., Mendham, J., & Denney, R. C. (1989). *Vogel's textbook of quantitative chemical analysis* (5th ed.). Longman Scientific & Technical. Harlow, U.K. 2. Khopkar, S. M. (2008). *A laboratory manual for environmental chemistry* (1st ed.). I. K. International Publishing House. New Delhi, India. 3. Manahan, S. E. (2017). *Environmental chemistry* (10th ed.). CRC Press. Boca Raton, FL, USA. 4. Moore, J. W., & Moore, F. A. (2012). *Environmental chemistry.* Academic Press. New Delhi, India. 5. Rice, E. W., Baird, R. B., Eaton, A. D., & Clesceri, L. S. (2012). *Standard methods for the examination of water and wastewater* (22nd ed.). American Public Health Association. Washington, DC, USA. 6. Sawyer, C. N., McCarty, P. L., & Parkin, G. F. (2002). *Chemistry for environmental engineering and science* (5th ed.). McGraw-Hill Education. New York, USA. 7. Sharma, B. K. (2016). *Environmental chemistry and pollution control* (Rev. ed.). Krishna Prakashan Media. Meerut, India.

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Title of the Course	Field work and Environmental Sampling Practical
Course Code	ENV-6403
Number of Credits	02
Theory/Practical	Practical
Level	500
Effective from AY	2026-2027
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	• To impart field-based skills in environmental sampling, measurement, and monitoring. • To familiarize students with sampling design, collection techniques, and data recording methods for various environmental components (air, water, soil, vegetation). • To provide training in field data analysis, interpretation, and report preparation for environmental assessment.	
Course Outcomes:	Student will learn to:	**Mapped to PSO**
	CO 1. Identify and apply standard field and sampling methods for environmental data collection.	PSO 1
	CO 2. Employ appropriate field instruments for measuring abiotic and biotic parameters.	PSO 1
	CO 3. Analyze and interpret field-collected environmental data using quantitative and graphical tools.	PSO 1
	CO 4. Evaluate the quality and reliability of sampling data for environmental decision-making.	PSO 1

	CO 5. Design field-based mini-projects or sampling protocols integrating ecological and environmental indicators.		PSO 1	
Content:		**No. of Hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	1. Introduction to environmental sampling principles: random, stratified, systematic sampling. 2. Field orientation and safety protocols. 3. Measurement of microclimatic parameters: temperature, humidity, light, and wind speed using field sensors. 4. Collection of soil and sediment samples for physical and chemical analysis (pH, texture, moisture, organic matter). 5. Sampling and preservation of surface and groundwater samples for physico-chemical analysis (DO, BOD, COD, pH, EC, TDS). 6. Air quality monitoring: measurement of SPM, $PM_{2.5}$, and gaseous pollutants using portable samplers.	**30**	CO 1, CO 2, CO 3, CO 4, CO 5	K2, K3, K4, K5, K6
Module 2:	1. Field data sheet preparation and calibration of sampling instruments. 2. Quadrat and transect sampling for vegetation studies (density, frequency, abundance). 3. Canopy cover estimation and biomass assessment. 4. Biodiversity indices calculation (Shannon–Wiener, Simpson) using field data. 5. Field report preparation: integration of abiotic and biotic data for environmental interpretation.	**30**	CO 1, CO 2, CO 3, CO 4, CO 5	K2, K3, K4, K5, K6
Pedagogy:	Field-based experiential learning; visits to terrestrial, freshwater, and industrial sites for hands-on training.			
Texts:	1. Allen, S. E. (Ed.). (1989). *Chemical Analysis of Ecological Materials* (2nd ed.). Blackwell Scientific Publications. 2. APHA. (2017). *Standard Methods for the Examination of Water and Wastewater* (23rd ed.). American Public Health Association. 3. Barbour, M. G., Burk, J. H., & Pitts, W. D. (1999). *Terrestrial Plant Ecology* (3rd ed.). Benjamin Cummings. 4. Henderson, P. A., & Southwood, T. R. E. (2016). *Ecological Methods* (4th ed.). Wiley. 5. Krebs, C. J. (2014). *Ecological Methodology* (3rd ed.). Addison-Wesley.			

	6. Misra, R. (1968). *Ecology Workbook.* Oxford & IBH Publishing. 7. Trivedy, R. K., & Goel, P. K. (1986). *Chemical and Biological Methods for Water Pollution Studies.* Environmental Publications.
References/ Readings:	1. Boyd, C. E. (2020). *Water Quality: An Introduction* (3rd ed.). Springer. 2. Peavy, H. S., Rowe, D. R., &Tchobanoglous, G. (1985). *Environmental Engineering.* McGraw-Hill. 3. Sharma, B. K., & Kaur, H. (2015). *Environmental Chemistry* (5th ed.). Goel Publishing House. 4. Sutherland, W. J. (Ed.). (2006). *Ecological Census Techniques: A Handbook* (2nd ed.). Cambridge University Press. Cambridge, UK.
Web Resources:	1. Central Pollution Control Board (CPCB) – Sampling protocols and environmental monitoring guidelines. https://cpcb.nic.in/ 2. Global Biodiversity Information Facility (GBIF) – Biodiversity data and sampling resources. https://www.gbif.org/ 3. National Environmental Engineering Research Institute (NEERI) – Research and field protocols. https://www.neeri.res.in/ 4. National Institute of Hydrology (NIH), India – Surface and groundwater sampling manuals. https://nihroorkee.gov.in/ 5. OpenAir Project – Air quality data analysis and visualization tools. https://davidcarslaw.github.io/openair/ 6. United States EPA Sampling and Analytical Methods – Standard operating procedures for field sampling. https://www.epa.gov/

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Title of the Course	Environmental Data Analysis Practical
Course Code	ENV-6404
Number of Credits	02
Theory/Practical	Practical
Level	500
Effective from AY	2026-2027
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	To analyze environmental data using appropriate statistical tools.	
Course Outcomes:	Student will learn to:	**Mapped to PSO**
	CO 1. Use visualization and statistical softwares for environmental data analysis.	PSO 2
	CO 2. Identify the different types of softwares used for data analysis and their utility.	PSO 2, PSO 6
	CO 3. Discriminate between analytical methods for different types of environmental data.	PSO 2, PSO 6
	CO 4. Design analysis strategies for environmental data.	PSO 2, PSO 6
	CO 5. Interpret environmental datasets effectively.	PSO 2, PSO 6

Content:		No of hours	Mapped to CO	Cognitive Level
Module 1:	1. Collection of physico-chemical and biological datasets from public sources and processing using pie charts, line graphs and bar graphs using Excel/Grapher software. 2. Preparation of Contour maps. 3. Statistical analysis of data: analysis of normality and homogeneity of variances. 4. Parametric statistical analysis (t-test; one-way, two-way and repeated measures ANOVA; Tukey's/Dunnett's post-hoc test).	**30**	CO 1, CO 2, CO 3, CO 4, CO 5	K4, K5, K6
Module 2:	1. Non-parametric statistical analysis: Mann-Whitney U test, Wilcoxon Signed Rank test, Kruskal-Wallis test). 2. Univariate data analysis: analysis of measures of community structure – Shannon-Wiener species diversity, Pielou's species evenness and Margalef's species richness indices. 3. Multivariate analysis – construction of dendograms and Nonmetric Multi-Dimensional Scaling (NMDS) ordination diagrams. 4. Principal Component Analysis; Canonical Component Analysis.	**30**	CO 3, CO 4, CO 5	K4, K5
Pedagogy:	Data processing/ computation.			
References/ Readings:	1. Arora, P.N. & Malhan, P.K. (2012). Biostatistics, Himalaya Publishing House. New Delhi, India. 2. Basic Tasks in Excel - https://support.microsoft.com/en-us/office/basic-tasks-in-excel-dc775dd1-fa52-430f-9c3c-d998d1735fca 3. Christian, H. & Michael, S. (2016). Introduction to Statistics and Data Analysis: With Exercises, Solutions and Applications in R. Springer Publications. Switzerland. 4. Grapher User's Guide (2020). Golden Software, LLC USA, www.GoldenSoftware.com 5. Kothari, C. R. (1992). Quantitative Techniques, Vikas Publishing House. New Delhi, India. 6. Kovach, W. (1998). Multi-Variate Statistical Package. Ver.3.01. Pentraeth, United Kingdom. 7. PRIMER: User Manual/Tutorial. PRIMER-E. Plymouth. 8. Statistica for Windows, Data Analysis Software System, www.statistica.com			

	9. Surfer 12 Full User's Guide (2014). Golden Software, LLC USA, www.GoldenSoftware.com 10. ter Braak, C.J.F. (1995). Ordination. In: Jongman, R.H.G., ter Braak, C.J.F. & van Tongeren, O.F.R. (eds.), Data Analysis in Community and Landscape Ecology. Cambridge University Press, Cambridge, pp. 91e173. England.

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Title of the Course	Analysis of Environmental Impact Assessment
Course Code	ENV-6405
Number of Credits	02 (1T+1P)
Theory/Practical	Theory and Practical
Level	500
Effective from AY	2026-2027
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	• To understand the theoretical foundations, principles, and processes of Environmental Impact Assessment (EIA). • To analyze the structure, scope, and methodologies used in environmental assessment and management planning. • To evaluate the limitations, ethics, and legal frameworks governing EIA at national and international levels. • To gain hands-on experience in applying EIA methodologies, interpreting baseline data, and reviewing Environmental Management Plans (EMP). • To enable students to critically review EIA reports and recommend mitigation and monitoring strategies for sustainable development.	
Course Outcomes:	Students will learn to:	**Mapped to PSO**
	CO 1. Explain the fundamental principles, objectives, and stages of the EIA process.	PSO 3
	CO 2. Apply EIA methods and impact-prediction tools for different development sectors.	PSO 3

	CO 3. Analyze EIA reports and assess Environmental Management Plans (EMP) using qualitative and quantitative criteria.		PSO 3	
	CO 4. Evaluate the legal, procedural, and participatory frameworks of EIA in India and globally.		PSO 3	
	CO 5. Design and recommend mitigation and monitoring plans for sustainable environmental management.		PSO 3	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	Foundations of EIA: Concept, history, need and evolution; principles, objectives and its role in sustainable development. EIA Process and Framework: Screening, scoping, baseline data collection, impact prediction, evaluation, mitigation, monitoring and post-project appraisal. Types of Impacts: Direct, indirect, cumulative and synergistic; temporal and spatial considerations. EIA Methodologies and Tools: Checklists, matrices (Leopold, Battelle), overlays and networks; modelling for air, water, noise and ecological components; risk assessment and cost–benefit analysis. Environmental Management and Monitoring: Preparation of EMP, mitigation hierarchies, performance indicators and adaptive management. Advanced Approaches: Strategic Environmental Assessment (SEA) and Cumulative Impact Assessment (CIA). Applied Perspectives and Case Studies: Environmental clearance process and policy framework in India; sector-specific case studies (mining, infrastructure, hydropower); ethical and participatory dimensions of EIA practice.	**15**	CO 2, CO 3, CO 4, CO 5	K3, K4, K5, K6
Module 2:	1. EIA report structure: Executive summary, baseline environment, impact prediction, mitigation and management plan. 2. Screening and scoping exercise: Project categorization, screening criteria and scoping matrices. 3. Environmental management plan (EMP) assessment: Mitigation and monitoring	**30**	CO 1, CO 2, CO 3	K1, K2, K3, K4,

	strategies; compliance and sustainability indicators. 4. Legal and institutional framework: Review of EIA Notification (2006) and amendments; SEAC, SEIAA and NGT roles in project clearance. 5. Case study evaluation: Comparative analysis of two EIA reports (e.g., mining vs infrastructure); group presentation and critical review report. 6. Practical outcome: Preparation of a structured "EIA Analysis Report" summarizing observations and recommendations.			K5
Pedagogy:	Lectures/ tutorials/ assignments/ discussion.			
Texts:	1. Biswas, A. K., & Agarwal, A. (Eds.). (1994). *Environmental impact assessment for developing countries.* Butterworth-Heinemann, Oxford, UK. 2. Canter, L. W. (1996). *Environmental impact assessment* (2nd ed.). McGraw-Hill, New York, NY, USA. 3. Glasson, J., Therivel, R., & Chadwick, A. (2013). *Introduction to environmental impact assessment* (4th ed.). Routledge, London, UK. 4. Jain, R. K., Urban, L. V., & Stacey, G. S. (2004). *Environmental impact analysis: A new dimension in decision-making.* CBS Publishers, New Delhi, India. 5. Morgan, R. K. (2012). Environmental impact assessment: The state of the art. *Impact Assessment and Project Appraisal, 30*(1), 5–14. https://doi.org/10.1080/14615517.2012.661557 6. Morris, P., & Therivel, R. (2001). *Methods of environmental impact assessment* (2nd ed.). Routledge, London, UK. 7. Noble, B. (2014). *Introduction to environmental impact assessment: A guide to principles and practice* (3rd ed.). Oxford University Press, Don Mills, Ontario, Canada. 8. Petts, J. (Ed.). (1999). *Handbook of environmental impact assessment.* Blackwell Science, Oxford, UK. 9. Sadler, B. (1996). *Environmental assessment in a changing world: Evaluating practice to improve performance.* International Association for Impact Assessment (IAIA) & Canadian Environmental Assessment Agency (CEAA), Ottawa, Canada.			
References/ Readings:	1. Biswas, A. K., & Agarwal, A. (Eds.). (1994). *Environmental impact assessment for developing countries.* Butterworth-Heinemann, Oxford, UK. 2. Morgan, R. K. (2012). Environmental impact assessment: The state of the art. *Impact Assessment and Project Appraisal, 30*(1), 5–14. https://doi.org/10.1080/14615517.2012.661557 3. Morris, P., & Therivel, R. (2001). *Methods of environmental impact assessment* (2nd ed.). Routledge, London, UK. 4. Sadler, B. (1996). *Environmental assessment in a changing world: Evaluating practice to improve performance.*			

	International Association for Impact Assessment (IAIA) & Canadian Environmental Assessment Agency (CEAA), Ottawa, Canada.
Web Resources:	1. Central Pollution Control Board (CPCB) – Environmental standards and assessment protocols. 🔗 https://cpcb.nic.in/ 2. EIA Resource and Response Centre (ERC India) – Repository of Indian EIA reports and reviews. 🔗 https://ercindia.org/ 3. IAIA (International Association for Impact Assessment) – Global standards and best practices in EIA. 🔗 https://www.iaia.org/ 4. MoEFCC, India – EIA Notification (2006) and sectoral guidelines. 🔗 https://moef.gov.in/ 5. UNEP Environmental Assessment Resources – Global environmental evaluation guidelines. 🔗 https://www.unep.org/ 6. World Bank Environmental and Social Framework (ESF) – International EIA guidance. 🔗 https://www.worldbank.org/en/projects-operations/environmental-and-social-framework

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SEMESTER IV

Generic Elective (GE) Courses

Title of the Course	Coral Ecosystem and Threats	
Course Code	ENV-6201	
Number of Credits	03	
Theory/Practical	Theory	
Level	500	
Effective from AY	2026-2027	
New Course	No	
Bridge Course/ Value added Course	No	
Course for advanced learners	No	
Pre-requisites for the Course:	Nil	
Course Objectives:	• To understand the reef formation, distribution and biological/ecological processes of coral reefs. • To explore the coral biome and its ecological interactions. • To study the climate change adversities, conservation and restoration of coral habitats.	
Course Outcomes:		**Mapped to PSO**
	CO 1. Describe coral ecosystem function and examine its economic implications.	PSO 1
	CO 2. Indicate the physico-chemical and biological factors influencing coral ecology.	PSO 2
	CO 3. Educate and create awareness of impact of anthropogenic activities on coral health.	PSO 4

	CO 4. Survey the conservation and management strategies of damaged corals and their recovery.		PSO 3	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	Coral reef distribution, evolution and significance: Types of coral reefs and their global distribution with special emphasis to Indian waters. Salient features of the ecosystem: Habitat characteristics, reef biodiversity and nursery grounds, interactions with seagrass ecosystem and migratory corridors, natural barriers; Paleoecology of corals. Theories of evolution: Subsidence theory, Glacial control theory, Stand still theory, Cycle of erosion theory; Coral reef formation, morphology and functional zones, Ocean chemistry and aragonite saturation; Hydrodynamics and lagoon circulation. Economic Importance: Fisheries and marine products, tourism and recreational activities.	**15**	CO 1	K1, K2, K3
Module 2:	Factors influencing coral biome: Environmental factors (pH, temperature, salinity, sedimentation, waves, ocean currents, weather, nutrients, aerial exposure, light) and their impact. Competitors, Microbial infections, predators, parasites. Coral communities and trophic structure: Primary producers, consumers, food webs, productivity in coral reefs. Symbiotic associations: Algal-coral associations, bacterial symbiosis, multi-partner symbiosis; Internal nutrient cycling, Energy transfer/trophodynamics, Adaptive bleaching hypothesis, Coral probiotic hypothesis, Rosenberg's hologenome hypothesis.	**15**	CO 2	K3, K4
Module 3:	Threats to corals, disease spread assessment and prophylactic measures: Anthropogenic threats: Tourism and its impact, pollution, overfishing, habitat destruction; Global warming, thermal bleaching, ocean acidification, sea level rise and its effect on coral health; Coral disease survey and monitoring protocols; Disease response plan and outbreak management. Ex-situ treatment measures: Use of antibiotics, anti-oxidants and Phage therapy. Cultivation and conservation of corals: Coral Restoration and Health Consortium (CRHC), Global Coral Reef Conservation Project, Resilient Reef Initiative Project,	**15**	CO 3, CO 4	K5, K6

	Mithapur Coral Reef Recovery Project; Traits of climate change resilient clades; Laws and policies for conservation and management of corals in Indian seas/waters.			
Pedagogy:	Lectures/tutorials/assignments/case-studies.			
References/ Readings:	1. Chakravarti, L. J., & van Oppen, M. J. H. (2018). Experimental evolution in coral photosymbionts as a tool to increase thermal tolerance. *Frontiers in Marine Science, 5*, Article 227. https://doi.org/10.3389/fmars.2018.00227 2. Contardi, M., Montano, S., Liguori, G., Heredia-Guerrero, J. A., Galli, P., Athanassiou, A., & Bayer, I. S. (2020). Treatment of coral wounds by combining an antiseptic bilayer film and an injectable antioxidant biopolymer. *Scientific Reports, 10*(1), Article 57980. https://doi.org/10.1038/s41598-020-57980-1 3. Dubinsky, Z., & Stambler, N. (2014). *Coral reefs: An ecosystem in transition* (1st ed.). Springer, Dordrecht, Netherlands. 4. Harvell, D., Jordán-Dahlgren, E., Merkel, S., Rosenberg, E., Raymundo, L., Smith, G., Weil, E., & Willis, B. (2007). Coral disease, environmental drivers, and the balance between coral and microbial associates. *Oceanography, 20*(1), 172–195. https://doi.org/10.5670/oceanog.2007.91 5. Laurie, J. R., Courtney, S. C., & Harvell, D. C. (2021). *Coral disease handbook: Guidelines for assessment, monitoring & management.* ReefBase, Townsville, Australia. ISBN 978-1921317019 6. Sheppard, C., Davy, S., Pilling, G., & Graham, N. (2018). *The biology of coral reefs* (Biology of Habitats Series, 2nd ed.). Oxford University Press, Oxford, United Kingdom. 7. van Oppen, M. J. H., & Blackall, L. L. (2019). Coral microbiome dynamics, functions and design in a changing world. *Nature Reviews Microbiology, 17*(9), 557–567. https://doi.org/10.1038/s41579-019-0223-4 8. van Oppen, M. J. H., Oliver, J. K., Putnam, H. M., & Gates, R. D. (2015). Building coral reef resilience through assisted evolution. *Proceedings of the National Academy of Sciences, 112*(8), 2307–2313. https://doi.org/10.1073/pnas.1422301112			

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Title of the Course	Disaster Management
Course Code	ENV-6202
Number of Credits	03
Theory/Practical	Theory
Level	500
Effective from AY	2026-2027
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	• To introduce students to the fundamental concepts of disasters, hazards, vulnerability, risk, and capacity, and to provide a comprehensive understanding of natural, anthropogenic, and emerging disaster types. • To develop knowledge of the disaster management cycle and to familiarize students with scientific and technological applications (e.g., GIS, RS, GPS, early warning systems) for disaster risk reduction and management. • To expose students to national and international disaster management frameworks, policies, and institutional mechanisms, with special emphasis on the Disaster Management Act 2005 and community-based approaches. • To enable students to critically analyze case studies of major disasters, evaluate their causes and consequences, and suggest sustainable strategies for mitigation, preparedness, response, and recovery.	
Course Outcomes:	Student will learn to:	**Mapped to PSO**
	CO 1. Explain the fundamental concepts of disasters, hazards, vulnerability, risk, and capacity, and classify different types of natural, biological, and anthropogenic disasters.	PSO 1, PSO 4, PSO6

	CO 2. Analyze the disaster management cycle, including pre-disaster risk reduction, disaster response, and post-disaster recovery, and apply scientific and technological approaches (GIS, remote sensing, early warning systems).		PSO 1, PSO 2, PSO 5, PSO 6	
	CO 3. Evaluate institutional frameworks, policies, and international strategies for disaster risk reduction, with a focus on India's Disaster Management Act (2005) and community-based approaches.		PSO 1, PSO 4, PSO 6	
	CO 4. Apply theoretical knowledge to practical case studies of disasters to assess causes, consequences, and lessons learned for sustainable disaster risk reduction.		PSO 1, PSO 2, PSO 4, PSO 5, PSO 6	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	Definitions, Concepts, Classifications, Emerging Trends of disaster, Hazard, Vulnerability, Risk, Capacity – Disaster and Development, and disaster management. Natural and Manmade disasters, Global Disaster Trends; Emerging Risks of Disasters; Climate Change and Urban Disasters: The Refugee Problem. Types, trends, causes, consequences and control of disasters - Geological Disasters (earthquakes, volcanic eruptions, landslides, tsunami, land subsidence); Hydro-Meteorological Disasters (floods, cyclones, lightning, thunderstorms, hail storms, avalanches, droughts, cold and heat waves). Biological Disasters (epidemics, pest attacks, forest fire); and Anthropogenic Disasters (building collapse, mining mishaps, rural and urban fire, road and rail accidents, oil spills, nuclear, radiological, industrial, chemicals and biological disasters, terrorism).	**15**	CO 1, CO 4	K1, K2, K3
Module 2:	Disaster management cycle and framework, and applications of science and technology to disaster management: Disaster Management Cycle and the Paradigm Shift in Disaster Management. Pre-Disaster – Risk Assessment and Analysis, Risk Mapping, zonation and Microzonation, Prevention and Mitigation of Disasters, Early Warning System; Preparedness, Capacity Development; Awareness During Disaster: Evacuation, Disaster Communication, Search and Rescue, Emergency Operation Centre, Incident Command System, Relief and Rehabilitation. Post-disaster: Damage and needs assessment, Restoration of critical infrastructure, Early recovery, Reconstruction and Redevelopment Geo-informatics in Disaster Management	**15**	CO 2, CO 4	K2, K3, K4

	(RS, GIS, GPS). Disaster Communication System (Early Warning and Its Dissemination). Land Use Planning and Development Regulations. Disaster Safe Designs and Constructions. Structural and Non-Structural Mitigation of Disasters. S&T Institutions for Disaster Management in India			
Module 3:	*International organizations, NGOs, best practices and disaster management in India:* International organisations: Red Cross, Sphere, Oxfam, World Relief, CBM International, UNDRO, UNDDR. Yokohama Strategy, Hyogo Framework of Action, UNISDR. Critical analysis of NGO experience. Community Based Disaster Risk Reduction (CBDRR). Disaster Profile of India – Mega Disasters of India and Lessons Learnt. Disaster Management Act 2005 – Institutional and Financial Mechanism. National Policy on Disaster Management, National Guidelines and Plans on Disaster Management; Role of Government (local, state and national), Non-Government and Inter-Governmental Agencies.	**15**	CO 3, CO 4	K2, K4, K5
Pedagogy:	Lectures/ tutorials/ assignments/discussions.			
Texts:	1. Alexander, D. (1999). *Natural disasters.* Kluwer Academic Publishers, London, UK. 2. Coppola, D. P. (2007). *Introduction to international disaster management.* Elsevier Science (Butterworth-Heinemann), London, UK. 3. Government of India & United Nations Disaster Risk Programme. (2009–2020). *Disaster management guidelines.* New Delhi, India. 4. Government of India. (2005). *Disaster Management Act, 2005.* Government of India, New Delhi, India. 5. Goyal, S. L. (2006). *Encyclopaedia of disaster management* (Vols. 1–3). Deep & Deep Publications, New Delhi, India. 6. Gunn, A. M. (2008). *Encyclopaedia of disasters: Environmental catastrophes and human tragedies* (Vols. 1–2). Greenwood Press, Westport, CT, USA. 7. Gupta, A. K., Nair, S. S., & Chatterjee, S. (2013). *Disaster management and risk reduction: Role of environmental knowledge.* Narosa Publishing House, Delhi, India. 8. Gupta, M. C., Sharma, K., Gupta, L. C., & Tamini, B. K. (2001). *Manual on natural disaster management in India.* National Centre for Disaster Management, Government of India, New Delhi, India. 9. International Federation of Red Cross and Red Crescent Societies. (2009–2020). *World disasters report.* Geneva,			

	Switzerland. 10. Kapur, A. (2005). *Disasters in India: Studies of grim reality*. Rawat Publications, Jaipur, India. 11. Lopez-Carresi, A., Fordham, M., Wisner, B., Kelman, I., & Gaillard, J. C. (2014). *Disaster management: International lessons in risk reduction, response and recovery*. Routledge, London, UK. 12. Modh, S. (2010). *Managing natural disasters*. Macmillan Publishers India Ltd., New Delhi, India. 13. Rubin, C. B., & Cutter, S. L. (2020). *U.S. emergency management in the 21st century: From disaster to catastrophe*. Routledge, New York, NY, USA. 14. Srivastava, H. N., & Gupta, G. D. (2006). *Management of natural disasters in developing countries*. Daya Publishing House, Delhi, India. 15. United Nations International Strategy for Disaster Reduction (UNISDR). (2002). *Natural disasters and sustainable development: Understanding the links between development, environment and natural disasters* (Background Paper No. 5). United Nations, Geneva, Switzerland.
References/ Readings:	Publications of National Disaster Management Authority (NDMA) on Various Templates and Guidelines for Disaster Management
Web Resources:	1. https://www.preventionweb.net/ 2. https://www.undrr.org/implementing-sendai-framework/what-sendai-framework 3. https://appliedsciences.nasa.gov/what-we-do/disasters 4. https://www.adpc.net 5. https://ndma.gov.in 6. https://sdma.goa.gov.in/ 7. https://libguides.worldbank.org/disasterriskmanagement/data?utm

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Title of the Course	Environmental Economics
Course Code	ENV-6203
Number of Credits	03
Theory/Practical	Theory
Level	500
Effective from AY	2026-2027
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	• To understand the implications of production and consumption outcomes on the environment. • Assess market and non-market tools that can be used in policy-making to move towards sustainable development.	
Course Outcomes:	Student will learn to:	**Mapped to PSO**
	CO 1. Undertake basic environmental valuation,	PSO 1, PSO 4, PSO 6
	CO 2. Explore cost-benefit analysis of projects	PSO 1, PSO 2
	CO 3. Analyse implications of alternative environmental policies	PSO 4, PSO 6
	CO 4. Explain behavioural choices with respect to the environment	PSO 1, PSO 6

Content:		No of hours	Mapped to CO	Cognitive Level
Module 1:	Perspectives on the environment economics and the environment; A framework for environmental analysis; Environmental microeconomics and macroeconomics resources. Environment and economic development: A brief history of economic growth and the environment; A summary of recent growth; The future of economic growth and the environment; Sustainable development. The theory of environmental externalities: The theory of externalities; Welfare analysis of externalities; Property Rights and the environment; Common property resources and public goods; Common property, Open access, and property rights; The environment as a public good; The global commons.	**15**	CO 1, CO 2, CO 3, CO 4	K1, K2, K3, K4 K5
Module 2:	Resource allocation over time allocation of non-renewable resources; Hotelling's rule and time discounting valuing the environment; Total economic value. Overview of valuation techniques: Revealed preference methods, Stated preference methods; Cost-benefit analysis and its role in policy decisions. Ecological economics: Basic concepts, An ecological perspective; Natural capital; Issues of macroeconomic scale; Long-term sustainability; Energy and entropy.	**15**	CO 1, CO 2, CO 3, CO 4	K1, K2, K3, K4 K5
Module 3:	Ecosystem management and biodiversity; The economics of biodiversity; Reconciling economic and ecological principles; Pollution: Impacts and policy responses; The economics of pollution control; Policies for pollution control; The scale of pollution impacts; Assessing pollution control policies; Pollution control policies in practice; National income and environmental accounting; Greening the national income accounts; Environmentally adjusted net domestic product; Adjusted net saving; The genuine progress indicator; The better life index; Environmental asset accounts; The future of alternative indicators.	**15**	CO 1, CO 2, CO 3, CO 4	K1, K2, K3, K4 K5
Pedagogy:	Chalk and talk aided by ICT enabled lectures; Flipped classroom; PC lab exercises; Assignments and presentations; Group activity; MOOC (or similar) component.			
Texts:	1. Dasgupta, P. (2021). *The economics of biodiversity: The Dasgupta review (abridged version).* HM Treasury,			

	London, United Kingdom. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/957292/Dasgupta_Review_-_Abridged_Version.pdf 2. Harris, J. M., & Roach, B. (2018). *Environmental and natural resource economics: A contemporary approach* (4th ed.). Taylor and Francis, New York, NY, USA. 3. Lewis, L., & Tietenberg, T. H. (2020). *Environmental economics and policy*. Routledge, London, United Kingdom.
References/ Readings:	1. Kolstad, C. D. (2012). *Intermediate environmental economics.* Oxford University Press, New Delhi, India. 2. Smith, S. (2011). *Environmental economics: A very short introduction.* Oxford University Press, Oxford, England.

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Title of the Course	Environmental Implication of Marine Productivity
Course Code	ENV-6204
Number of Credits	03
Theory/Practical	Theory
Level	500
Effective from AY	2026-2027
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	• To describe the role of plankton communities in marine ecosystem function. • To understand the factors responsible for marine productivity and its implication on the health of marine environment.	
Course Outcomes:	Student will learn to:	**Mapped to PSO**
	CO 1. Discuss the significance and diversity of planktonic biota in the marine ecosystem.	PSO 1
	CO 2. Analyse their role in ocean productivity, biological carbon pump and to the health of the oceans and global climate.	PSO 1
	CO 3. Identify various techniques for measuring productivity.	PSO 2
	CO 4. Discover on-going research at global scale through monitoring projects.	PSO 4

Content:		No of hours	Mapped to CO	Cognitive Level
Module 1:	Marine environment zonation, coastal and open ocean, significance of oceans and its diversity to humans, importance of planktonic biota to the health of oceans, distribution of plankton in the Tree of Life, major groups of virioplankton (viruses), picoplankton, phytoplankton and zooplankton, their biology and role. Diatom/dinoflagellate index as an indicator for ecosystem change, haptophytes (prymnesiophytes), prasinophytes, zooplankton (holoplankton, meroplankton): chaetognaths, cnidarians, molluscs, radiolarians, foraminiferans, crustaceans, larvaceans, multiple marine protistan lineages in seven supergroups of eukaryotic tree of life, factors affecting primary production: light, nutrients, mixed layer depth, chelating agents, tides, turbulence, grazing, mixotrophy, interactions within and across trophic levels (allelopathic interactions).	**15**	CO 1	K2, K3
Module 2:	Significance of plankton in marine ecosystem functioning: Planktonic food web structure and trophic transfer, microbial food webs, viral shunt, phytoplankton C:N:P ratios, stoichiometric plasticity, phenotypic plasticity, role in biogeochemical cycles, carbon Sequestration, biological carbon pump (soft and hard), ecological success of diatoms, blooms, Harmful Algal Blooms (HABs) and biotoxins, morphological and physiological characteristics of HAB species, HAB dynamics, implications of climate change on plankton (global warming, ocean acidification).	**15**	CO 2	K2, K3
Module 3:	Quantitative observations of planktonic ecosystems: Primary productivity measurements: oxygen technique, chlorophyll extraction method, Radiocarbon technique, Satellite colour scanning, techniques and instruments used in plankton studies: advances in automated technology to observe and measure plankton, pigment composition, optical and acoustical methods (Optical Plankton Counter, Zooglider), quantitative imaging devices (Flow Cytometry, FlowCAM, FlowCytoBot), molecular phylogenetic approaches, high throughput 'omics' data, monitoring plankton in oceans through various international projects: Continuous Plankton Recorder (CPR), Global Alliance of CPR Surveys (GACS), The Scientific Committee on Oceanic Research (SCOR), Global Ocean Observing System (GOOS), Global Ocean Ecosystem Dynamics (GLOBEC), Integrated Marine Biosphere Research	**15**	CO 3, CO 4	K3, K4, K5

	(IMBeR), TARA Oceans, GEOHAB.			
Pedagogy:	Lectures/ tutorials/ assignments/ videos.			
References/ Readings:	1. Jungblut, S., Liebich, V., & Bode, M. (Eds.). (2018). *YOUMARES 8 – Oceans across boundaries: Learning from each other.* Springer Open, Cham, Switzerland. 2. Lalli, C. M., & Parsons, T. R. (Eds.). (2010). *Biological oceanography: An introduction* (2nd ed.). Elsevier, Amsterdam, Netherlands. 3. Levinton, J. S. (Ed.). (2011). *Marine biology: Function, biodiversity, ecology.* Oxford University Press, New York, NY, USA. 4. Mitra, A., Banerjee, K., & Gangopadhyay, A. (Eds.). (2004). *Introduction to marine plankton.* Daya Publishing House, Delhi, India. 5. Morrissey, J. F., & Sumich, J. L. (2018). In Pinkard-Meier, D. R. (Ed.), *Introduction to the biology of marine life* (11th ed.). Jones & Bartlett Learning, Burlington, MA, USA. 6. Nybakken, J. W., & Bertness, M. D. (Eds.). *Marine biology: An ecological approach.* Pearson Education, San Francisco, CA, USA. 7. Ormond, R. (Ed.). (1997). *Marine biodiversity: Patterns and processes.* Cambridge University Press, Cambridge, UK. 8. Sardet, C., & Rosengarten, R. D. (Eds.). (2015). *Plankton: Wonders of the drifting world.* The University of Chicago Press, Chicago, IL, USA.			

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Title of the Course	Green Chemistry
Course Code	ENV-6205
Number of Credits	03
Theory/Practical	Theory
Level	500
Effective from AY	2026-2027
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	• To learn basic knowledge and principles involved in green chemistry and create awareness of greener chemistry. • To understand energy saving and making green processes in chemical reactions. • To develop social concern for waste generated from various processes. • to evaluate chemical practices based on their environmental impact, efficiency, and safety, while exploring innovative alternatives that contribute to sustainable development.	
Course Outcomes:	Student will learn to:	**Mapped to PSO**
	CO 1. Explain the fundamental principles of Green Chemistry and their significance in sustainable development.	PSO 1, PSO 4
	CO 2. Analyze conventional chemical processes in terms of atom economy, energy efficiency, and environmental impact.	PSO 1, PSO 4

	CO 3. Apply green chemistry strategies to design safer chemical syntheses and industrial processes.		PSO 1, PSO 4	
	CO 4. Evaluate alternative solvents, reagents, and energy sources (e.g., microwaves, ultrasound, biocatalysis) for sustainable chemical practices.		PSO 1, PSO 4	
	CO 5. Demonstrate awareness of global environmental challenges and the role of chemistry in addressing them.		PSO 1, PSO 4	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	Introduction to green chemistry: Need for Green Chemistry; Overview of twelve green chemistry principles as proposed by Paul Anastas and John Warner; Explanation with examples under each principle. New trends in green chemistry, Basic principles, Atom economy concept and its environmental importance, Green reagents and Green solvents. Waste production, problems and prevention: Problems caused by waste; Sources of waste from the chemical industry; Waste minimization techniques; On-site waste treatment; physical treatment; Chemical treatment; Biotreatment; Degradation; Rules for degradation; Polymer recycling.	**15**	CO 1, CO 2	K1, K2, K3
Module 2:	Chemicals from renewable raw materials: Carbohydrates; Ethanol; Lactic acid; Indigo-natural colour; Riboflavin; Ascorbic acid; Fats and Oils; Biodiesel; Fatty acid esters; Terpenes; Green Polymers from Renewable Raw Materials. Designing greener approaches, Safer designs for the target molecule, Minimization, Simplification, Substitution, Moderation, Limitations, Replacement of Toxic Reagents, Use of Alternative Solvents (suitable examples in each case). Alternative energy sources for greener processes: Design for Energy Efficiency; Photochemical Reactions; Advantages of and Challenges Faced by Photochemical Processes; Examples of Photochemical Reactions; Chemistry Using Microwaves; Microwave Heating; Microwave-assisted Reactions; Sonochemistry; Electrochemical Synthesis.	**15**	CO 2, CO 3, CO 4	K1, K2, K3, K4,

Module 3:	Bio-inspired Green Nanomaterials: Bio-inspired Green Nanomaterials; microbial synthesis of nanoparticles; Biosynthesis of Nanoparticles by bacteria and Fungi; Biosynthesis of nanoparticles using plant extracts; Advantage of biosynthesis. Future Trends in Green Chemistry: Introduction to solid acid catalysts and their significance in industrial applications; phase-transfer catalysis, Biocatalysis: basic principles, enzyme catalysed reactions, Photocatalysis: Introduction and significance with examples.	**15**	CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5
Pedagogy:	Mainly lectures / tutorials/ Seminars / assignments / presentations / combination of some of these could also be used to some extent.			
Texts:	1. Afonso, C. A. M., & Crespo, J. G. (2005). Green separation processes: Fundamentals and separation. WILEY-VCH, Weinheim, Germany. ISBN 3-527-30985-3 2. Ahluwalia, V. K., & Kidwai, M. (2004). New trends in green chemistry (1st ed., reprint 2012). Springer, Netherlands. ISBN 978-94-015-7102-9 3. Basiuk, V. A., & Basiuk, E. V. (2015). Green processes for nanotechnology: From inorganic to bioinspired nanomaterials (1st ed.). Springer International Publishing, Cham, Switzerland. ISBN 978-3-319-36539-8 4. Lancaster, M. (2002). Green chemistry: An introductory text (1st ed.). Royal Society of Chemistry, Cambridge, UK. ISBN 0-85404-620-8 5. Matlack, S. (2001). Introduction to green chemistry (2nd ed.). Marcel Dekker, Inc., New York, NY, USA. ISBN 0-8247-0411-8 6. Sheldon, R. A., Arends, I., & Hanefeld, U. (2007). Green chemistry and catalysis (1st ed.). WILEY-VCH, Weinheim, Germany. ISBN 978-3-527-30715-9			
Web Resources:	https://www.acs.org/green-chemistry-sustainability/education.html			

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Title of the Course	Marine Biodiversity and Conservation Practices
Course Code	ENV-6206
Number of Credits	03
Theory/Practical	Theory
Level	500
Effective from AY	2026-2027
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	• Addresses basic concepts of marine biodiversity at all levels, • IPR, life patenting and its implications on the environment and human life	
Course Outcomes:	Student will learn to:	**Mapped to PSO**
	CO 1. Define biodiversity and explore its types	PSO 1
	CO 2. Analyze the various factors affecting biodiversity	PSO 1
	CO 3. Assess factors influencing marine biodiversity, understand ecosystem functions and keystone species, and evaluate biodiversity hypotheses.	PSO 1
	CO 4. Understand the laws used to protect and conserve biodiversity	PSO 1

Content:		No of hours	Mapped to CO	Cognitive Level
Module 1:	Biodiversity, definition, concept, types; Biodiversity measurements - taxic, phylogenetic and molecular approaches. Intra-specific Genetic variance and factors affecting, biodiversity and intra-specific variations, dominance and over-dominance hypothesis, adaptive polymorphism, genetic variations, loss and increase dynamics of biological diversity, conceptual models, hypothesis proposed in deep sea biodiversity.	**15**	CO 1, CO 2	K2, K3
Module 2:	Marine Biodiversity and ecosystem functions, competition, predation and heterogeneity as biodiversity determinants; ecosystem approach, functions and keystone species, engineer organisms, diversity-stability, rivet, drivers and passengers, idiosyncratic hypothesis, co-operative relations, top-down and bottom-up theories, cascade effects and fishing through the food webs.	**15**	CO 3	K5
Module 3:	Biodiversity and Intellectual Property Rights (IPR) and biopiracy, life patenting and implications, impact of GATT/WTO on farmers' rights, indigenous, and traditional knowledge. Biodiversity conservation - Biological diversity Act, sanctuaries, marine parks, protected areas, hotspots and marine biosphere reserves of India.	**15**	CO 4	K2
Pedagogy:	Lectures/ Tutorials/ Assignments.			
References/ Readings:	1. Hiscock, K. (2014). *Marine biodiversity conservation: A practical approach.* Routledge Taylor & Francis Group, London, England. 2. Kumar, A. (2004). *Biodiversity & environment.* A.P.H. Publishing Corporation, New Delhi, India. 3. Ormond, R., Gage, J. D., & Angel, M. V. (1997). *Marine biodiversity: Patterns and processes.* Cambridge University Press, Cambridge, England. 4. Queiroga, H. (2006). *Marine biodiversity: Patterns and processes, assessment, threats, management and conservation.* Springer, Dordrecht, Netherlands. 5. Shiva, V. (1994). *Cultivating diversity: Biodiversity conservation and the politics of the seed.* Research Foundation for Science, Technology & Natural Resource Policy, Dehra Dun, India.			

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Title of the Course	Polar Sciences
Course Code	ENV-6207
Number of Credits	03
Theory/Practical	Theory
Level	500
Effective from AY	2026-2027
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	To increase student's knowledge about polar regions, their biota and their sensitivity to climate change.	
Course Outcomes:	Student will learn to:	**Mapped to PSO**
	CO 1. Gain information on the unique characteristics of polar regions.	PSO 1
	CO 2. Recognize the significance of polar regions in the context of atmospheric circulation and energy exchange.	PSO 1
	CO 3. Gain insight into the biological diversity and functioning of polar ecosystems.	PSO 1
	CO 4. Understand the sensitivity of polar regions to global climate change.	PSO 1

Content:		No of hours	Mapped to CO	Cognitive Level
Module 1:	Introduction: Delimitation of Arctic and Antarctic, their basic differences, discovering, exploitation and scientific utilizability. Astronomic factors and their reflexion in polar regions. Ecology of polar region: Climate of polar regions - energy balance of the ground surface, water balance, baric field and atmospheric circulation, air temperature and air humidity, precipitation. Climate change and climate variation and their consequences i.e. polar regions (glacials and interglacials and their influence on the hydrosphere, geosphere, cryosphere and biosphere). Freshwater hydrology and oceanology. Surface water and ground water. Polar oceans - submarine relief, systems of sea currents, water substitution with the lower latitudes and its energy consequences.	**15**	CO 1	K1, K2
Module 2:	Glaciology: Glaciology of polar regions - reasons of glaciation and its development, glaciation of continents and of sea surface, ice mass balance. Cryosphere as a stabilizer of Earth climate. Development of earth surface in polar regions, glacial and periglacial geomorphologic processes - permafrost and its energy roots, regional structure, active layer of permafrost, frost weathering, slope dynamics. Soil in polar regions.	**15**	CO 1, CO 2	K1, K2, K3
Module 3:	Flora and fauna: Vegetation in polar regions - limiting by abiotic factors (microclimate, nutrients, water), soil flora, space structure of polar vegetation (subpolar, polar, polar deserts and semideserts, polar wetlands). Origin of polar (alpine) plants, vascular plants and their adaptation and acclimatization on the polar environment. Cryptogams in polar regions. Stress physiology of polar plants. Fauna of polar regions - invertebrates, evolution and space structure, physiological adaptation on polar conditions, nutrient succession. Microbial diversity; Anthropogenic impacts on polar ecosystems; Heat pollution of planetary geosystem, changes in chemical composition of atmosphere and their consequences (global transport of pollutants, anthropogenic change in greenhouse effect, ozone depletion and its consequences), changes in biodiversity.	**15**	CO 3, CO 4	K1, K2, K3, K4
Pedagogy:	Lectures/tutorials/assignments/visit to research laboratory.			
References/ Readings:	1. Holdgate, M. W. (1970). *Antarctic ecology*. Academic Press, London, UK; New York, NY, USA. 2. King, J. C., & Turner, J. (1997). *Antarctic meteorology and climatology*. Cambridge University Press, Cambridge,			

	UK. 3. Oke, T. R. (1987). *Boundary layer climates.* Routledge, London, UK; New York, NY, USA. 4. Przybylk, R. (2003). *The climate of the Arctic*. Kluwer Academic Publishers, Dordrecht, Netherlands. 5. Richard, S., & Per, M. (2006). *Buffalo: A complete guide to Arctic wildlife.* Firefly Books, New York, NY, USA. 6. Stonehouse, B. (1989). *Polar ecology*. Blackie, Glasgow, UK; London, UK. 7. Thurman, H. V., & Alan, P. T. (2005). *Oceánografie: [Tajemný svět moří a oceánů].* Computer Press, Prague, Czech Republic. 8. Warwick, F., Johanna, V., & Parry, L. (2008). *Polar lakes and rivers: Limnology of Arctic and Antarctic aquatic ecosystems*. Oxford University Press, Oxford, UK.

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Title of the Course	Water Resource Management
Course Code	ENV-6208
Number of Credits	03
Theory/Practical	Theory
Level	500
Effective from AY	2026-2027
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	• Explain the components and functioning of water cycle. • Examine water quality with respect to consumption and irrigation needs. • Evaluate the techniques used for exploration and management of water. • Summarizing the issues and possible solutions for degradation of water quality.	
Course Outcomes:	Student will learn to:	**Mapped to PSO**
	CO 1. Explain the components and functioning of water cycle.	PSO 1, PSO 2
	CO 2. Demonstrate the techniques used for exploration and management of water.	PSO 1, PSO 3
	CO 3. Critically analyze water quality with respect to consumption and irrigation needs.	PSO 1, PSO 2
	CO 4. Explain the issues and possible solutions for degradation of water quality.	PSO 3

Content:		No of hours	Mapped to CO	Cognitive Level
Module 1:	Traditional methods of water management; Hydrological cycle; Evaporation, evapotranspiration, precipitation, runoff and infiltration; Classification of aquifers and confining layers, hydraulic properties of aquifers, water table and piezometric surface; Water control and crop production. Problems related to overexploitation and groundwater mining; Saline water intrusion in coastal aquifers and its control; Fresh-salt water interface.	**15**	CO 1, CO 2	K1, K2
Module 2	Nature, extent, magnitude and frequency of floods; Availability of water in Lakes, ponds, streams and rivers; Impact of climate change on water availability; Sub-surface investigation of groundwater; Classification of rocks based on water bearing capacity; Drilling methods, construction, development and maintenance of wells; Rainwater harvesting and water conservation techniques and its importance; Concept of artificial recharge: methods, wastewater recharge for reuse.	**15**	CO 1, CO 3	K1, K2 K4, K5
Module 3:	Pollution of surface and groundwater: Municipal sources, industrial sources, agricultural sources; Case studies of water pollution in India; Physical, chemical, biological properties of water. Quality criteria for different uses. Concept of Groundwater flow lines and flow net. Water Governance: Salient features of The Water (Prevention and control of pollution) Act, 1974 and Goa water (Prevention and Control of Pollution) Rules, 1988.	**15**	CO 2, CO 4	K2, K3 K5, K6
Pedagogy:	Lectures, case studies, discussions and assignments.			
References/ Readings:	1. Fetter, C. W. (2018). *Applied hydrogeology*. Waveland Press. Long Grove, Illinois. 2. Grafton, R. Q., & Hussey, K. (Eds.). (2011). *Water resources planning and management*. Cambridge University Press. Cambridge, England. 3. Jain, S. K., Agarwal, P. K., & Singh, V. P. (2007). *Hydrology and water resources of India* (Vol. 57). Springer Science & Business Media. 4. Johnson, W. (1982). *Environmental Geology-Coates, DR.* 5. Keller, E. A. (2007). *Introduction to environmental geology*. Prentice-Hall, Inc. Upper Saddle River, NJ. 6. Kumar, R., Singh, R. D., & Sharma, K. D. (2005). Water resources of India. *Current science*, 794-811. 7. Nitya, J. (2008). *Jalatra: exploring India's traditional water management systems.*			

	8. Pennington, K. L., & Cech, T. V. (2009). *Introduction to water resources and environmental issues*. Cambridge University Press. Cambridge, UK. 9. Todd, D. K., & Mays, L. W. (2004). *Groundwater hydrology*. John Wiley & Sons. New York, NY. 10. Vaidyanathan, A. (1999). *Water resource management: institutions and irrigation development in India*. Oxford University Press. New Delhi, India.

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Title of the Course	Ecological Significance of Symbiosis
Course Code	ENV-6209
Number of Credits	02
Theory/Practical	Theory
Level	500
Effective from AY	2026-2027
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	To understand the diversity, nuances and ecological relevance of symbiotic associations.	
Course Outcomes:	Student will learn to:	**Mapped to PSO**
	CO 1. Describe the concept of symbiosis accurately.	PSO 1
	CO 2. Understand the nuances of symbiotic associations and their dynamic nature.	PSO 1
	CO 3. Describe the diversity of symbiotic associations in the environment.	PSO 1
	CO 4. Develop knowledge of the diverse ecological roles of symbiotic associations in the environment.	PSO 1
	CO 5. Develop knowledge of the relevance of symbiotic associations in evolution and speciation.	PSO 1

Content:		No of hours	Mapped to CO	Cognitive Level
Module 1:	Introduction: Concept of symbiosis, ecto-symbiosis and endo-endosymbiosis; multipartner symbiotic systems; initiation, establishment and transmission of symbiotic associations; vertical versus horizontal transmission of symbionts; diversity of microbial symbiotic associations: mutualism, commensalism, synergism, syntrophism, competition, amensalism, parasitism, predation; concepts of rhizosphere, mycorrhizosphere, phycosphere and satellite bacteria; concept of microbiome with emphasis on archaea.	**15**	CO 1, CO 2, CO 3	K1, K2, K3
Module 2:	Molecular evolution and ecological significance of symbiosis: Role of quorum sensing in symbiosis, signalling molecules –AHLs, bacteriocins, peptides, nitric oxide, lipids; examples of symbiotic associations in the terrestrial environment – vesicular-arbuscular mycorrhizal fungi, legume-rhizobia, Plant Growth Promoting Rhizobacteria, insect-bacteria associations; examples of symbiotic associations in the marine environment – microalgae-bacteria, sponges-microbes; bobtail squid-bioluminescent bacteria. Influence of symbiotic interactions on Circadian rhythms and gene expression; holobiont concept, the hologenome theory of evolution and the role of microorganisms in evolution and speciation; endosymbiotic theory for the origin of eukaryotic organelles.	**15**	CO 4, CO 5	K1, K2, K3, K4
Pedagogy:	Lectures/ tutorials/ assignments.			
References/ Readings:	1. Duplouy, A., Dotson, B. R., Nishiguchi, M. K., & Cárdenas, C. A. (2021). Symbiosis in a Changing Environment. *Frontiers in Ecology and Evolution*, 536, https://doi.org/10.3389/fevo.2021.731892. 2. Heath-Heckman, E. A. (2016). The metronome of symbiosis: interactions between microbes and the host circadian clock. *Integrative and Comparative Biology*. 56(5), 776-783. https://doi.org/10.1093/icb/icw060 3. Lee, S. J., Morse, D., & Hijri, M. (2019). Holobiont chronobiology: mycorrhiza may be a key to linking aboveground and underground rhythms. *Mycorrhiza*, *29*(5), 403-412. 4. Lipnicki, L. I. (2015). The role of symbiosis in the transition of some eukaryotes from aquatic to terrestrial environments. *Symbiosis*, 65(2), 39-53. 5. Munn, C. B. (2011). *Marine microbiology: ecology & applications*. CRC Press. Boca Raton, Florida. 6. Pacheco, A. R., & Segrè, D. (2019). A multidimensional perspective on microbial interactions. *FEMS Microbiology*			

Letters, *366*(11), fnz125.

7. Kaltenpoth, M., Flórez, L. V., Vigneron, A., Dirksen, P., & Engl, T. (2025). Origin and function of beneficial bacterial symbioses in insects. *Nature Reviews Microbiology*, 1-17.
8. Rosenberg, E., & Zilber-Rosenberg, I. (2018). The hologenome concept of evolution after 10 years. *Microbiome*, *6*(1), 1-14.
9. Sanchez-Contreras, M., Bauer, W. D., Gao, M., Robinson, J. B., & Allan Downie, J. (2007). Quorum-sensing regulation in rhizobia and its role in symbiotic interactions with legumes. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *362*(1483), 1149-1163.
10. Weiland-Bräuer, N. (2023). Symbiotic interactions of archaea in animal and human microbiomes. *Current Clinical Microbiology Reports*, *10*(4), 161-173.

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Title of the Course	Ecology and Society
Course Code	ENV-6210
Number of Credits	02
Theory/Practical	Theory
Level	500
Effective from AY	2026-2027
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	• To understand the interrelationship between human societies and ecological systems. • To analyze and evaluate strategies for sustainable environmental management, including community-based conservation and environmental laws, in local and global contexts.	
Course Outcomes:	Student will learn to:	**Mapped to PSO**
	CO 1. Demonstrate an interdisciplinary understanding of ecological and social systems, and explain human–nature relationships.	PSO 1, PSO 6
	CO 2. Analyse socio-ecological systems using key concepts such as resilience, adaptive capacity, and ecosystem services to evaluate the impacts of human activity on ecological integrity and Sustainable Development Goals (SDGs).	PSO1, PSO2, PSO6
	CO 3. Evaluate case studies of environmental conflicts and conservation practices to identify	PSO3, PSO4, PSO6

	challenges of justice, equity, and participatory governance in environmental management.			
	CO 4. Apply knowledge of community-based conservation, traditional ecological knowledge, and spatial-environmental linkages for developing context-specific strategies for sustainable ecosystem management.		PSO4, PSO5, PSO6	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	Introduction to Ecology & Society: Definitions: Concept of ecology, ecosystem, and human-nature relationships, Historical perspective on human–nature relationships, Evolution of socio-ecological thought. Socio-Ecological Systems: Structure and function of socio-ecological systems, Feedback loops, resilience, and thresholds, Human-environment interactions and adaptive systems, Traditional ecological knowledge and indigenous practices. Ecosystem Services and Human Well-being: Types of ecosystem services, provisioning, regulating, cultural, supporting, Valuation of ecosystem services, Linkages between ecological integrity and human development goals (SDGs). Sustainability Challenges: Land-use change, urbanization, pollution, climate change, Biodiversity loss and socio-economic drivers, Vulnerability and adaptation in communities, Case studies: forest-dependent communities, watershed management.	**15**	CO 1, CO 2	K1, K2, K3
Module 2:	Foundations of Social and Cultural Ecology: Concepts of social ecology and cultural ecology; Ecological Conflicts and Environmental Justice; Development vs. conservation: displacement, rehabilitation, and participatory decision-making. Community-Based Conservation and Co-management: Concepts and principles of community-based natural resource management; Role of local institutions, panchayats, and NGOs in conservation; Role of gender and indigenous knowledge in conservation governance. Case studies: decentralized conservation and sustainable development initiatives (UNDP & MoEF & CC programs); Shifting cultivation systems, sacred groves, and pastoral landscapes of Goa; Mining and tribal land rights in Goa, and forest rights implementation	**15**	CO 1, CO 3, CO 4	K2, K4, K5, K6

	in Western Ghats; Bishnoi conservation ethos, and community forest movements.			
Pedagogy:	Lectures, assignments, interactive sessions, campus walks, Field Visits, documentaries, presentations, role plays.			
Texts:	1. Alvares, C. (2002). *Fish curry and rice: A source book on Goa, its ecology, and lifestyle.* Goa Foundation. Goa, India. 2. Bookchin, M. (1990). *The philosophy of social ecology: Essays on dialectical naturalism.* Black Rose Books. Montreal, Canada. 3. Guha, R. (1994). *Social ecology.* Oxford University Press. New Delhi, India. 4. Gadgil, M., & Guha, R. (2000). *Ecology and equity.* Oxford University Press. New Delhi, India. 5. Steward, J. (1972). *Theory of culture change: The methodology of multilinear evolution.* University of Illinois Press. Urbana, IL, USA.			
References/ Readings:	1. Baviskar, A. (2004). *In the belly of the river: Tribal conflicts over development in the Narmada Valley.* Oxford University Press, New Delhi, India. 2. Divan, S., & Rosencranz, A. (2021). *Environmental law and policy in India.* Oxford University Press, New Delhi, India. 3. Gadgil, M., & Guha, R. (2000). *Use and abuse of nature.* Oxford University Press, New Delhi, India.			
Web Resources:	1. Berkes, F. (2007). Community-based conservation in a globalized world. *Proceedings of the National Academy of Sciences of the United States of America, 104*(39), 15188–15193. https://doi.org/10.1073/pnas.0702098104 2. Chandran, M. D. S., & Hughes, J. D. (1997). The Sacred Groves of South India: Ecology, Traditional Communities and Religious Change. *Social Compass*, *44*(3), 413-427. https://doi.org/10.1177/003776897044003008 (Original work published 1997) 3. Ormsby, A. A., & Bhagwat, S. A. (2010). Sacred forests of India: a strong tradition of community-based natural resource management. *Environmental Conservation*, *37*(3), 320–326. doi:10.1017/S0376892910000561			

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Title of the Course	Gender Sensitivity and Rights Awareness
Course Code	ENV-6211
Number of Credits	02
Theory/Practical	Theory
Level	500
Effective from AY	2026-2027
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	This course aims to develop the basic understanding of gender related issues in the society among students with a multidisciplinary approach.	
Course Outcomes:	Student will learn to:	**Mapped to PSO**
	CO 1. Students will be enabled to develop the sensitive approach towards gender issues.	PSO 1,
	CO 2. Students will have an understanding of equity, its importance in our society	PSO 3, PSO 4
	CO 3. Identify systemic inequalities across multiple dimensions (gender, caste, class, disability, sexuality)	PSO 4
	CO 4. Develop intervention strategies for promoting equity in their fields	PSO 5, PSO6

Content:		No of hours	Mapped to CO	Cognitive Level
Module 1:	The Universal Declaration of Human Rights (UDHR) and its significance The universal commitment to Gender Equality and Social Equity- SDGs, Equality and Equity, Provisions in the Indian Constitution, Constitutional Rights and Legal Frameworks Towards Equality report and the creation of the discipline of Women's Studies in India. Sex and Gender: Non-duality of these terms. Nature vs Nurture debate, socialisation, and stereotyping.	**15**	CO 1, CO 2	K1, K2
Module 2:	Social Equity, Power, Intersectionality. Marginalised based on cast, class, abilities, religion, etc. Women's rights as human rights. Women's issues in Goa , Forms of violence against women: a review , Theories of Justice and Equity, Rights of Specific Vulnerable Groups; Workplace Rights and Economic Justice: Sexual Harassment at Workplace (Protection, Prohibition, and Redressal Act of 2013) and Protection of Women from Domestic Violence Act of 2005. Environmental Justice and Climate Rights, Advocacy, Activism, and Social Change.	**15**	CO 2, CO 3, CO 4	K2, K3, K4, K5, K6
Pedagogy:	This course will be taught through workshops/ Lectures/ group discussions /assignments/ quiz games /tutorials/assignments/ films/ documentaries/ group			
References/ Readings:	1. Government of India. (1974). *Towards equality: Report of the Committee on the Status of Women in India.* Government of India, New Delhi, India. 2. Government of India. (2005). *The Protection of Women from Domestic Violence Act, 2005.* http://ncw.nic.in/acts/TheProtectionofWomenfromDomesticViolenceAct2005.pdf 3. Government of India. (2013). *Sexual Harassment of Women at the Workplace (Prevention, Prohibition and Redressal) Act, 2013.* http://www.iitbbs.ac.in/notice/sexual-harrassment-of-women-act-and-rules-2013.pdf 4. Pilcher, J., & Whelehan, I. (2005). *50 key concepts in gender studies.* Sage Publications, New Delhi, India. 5. UNDP. (2014). *Women's rights are human rights.* http://www.undp.org/content/undp/en/home/librarypage/womens-empowerment.html			
Web Resources:	https://gender-equality-school.teachable.com/p/from-patriarchy-to-equality-be-the-change/			

Title of the Course	Mineral Resource Management
Course Code	ENV-6212
Number of Credits	02
Theory/Practical	Theory
Level	500
Effective from AY	2026-2027
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	• Provide an understanding of Earth's evolution, mineral resources, and their global distribution. • Examine the processes of mineral exploration, classification, and mining methods. • Evaluate the environmental impacts of mining and resource exploitation. • Promote sustainable approaches in mineral resource management, rehabilitation, and green mining.	
Course Outcomes:	By the end of this course, students will be able to:	Mapped to PSO
	CO 1. Explain the geological processes leading to the formation and classification of mineral resources.	PSO 1, PSO 2
	CO 2. Demonstrate knowledge of mining methods, ventilation, drainage, and their environmental implications.	PSO 1, PSO 3
	CO 3. Critically analyze the environmental and health impacts of mineral exploitation and trace	PSO 1, PSO 2,

	elements.		PSO 4	
	CO 4. Propose sustainable strategies for mineral resource management, mine closure, and eco-friendly mining.		PSO 3, PSO 5, PSO 6	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	Earth and Mineral Resources: Earth in Space and Time; Internal structure, geological time scale, Earth's evolution; Plate Tectonics and Seafloor Spreading: Role in mineral resource formation and distribution. Geological Evolution of Mineral Resources: Ore-forming processes, crustal concentration, major mineral belts. Classification of Resources: Mineral resources vs. reserves; UNFC system; international frameworks (UNRMS). Trace Elements and Health: Geochemical behaviour of trace elements; bioavailability; implications on human and ecosystem health.	**15**	CO 1, CO 3	K1, K2, K3, K4, K5
Module 2:	Mineral Resource Utilization and Management: Mining ventilation, mine air, drainage, gases and slope stability. Environmental Impacts of Mining; Land degradation, acid mine drainage, tailings, biodiversity loss. Green Mining and Sustainable Practices; Eco-friendly technologies, circular economy approaches, secondary resources/recycling. Mine rehabilitation; Post-mining land use, ecological restoration, legal/social frameworks. Mineral Resources and Society; Resource economics, supply–demand, critical minerals, sustainability perspectives.	**15**	CO 2, CO 3, CO 4	K2, K3, K4, K5, K6
Pedagogy:	Lectures, case studies, discussions and assignments.			
References/ Readings:	1. Craig, J. R., Vaughan, D. J., & Skinner, B. J. (1996). *Resources of the earth: Origin, use, and environmental impact.* Prentice Hall, Upper Saddle River, NJ, USA. 2. Keller, E. A. (2012). *Introduction to environmental geology* (5th ed.). Prentice Hall, Upper Saddle River, NJ, USA.			

	3. Kesler, S. E., & Simon, A. F. (2015). *Mineral resources, economics and the environment.* Cambridge University Press, Cambridge, UK. 4. Merritts, D., De Wet, A., & Menking, K. (1997). *Environmental geology: An earth system science approach.* W. H. Freeman, New York, NY, USA. 5. Montgomery, C. W. (2010). *Environmental geology* (9th ed.). McGraw-Hill, New York, NY, USA. 6. Montgomery, C. W. (2020). *Environmental geology* (11th ed.). McGraw-Hill, New York, NY, USA. 7. Pipkin, B. W., Trent, D. D., Hazlett, R., & Bierman, P. (2013). *Geology and the environment.* Cengage Learning, Boston, MA, USA. 8. Valdiya, K. S. (1987). *Environmental geology: Indian context.* Tata McGraw-Hill Publishing Company, New Delhi, India.

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Title of the Course	Nitrogen and Climate Change
Course Code	ENV-6213
Number of Credits	02
Theory/Practical	Theory
Level	500
Effective from AY	2026-2027
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	• To introduce students to nitrogen dynamics in marine environments. • To understand the effects of climate change and human activities on nitrogen cycling, and the role of nitrous oxide in global warming.	
Course Outcomes:	Student will learn to:	Mapped to PSO
	CO 1. Describe the different nitrogen species in the marine environment and their primary sources.	PSO 5
	CO 2. Explain the spatial and seasonal distribution of dissolved nitrogen compounds and the factors controlling their variability.	PSO 5
	CO 3. Apply analytical methods for measuring nitrogen compounds in marine systems and interpret resulting data.	PSO 5

	CO 4. Analyze the biogeochemical cycling of nitrogen, including key processes.		PSO 5	
	CO 5. Evaluate the impacts of anthropogenic activities and climate change on marine nitrogen cycling and nitrous oxide emissions.		PSO 5	
	CO 6. Propose mitigation strategies to manage excess nitrogen in aquatic systems and reduce associated greenhouse gas emissions.		PSO 5	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	Nitrogen in the marine environment: Inorganic forms: Nitrate (NO_3^-), Nitrite (NO_2^-), Ammonium (NH_4^+); organic forms: Dissolved organic nitrogen (DON), Particulate organic nitrogen (PON); gaseous forms: N_2, N_2O; primary routes for entry of nitrogen into the marine environment - atmospheric deposition (natural and anthropogenic sources); riverine inputs and runoff, nitrogen fixation by diazotrophs; upwelling and ocean circulation; spatial and seasonal distribution of dissolved nitrogen compounds in seawater - vertical profiles in the water column, influence of latitude, temperature, salinity, and seasonal cycles; regional case studies of nitrogen distribution in polar, temperate, and tropical oceans; analytical methods for the study of nitrogen compounds - colorimetric, chromatographic, and isotopic techniques.	**15**	CO 1, CO 2, CO 3	K2, K3
Module 2:	Nitrogen cycling and climate interactions Biogeochemical cycling of nitrogen: Key processes; controlling factors; Feedbacks to primary productivity and marine ecosystems; disruptions to marine nitrogen cycle - effects of seawater stratification and upwelling changes; impacts of agricultural runoff, fossil fuel emissions, and aquaculture on marine nitrogen; altered nutrient ratios and eutrophication; role of N_2O as a potent greenhouse gas; influence of warming, deoxygenation, and acidification on N_2O cycling; ocean–atmosphere N_2O fluxes and regional emission patterns; mitigation strategies for excess nitrogen in aquatic systems; ocean-based strategies - denitrification enhancement, nutrient management; policy and regulatory frameworks for nitrogen control.	**15**	CO 4, CO 5, CO 6	K4, K5, K6
Pedagogy:	Lectures/ tutorials/ assignments / case study analysis/ group discussion.			

References/ Readings:	1. Codispoti, L. A. (2007). An oceanic fixed nitrogen sink exceeding 400 Tg N a^{-1} vs the concept of homeostasis in the fixed-nitrogen inventory. *Biogeosciences, 4*(3), 233–253. https://doi.org/10.5194/bg-4-233-2007 2. Gruber, N., & Galloway, J. N. (2008). An earth-system perspective of the global nitrogen cycle. *Nature, 451*(7176), 293–296. https://doi.org/10.1038/nature06592 3. Keeling, R. F., Körtzinger, A., & Gruber, N. (2010). Ocean deoxygenation in a warming world. *Annual Review of Marine Science, 2*(1), 199–229. https://doi.org/10.1146/annurev-marine-120308-081105 4. Codispoti, L. A., Brandes, J. A., Christensen, J. P., Deutsch, C., Gilbert, D., Naqvi, S. W. A., Yoshinari, T., & Devol, A. H. (2001). The oceanic fixed nitrogen and nitrous oxide budgets: Moving targets as we enter the anthropocene? Science, 292(5526), 1867–1870. https://doi.org/10.1126/science.1058676 5. Naqvi, S. W. A., Jayakumar, D. A., Narvekar, P. V., & D'Souza, W. (2010). Coastal and open-ocean denitrification in the Arabian Sea. *Biogeosciences, 7*, 2255–2277. https://doi.org/10.5194/bg-7-2255-2010 6. Capone, D. G., Zehr, J. P., Paerl, H. W., Bergman, B., & Carpenter, E. J. (1997). Trichodesmium, a globally significant marine cyanobacterium. *Science, 276*(5316), 1221–1229. https://doi.org/10.1126/science.276.5316.1221 7. Naqvi, S. W. A., Jayakumar, D. A., Narvekar, P. V., Sarma, V. V. S. S., D'Souza, W., Joseph, S., Naik, H., Reddy, G. V., Pratihary, A. K., & Fernandes, V. (2008). Increased marine production of N_2O due to intensifying anoxia on the Indian continental shelf. Nature, 461(7261), 78–81. https://doi.org/10.1038/nature08234 8. Codispoti, L. A., & Yoshinari, T. (2004). Nitrogen cycling in the ocean. In D. Capone, D. Bronk, M. Mulholland, & E. Carpenter (Eds.), *Nitrogen in the marine environment* (2nd ed., pp. 761–862). Academic Press. San Diego, CA. 9. Bange, H. W., Rapsomanikis, S., & Andreae, M. O. (1996). Nitrous oxide in rivers, estuaries, and coastal waters. *Chemosphere, 33*(6), 1101–1116. https://doi.org/10.1016/0045-6535(96)00044-0. 10. Zhang, J., Suntharalingam, P., & Jayne, S. R. (2018). Global nitrogen cycle and climate change: Interactions and feedbacks. *Earth-Science Reviews, 178*, 63–79. https://doi.org/10.1016/j.earscirev.2017.12.007

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Title of the Course	Coastal Geohazards	
Course Code	ENV-6214	
Number of Credits	01	
Theory/Practical	Theory	
Level	500	
Effective from AY	2026-2027	
New Course	No	
Bridge Course/ Value added Course	No	
Course for advanced learners	No	
Pre-requisites for the Course:	Nil	
Course Objectives:	• To provide an understanding of coastal processes including wave dynamics, sediment transport, and shoreline evolution. • To examine coastal hazards, erosion factors, and stabilization techniques for sustainable coastal zone management.	
Course Outcomes:	Student will learn to:	**Mapped to PSO**
	CO 1. Explain the formation and dynamics of ocean waves, beach morphology, and sediment transport processes along coastal environments.	PSO 1
	CO 2. Analyze the causes and impacts of coastal erosion, rip currents, and sea-level changes on coastal geomorphology and ecosystems.	PSO 1
	CO 3. Evaluate various coastal stabilization and management strategies—soft, hard, and managed retreat—in mitigating erosion and hazards.	PSO 1
	CO 4. Assess human influences on coastal processes and propose sustainable approaches for	PSO 1

	coastal zone management and resilience.			
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	Waves, beach form and processes, transport and deposition of sediment, rip currents, coastal erosion, and erosional factors; Sea level changes, impact and responses; Coastal hazards and Stabilization: soft stabilization, hard stabilization and managed retreat; human activity and coastal erosion.	**15**	CO 1, CO 2	K2, K3
Pedagogy:	Lectures, case studies, discussions and assignments.			
References/ Readings:	1. Finkl, W. C., & Makowski, C. (2013). *Coastal hazards.* Springer, Dordrecht, Netherlands. 2. Keller, E. A. (2012). *Introduction to environmental geology* (5th ed.). Prentice Hall, Upper Saddle River, NJ, USA. 3. Krynine, D. P., & Judd, W. R. (1957). *Principles of engineering geology and geotechnics* (pp. 1–3). McGraw-Hill, New York, NY, USA. 4. Montgomery, C. W. (2006). *Environmental geology* (p. 540). McGraw-Hill, New York, NY, USA. 5. Pipkin, B. W., Trent, D. D., Hazlett, R., & Bierman, P. (2013). *Geology and the environment.* Cengage Learning, Boston, MA, USA. 6. Valdiya, K. S. (1987). *Environmental geology: Indian context.* Tata McGraw-Hill Publishing Company, New Delhi, India.			

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Title of the Course	Environmental Externalities and Policy
Course Code	ENV-6215
Number of Credits	01
Theory/Practical	Theory
Level	500
Effective from AY	2026-2027
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	This course introduces the concept of environmental externalities and policy responses without requiring prior economics training. Students will learn how economic activities affect the environment, why markets fail to account for environmental costs, and how policies can address these failures.	
Course Outcomes:	Students will learn to:	**Mapped to PSO**
	CO 1. Explain what environmental externalities are and why they occur.	PSO 1, PSO 4, PSO 6
	CO 2. Identify different types of environmental externalities in real-world contexts.	PSO 1, PSO 2
	CO 3. Understand the rationale for government intervention in environmental problems.	PSO 4, PSO 6
	CO 4. Critically assess the strengths and limitations of different policy approaches.	PSO 1, PSO 6

Content:		No of hours	Mapped to CO	Cognitive Level
Module 1:	Understanding externalities: Definition: costs or benefits affecting third parties not involved in a transaction; The concept of "spillover effects"; Why markets don't automatically account for externalities; Air pollution (local and global); Water pollution and contamination; Climate change as the ultimate externality; Biodiversity loss and ecosystem degradation; Resource depletion. Why Externalities Matter: The gap between private costs and social costs; Overproduction and overconsumption when externalities exist; Distributional impacts: who bears the costs?; Environmental justice considerations. Evaluating Environmental Policies: Criteria for evaluation; Environmental effectiveness (did it work?); Economic efficiency (was it cost-effective?); Equity and distributional impacts (who paid, who benefited?); Political feasibility and public acceptance; Administrative feasibility (can it be implemented?); Dynamic effects (innovation, long-term change). Policy mixes and complementarities: Why single instruments often aren't enough; Combining regulations, taxes, subsidies, and information campaigns; Circular economy: multiple instruments for waste reduction; The role of non-regulatory instruments: information disclosure, voluntary agreements, certification schemes.	**15**	CO 1, CO 2, CO 3, CO 4	K1, K2, K3, K4, K5
Pedagogy:	Chalk and talk aided by ICT enabled lectures; Flipped classroom; PC lab exercises; Assignments and presentations; Group activity; MOOC (or similar) component.			
References/ Readings:	1. Kolstad, C. D. (2012). *Intermediate environmental economics.* Oxford University Press, New Delhi, India. 2. Smith, S. (2011). *Environmental economics: A very short introduction.* Oxford University Press, Oxford, UK.			

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Title of the Course	Gender and Ecology in Goan Society
Course Code	ENV-6216
Number of Credits	01
Theory/Practical	Theory
Level	500
Effective from AY	2026-2027
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	The module on Gender and Ecology in Goan Society, will introduce students to the politics behind the popular connect between women and nature, and will deliberate on the concerns regarding Land, water and Livelihoods, menstruation and environment with a focus on issues in Goa.	
Course Outcomes:	Student will learn to:	**Mapped to PSO**
	CO 1. Learners will understand and analyze the relationship between gender and environmental management in Goa	PSO 1, PSO 2
	CO 2. Sensitization of students towards the environment with respect to the global scenario and the related problems, impact, along with methods to tackle the problems.	PSO 3, PSO 4, PSO 6
	CO 3. Assess the gendered impacts of environmental change and development in Goan communities	PSO 4, PSO 5

	CO 4. Analyze, develop, design and propose gender-sensitive environmental policies for sustainable development with gender lens		PSO 5, PSO 6	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	Introduction to Gender and Ecology: Defining gender vs. sex: social construction of gender roles, "Is female to male as nature is to culture" Sherry Ortner, Ecofeminism, Goan socio-ecological context; Goa's ecological diversity: coastal ecosystems, Western ghats, agricultural zones, ecology, livelihood and gender: Water, land ownership, work, participation and impacts (tourism, mining, agriculture, fishing, craft and small-scale industry); Women and Natural Resource Management: Women in Agriculture and Agroecology, Coastal Livelihoods and Gender, Contemporary environmental challenges: mining, tourism, urbanization, coastal erosion; Water, sanitation, and gender: Sanitation, Hygiene, and Women's Health; Menstruation: Hygiene, management, eco-cultural practices and social exclusion; Tourism, development, and ecology, Women as agents of climate action, Gender-responsive environmental policy.	**15**	CO 1, CO 2, CO 3, CO 4	K2, K3 K4, K5, K6
Pedagogy:	Lectures/ assignments/ workshops/ street play/ brainstorming sessions/ outreach programmes/ campus walks/ documentaries and discussion/ presentations.			
Texts:	Shiva, Vandana.1998 "Staying Alive: Women, Ecology and Survival in India. New Delhi: kali for Women			
References/ Readings:	1. Garcia, S.L. (2019). Gender and water. Gender CC-Women for climate justice. UN 2. Kaur, R., Kaur, K., & Kaur, R. (2018). Menstrual hygiene management, and waste disposal: Practice and challenges faced by girls/women of developing countries. *Journal of Environmental and Public Health* Feb 20; 2018:1730964. Doi: 10.1155/2018/1730964. 3. Lynn, H. (2018). Seeing red: Menstruation and environment, # PLASTICFREEPERIODS. *Women's Environment Network: Landon*. 4. Manisha, P.et al (2009). Human rights, gender and the environment. Dorling Kinderseley. New Delhi, India.			

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Title of the Course	Concepts in Environmental Valuation
Course Code	ENV-6217
Number of Credits	01
Theory/Practical	Theory
Level	500
Effective from AY	2026-2027
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	• Introduce the need and theoretical basis for valuing environmental goods and services. • Familiarize students with key valuation methods used in environmental economics. • Develop the ability to critically interpret and apply valuation results in policy contexts. • Provide exposure to case studies and simple empirical exercises relevant to India.	
Course Outcomes:	Student will learn to:	**Mapped to PSO**
	CO 1. Explain why environmental valuation is necessary in economic decision-making.	PSO 1, PSO 4, PSO 6
	CO 2. Distinguish between different valuation methods and understand their applicability.	PSO 1, PSO 2
	CO 3. Interpret valuation estimates and their implications for environmental policy.	PSO 4, PSO 6

	CO 4. Apply simple valuation approaches using real or secondary data.		PSO 1, PSO 6	
	CO 5. Explain why environmental valuation is necessary in economic decision-making.		PSO 1, PSO 2	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	Introduction to Environmental Valuation: The need for valuation of environmental goods; Market failure and externalities; Total Economic Value (TEV) framework: use and non-use values. Direct Market Methods: Market price method, productivity approach, replacement cost; Applications to forest products, water, and ecosystem services. Revealed Preference Methods: Travel Cost Method (TCM): concept, data needs, applications; Hedonic Pricing Method (HPM): property values and environmental quality. Stated Preference Methods: Contingent Valuation Method (CVM): designing a survey, willingness to pay (WTP) and willingness to accept (WTA); Choice Modelling (basic idea and applications). Policy and Case Applications: Use of valuation in Cost–Benefit Analysis (CBA); Case studies from India (e.g., river cleaning projects, biodiversity valuation).	**15**	CO 1, CO 2, CO 3, CO 4	K1, K2, K3, K4, K5
Pedagogy:	Chalk and talk aided by ICT enabled lectures; Flipped classroom; PC lab exercises; Assignments and presentations; Group activity; MOOC (or similar) component.			
References/ Readings:	1. Carson, R.T. (2012). *Contingent Valuation: A Comprehensive Bibliography and History*. Edward Elgar. Cheltenham, UK. 2. Freeman, A.M. (2003). *The Measurement of Environmental and Resource Values: Theory and Methods*. RFF Press. Washington, DC. 3. Pearce, D.W. & Turner, R.K. (1990). *Economics of Natural Resources and the Environment*. Harvester Wheatsheaf. Hemel Hempstead, England.			

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Title of the Course	Marine Habitat Conservation and Restoration
Course Code	ENV-6218
Number of Credits	01
Theory/Practical	Theory
Level	500
Effective from AY	2026-2027
New Course	No
Bridge Course/Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	To create awareness regarding habitat degradation, monitoring and strategies for restoration with specific reference to coastal habitats.	
Course Outcomes:	Student will learn to:	**Mapped to PSO**
	CO 1. Describe the importance of restoration	PSO 1
	CO 2. Evaluate the impact of anthropogenic input on ecosystems	PSO 1
	CO 3. Analyze the techniques involved in ecosystem restoration	PSO 1
	CO 4. Understand the role monitoring in ecosystem restoration	PSO 1

Content:		No of hours	Mapped to CO	Cognitive Level
Module 1:	Introduction to restoration, importance, types, concepts and principles; Habitat degradation, Human interference and anthropogenic inputs, tourism effect, damaged ecosystems, fragmentation Marine Protected areas, restoration ecology and global framework, Coral reef damage, bleaching, restoration, Seagrass beds, restoration initiatives at GBR and India, Cost-benefit analysis of restoration, ecosystem development and restoration program design, Monitoring and evaluation - adaptive management, the purpose and importance of monitoring and evaluation, and feedback mechanisms to improve the management of the restoration process.	**15**	CO 1, CO 2, CO 3, CO 4	K2, K4, K5
Pedagogy:	Lectures/ Tutorials/ Assignments.			
References/ Readings:	1. Andrew, W. (2013). *Handbook of environmental degradation of materials* (3rd ed.). Elsevier, Amsterdam, Netherlands. 2. Hawksworth, D. L. (2020). Books on biodiversity and conservation. *Biodiversity and Conservation, 29,* 3843–3862. Dordrecht, Netherlands. 3. Kellert, S. R. (1996). *The value of life: Biological diversity and human society.* Island Press, Washington, DC, USA. 4. Perrow, M. R., & Davy, A. J. (Eds.). (2009). *Handbook of ecological restoration, Volume 1: Principles of restoration.* Cambridge University Press, New York, NY, USA.			

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Title of the Course	Spatial Economic Analysis
Course Code	ENV-6219
Number of Credits	01
Theory/Practical	Theory
Level	500
Effective from AY	2026-2027
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	• To introduce spatial economic analysis to the students to make them understand the development and growth process. • To expose the students to tools that integrate GIS (Geographic Information System) and remote sensing in order to analyse economic change.	
Course Outcomes:	Student will learn to:	**Mapped to PSO**
	CO 1. The students will to understand basics of satellite data imaging.	PSO 1
	CO 2. The students will learn application of remote sensing in socio-economic analysis.	PSO 1, PSO 4, PSO 5
	CO 3. The students will learn socio economic models.	PSO 4, PSO 5
	CO 4. The students will learn limitation of remote sensing in socio-economic analysis.	PSO 1

Content:		No. of Hours	Mapped to CO	Cognitive Level
Module 1:	Remote sensing applications in urban socio-economic analysis: Introduction to Remote Sensing, Principles of urban socio-economic studies using remote sensing technologies, Socio-economic information estimation- Population estimation, Employment estimation, GDP estimation, Electrical power consumption estimation, Land use land cover, Advantages and limitations of remote sensing technologies in socio-economic applications.	**15**	CO 1, CO 2, CO 3, CO 4	K1, K2, K3
Pedagogy:	Lectures/ class discussion/Lab/ assignments			
Texts:	Mesev, V. (2007). *Integration of GIS and Remote Sensing*. John Wiley & Sons.			
References/ Readings:	1. Chuvieco, E. (2016). *Fundamentals of satellite remote sensing: An environmental approach.* CRC Press, Boca Raton, FL, USA. 2. Cutts, A., & Graser, A. (2018). *Learn QGIS: Your step-by-step guide to the fundamentals of QGIS 3.4* (4th ed.). Packt Publishing, Livery Place, UK.			

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