Department of Environmental Science

Effective from Session: 2025-2026							
Course Code	**B150801T/ ES418**	**Title of the Course**	**Marine and Coastal Science**	**L**	**T**	**P**	**C**
Year	**4th**	**Semester**	**VII**	**5**	**1**	**0**	**4**
Pre-Requisite	**Basic in science**	**Co-requisite**					
Course Objectives	This course aims to provide an in-depth understanding of marine and coastal systems, their ecological and economic importance, the threats they face, and the strategies for their conservation and sustainable use. The course introduces marine biodiversity, pollution types and sources, ocean-atmosphere interactions, and modern tools for coastal management.						

Course Outcome	
CO1	Understand the structure, function, and dynamics of marine and coastal ecosystems.
CO2	Recognize the richness and importance of marine biodiversity and its role in ecosystem services.
CO3	Assess the nature and sources of marine pollution and its environmental and health impacts.
CO4	Apply knowledge of mitigation, restoration, and sustainable management practices for marine ecosystems.
CO5	Analyze the importance of integrated coastal zone management and global policy frameworks. Also the Use modern tools, databases, and technologies for monitoring marine and coastal environments.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	**Introduction to Marine & Coastal Science**	Definition, scope, historical evolution, global and Indian marine zones, EEZ, coastal geomorphology.	8	CO1
2	**Marine Ecosystems**	Coral reefs, mangroves, estuaries, seagrass beds, open ocean and deep-sea habitats—productivity, trophic dynamics, and food webs.	8	CO1
3	**Marine Biodiversity**	Classification of marine organisms, plankton and nekton, biodiversity hotspots (Coral Triangle, Sunderbans), endemism, IUCN categories.	8	CO2
4	**Importance and Services of Marine and Coastal Systems**	Fisheries, tourism, blue economy, ecosystem services (regulation, provisioning, cultural), climate buffering, carbon sink.	8	CO2
5	**Marine and Coastal Pollution**	Types and sources: plastics, oil spills, eutrophication, heavy metals, ballast water, noise and thermal pollution, impacts on biodiversity and human health.	8	CO3
6	**Climate Change and Marine Systems**	Sea level rise, ocean acidification, coral bleaching, marine heatwaves, coastal erosion, climate resilience in marine areas.	6	CO3
7	**Mitigation, Restoration and Sustainable Use**	Bioremediation, marine protected areas (MPAs), eco-restoration of mangroves and corals, sustainable fisheries, pollution control strategies.	8	CO4
8	**Policy, Governance & Marine Spatial Tools**	Integrated Coastal Zone Management (ICZM), UNCLOS, Blue Flag Programme, SDG 14, GIS/RS in marine management, marine databases (OBIS, Aquamaps, Seaaroundus).	6	CO5

Reference Books

1. Sylvia Earle – The World is Blue: How Our Fate and the Ocean's Are One
2. UNEP – Marine and Coastal Ecosystems and Human Well-being
3. R. R. Nair – Marine Geology and Oceanography of the Arabian Sea
4. Charles Sheppard – Marine Ecology
5. IPCC Special Reports (e.g., SROCC 2019)
6. Reports from: NOAA, ICAR-CMFRI, IUCN, UNDP, UNEP

e-Learning Source:

SWAYAM, NPTEL (Oceanography and Coastal Management), MOOC (Coursera: Marine Megafauna, Blue Economy), eSkill India

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	1	3	1	1	1	1	-	3					2	3	1	1	2	
CO2	2	2	1	1	1	1	3	3					2	3	1	2	2	
CO3	3	1	1	1	-	1	3	3					2	3	2	1	2	
CO4	3	-	1	1	1	1	3	3	-	-	-	-	2	3	2	1	2	-
CO5	1	1	1	1	-	1	3	3	-	-	-	-	2	2	1	2	2	-

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Department of Environmental Science

Effective from Session: 2025-2026							
Course Code	**B150802T/ ES419**	**Title of the Course**	**Industrial Pollution and Waste Management**	**L**	**T**	**P**	**C**
Year	**4th**	**Semester**	**VII**	**5**	**1**	**0**	**4**
Pre-Requisite	**Basic in science**	**Co-requisite**					
Course Objectives	Students will learn to identify pollutants, assess their impact, and implement appropriate treatment and control technologies, while also understanding the relevant legal and regulatory frameworks.						

Course Outcome	
CO1	Identify and classify different types of industrial pollutants and their sources.
CO2	Analyze the environmental and health impacts associated with industrial pollution and waste.
CO3	Evaluate and select appropriate pollution control technologies for air, water, and solid waste treatment.
CO4	Design and implement effective waste management strategies including waste minimization, reuse, recycling, and safe disposal.
CO5	Interpret and apply environmental regulations, standards, and guidelines relevant to industrial pollution and waste management.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	**Introduction to Industrial Pollution**	Definition and classification of industrial pollution, Major sources and types: air, water, soil, noise, and thermal pollution, Pollution load from major industries (chemical, textile, food, paper, metal, etc.) Concept of pollution index and environmental carrying capacity	08	CO1
2	**Environmental Impacts of Industrialization**	Effects of pollutants on ecosystems and human health, Ecological risk assessment Cumulative and synergistic impacts	06	CO2
3	**Air Pollution Control in Industries**	Industrial emissions and their characterization, Control technologies: cyclones, electrostatic precipitators, scrubbers, filters, Stack monitoring and air quality standards, Clean Air Act and industrial emission regulations.	08	CO3
4	**Industrial Wastewater Management**	Characteristics of industrial effluents, Primary, secondary, and tertiary treatment methods, Effluent Treatment Plants (ETP), Common Effluent Treatment Plants (CETPs), Zero Liquid Discharge (ZLD) concept	06	CO3
5	**Solid and Hazardous Waste Management**	Types of solid wastes: process waste, hazardous, biomedical, and e-waste, Collection, segregation, storage, transportation, Treatment and disposal: landfilling, incineration, composting, pyrolysis, Hazardous waste rules and manifest system	08	CO4
6	**Waste Minimization and Cleaner Production**	Principles of waste minimization and resource recovery, Cleaner production techniques and life cycle analysis, Green chemistry and process modification, Energy recovery and material substitution	08	CO4
7	**Environmental Legislations and Standards**	Overview of environmental laws: EPA 1986, Water Act 1974, Air Act 1981, Industrial siting policy and EIA requirements, ISO 14001 Environmental Management System, Role of CPCB/SPCB and compliance monitoring	08	CO5
8	**Emerging Trends and Case Studies**	Role of IoT, AI, and automation in pollution monitoring, Circular economy and industrial symbiosis Case studies: successful industrial waste management models, National and international best practices	08	CO5

Reference Books

1. Mahajan, S. P. (1985). *Pollution control in process industries*. Tata McGraw-Hill Education.
2. Rao, C. S. (2010). *Environmental pollution control engineering* (2nd ed.). New Age International Publishers.
3. Woodard & Curran, Inc. (2006). *Industrial waste treatment handbook* (2nd ed.). Butterworth-Heinemann.
4. Pichtel, J. (2014). *Waste management practices: Municipal, hazardous, and industrial* (2nd ed.). CRC Press.

e-Learning Source:

1. https://www.sciencedirect.com/topics/earth-and-planetary-sciences/industrial-pollution
2. https://devic-earth.com/what-is-industrial-air-pollution-how-does-it-affect-the-township-residents/
3. https://www.embibe.com/exams/industrial-pollution/
4. https://www.sciencedirect.com/topics/earth-and-planetary-sciences/cleaner-production

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	1	3	1	1	1	1	3						2	3	1	1	2	
CO2	2	2	1	1	1	1	3						2	3	1	2	2	
CO3	3	1	1	1	1	1	3						2	3	2	1	2	
CO4	3	1	1	1	1	1	3						2	3	2	1	2	-
CO5		1	1	1	1	1	3						2	2	1	2	2	-

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Department of Environmental Science

Effective from Session: 2025-2026							
Course Code	**B150803T/ ES420**	**Title of the Course**	**Applied Biotechnology and Microbiology**	**L**	**T**	**P**	**C**
Year	**4th**	**Semester**	**VII**	**5**	**1**	**0**	**4**
Pre-Requisite	**Basic in Science**	**Co-requisite**					
Course Objectives	This course aims to provide students with a comprehensive understanding of biotechnology and microbiology, covering their principles, tools, and applications. Students will learn about the various branches of biotechnology, including plant and microbial biotechnology, and their industrial and environmental applications. By the end of the course, students will be equipped with knowledge of the latest techniques and technologies in biotechnology and microbiology, enabling them to pursue careers in research, industry, or academia.						

Course Outcomes

CO1	Understand the principles and applications of biotechnology and microbiology: Students will gain a comprehensive understanding of the fundamentals of biotechnology and microbiology and its various applications.
CO2	Students will learn to apply biotechnological tools and techniques, such as DNA manipulation and gene editing, to solve real-world problems.
CO3	Students will understand the structure, function, and interactions of microorganisms, including their roles in human health and the environment.
CO4	Students will learn to design and evaluate the microbial ecology and its applications.
CO5	Students will understand the importance of biosafety, biosecurity, and regulatory issues in biotechnology and microbiology, and apply this knowledge in practical scenarios.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Introduction to Biotechnology**	Definition and Scope of Biotechnology - Historical background, Branches of biotechnology. Basic Tools and Techniques- DNA manipulation (PCR, sequencing), Cloning and expression vectors, Ethical and Regulatory Issues, Biosafety and biosecurity, Intellectual property rights	8	CO1
2	**Plant Biotechnology**	Plant Tissue Culture- Types (meristem culture, embryo rescue), Applications (micropropagation, production of secondary metabolites)	6	CO1
3	**Genetic Engineering**	Genetic Engineering in Plants, Methods (Agrobacterium-mediated, biolistics), - Transgenic plants (Bt cotton, Golden Rice), Applications of Plant Biotechnology- Crop improvement (yield, disease resistance), Production of biopharmaceuticals	8	CO2
4	**Industrial and Environmental Biotechnology**	Microbial Biotechnology- Fermentation technology (beer, yogurt), Industrial Applications- Biocatalysts (enzymes, biosensors), Biofuels (ethanol, biodiesel), Environmental Applications - Waste management (biogas production), Pollution control (heavy metal removal)	8	CO2
5	**Fundamentals of Microbiology**	Introduction to Microbiology, History and Scope of Microbiology, Isolation of pure culture, cultivation of aerobic and anaerobic bacteria. Preservation, maintenance, and conservation of microbial cultures. Microscopy: Simple, Phase contrast, Fluorescence, Electron and Confocal Microscopes. Staining Techniques	8	CO3
6	**Microbial Structure and Function**	Prokaryotic and Eukaryotic Cell Structure, Microbial Nutrition and Growth, Microbial Metabolism and Genetics	6	CO3
7	**Microbial Interactions and Ecology**	Symbiotic Relationships (Mutualism, Commensalism, Parasitism), Microbial Ecology (Environmental Microbiology), Microbial Interactions with Hosts (Pathogenicity, Virulence)	6	CO4
8	**Applied & Environmental Microbiology**	Medical Microbiology (Infectious Diseases,), Industrial Microbiology (Fermentation, Food Microbiology), Bioremediation. Biofertilizers – history of biofertilizers, sources of nitrogen and the importance of biofertilizers, description and characteristics of biofertilizers- Rhizobium, Azotobacter, Azospirillum, Blue Green Algae, Azolla, Phosphate solubilizing microorganisms, VAM) Biofertilizer production technology-strain selection, sterilization, growth and fermentation, standards and quality control, biofertilizer application technology.	10	CO5

Reference Books:

1- Introduction To Plant Tissue Culture By MK Razdan

2- Molecular Cloning: A Laboratory Manual by Michael R. Green and Joseph Sambrook.

3-Robert LTate (1995) Soil Microbiology. 1st Edition, John Wiley & Sons, Inc. New York.

4-Atlas RN & Bartha R (1998) Microbial Ecology, 4th Edition, Benjamin Cummings.

e-Learning Source:

1. SWAYAM
2. MOOC
3. e-Skill India

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	1	1	1	1	3	1	-	-	-	-	-	3	3	3	1	2	-
CO2	3	1	1	1	1	3	1	-	-	-	-	-	3	3	3	1	2	-
CO3	2	1	1	1	1	2	1	-	-	-	-	-	3	3	3	1	2	-
CO4	2	1	1	1	1	3	1	-	-	-	-	-	3	3	3	1	2	-
CO5	3	1	1	1	1	2	1	-	-	-	-	-	3	3	3	1	2	-

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Department of Environmental Science

Effective from Session: 2025-2026							
Course Code	**B150804P / ES421**	**Title of the Course**	**Environmental Lab II**	**L**	**T**	**P**	**C**
Year	**4th**	**Semester**	**VIII**	**0**	**0**	**2**	**4**
Pre-Requisite	**Basic in Science**	**Co-requisite**					
Course Objectives	The objectives of this course are (a) Develop skills about analysis techniques of physico-chemical parameters of industrial effluent. (b) Hands on training on heavy metal determination through sophisticated instruments viz AAS, LCMS (c) To develop skills in solid waste management and gravimetric analysis. (d) Practical skills on Microbiological and Molecular biology tools & techniques. (e) Visit to industrial units to observe the production process and effluent treatment procedures along quality Assurance compliance.						

Course Outcomes	
CO1	Students will be able to Acquire practical skills in Analytical techniques and sophisticated Instruments
CO2	Understand the importance of solid waste management and their proper disposal through testing their contents
CO3	Students will be able to learn and adopt the microbial handling techniques
CO4	Students will be Aware about effluent treatment plants and process.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	**Industrial Pollution**	1. Physico-chemical Characterization of Industrial Effluent: Parameters: pH, BOD, COD, TDS, TSS, Conductivity, Oil & Grease. 2. Analysis of Heavy Metals in Industrial Wastewater: Atomic Absorption Spectroscopy (AAS), IC-PMS, Sample preparation, digestion and detection. 3.Determination of Air Pollutants: Parameters: Particulate matter (PM10, PM2.5), SO_2, NOx, CO.	15	CO1
2	**Solid Waste Characterization from an Industrial Unit**	Determination of Moisture content, Volatile matter, Ash content, Calorific value of solid waste generated in industrial unit.	15	CO2
3	**Applied Biotechnology and Microbiology**	1. Isolation and Cultivation of microorganisms from different sources: soil, sewage, and waste water 2. Gram Staining and Microscopic Observation: Study of morphology and Gram characteristics of bacterial isolates. 3.Biochemical Characterization: Tests: Catalase, Oxidase, Starch hydrolysis, Nitrate reduction test 4. Enzyme Activity Assays from Microbes: Enzymes: Amylase, Cellulase, Laccase 5. Assessment of Antibacterial Activity of Natural Extracts and Essential oils: Method: Disc/Well diffusion technique. 6. Study of Microbial Degradation of Organic Pollutants (e.g., Oil, Dye): Setup: Flask experiment with crude oil/dye and isolated microbes	15	CO3
4	**Industrial Visit**	Visit to Common Effluent Treatment Plant (CETP) / ETP: Observation: Unit operations like screening, sedimentation, aeration, sludge handling, Report: Process flow diagram, treatment capacity, compliance status	15	CO4

Reference Books:

1. Practical Environmental Analysis, By Miroslav Radojevic, Vladimir N Bashkin · 2015, Royal Society of Chemistry
2. Heavy Metal Contamination of Water and Soil Analysis, Assessment, and Remediation Strategies, Apple Academic press
3. Brunner R.C. 1989. Hazardous waste incineration, Mc Graw Hill.
4. Air Pollution Measurement, Modelling and Mitigation By Abhishek Tiwary, Ian Williams · 2018, CRC Press, e-book
5. Laboratory Manual of Microbiology, Biochemistry and Molecular Biology By Jyoti Saxena, Mamta Baunthiyal, Indu Ravi · 2015, Scientific Publishers, e-book

e-Learning Source:

1. https://www.biologydiscussion.com/ecosystem/ecosystem-its-structure-and-functions-with-diagram/6666
2. https://cpcb.nic.in/openpdffile.php?id=UHVibGljYXRpb25GaWxlLzk5OV8xNzM1NjIyNTA0X211ZGlhcGhvdG8xNjkzMC5wZGY=
3. https://sarvowater.com/understanding-effluent-treatment-plants/

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5	PSO7
CO1	2	1	1	1	1	3	2	-	-	-	-	-	2	1	2	1	3	-
CO2	2	1	1	1	1	3	2	-	-	-	-	-	2	1	2	1	3	-
CO3	2	1	1	1	1	3	2	-	-	-	-	-	2	1	2	1	3	-
CO4	2	1	1	1	1	3	2	-	-	-	-	-	2	1	2	1	3	-

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Department of Environmental Science

Effective from Session:2025-2026							
Course Code	**B150805P/ ES422**	**Title of the Course**	**Field Project/ Educational Tour/ Industry Visit**	**L**	**T**	**P**	**C**
Year	**4th**	**Semester**	**VIII**	**0**	**0**	**0**	**4**
Pre-Requisite	**Basic in Science**	**Co-requisite**	Nil				
Course Objectives	Upon finishing the course students will be able to come up with a gain of professional work in industry and research project experience.						

Course Outcomes	
CO1	To apply theoretical concepts learned in degree course work to a practical situation
CO2	To obtain experience with relevant materials and methodologies.
CO3	Achieve/complete assigned target(s)/ task(s) given by the person to whom the intern or apprentice is reporting (Supervisor)

Unit No.	**Title of the Unit**	**Content of unit**	**Mapped CO**
1	**Field Project/ Educational Tour/ Industry Visit**	Students are encouraged to undergo summer/winter plant training in a suitable industry, consultancy, research laboratory, institute, Protected Area etc. to get firsthand experience of corporate environmental management and of natural habitat. Candidates will write a field project report on issues related to Environmental Science under the guidance of their respective guides. Each student will work independently on the topic. The field project must consist of a review of the literature and produce a deep insight of the subject based on personal research. Field project work will be initiated at the start of the Semester. The students will undertake fieldwork in terms of the collection of data and surveys. The field project will have to be submitted for appraisal and acceptance by the University. The students should submit their field project report in the following format: Chapter I: Introduction with Aims and Objectives: A background with historical information and a review of existing material or data on the subject along with the aims and objectives of the study. Chapter II: Methodology with Material and Methods: Description of the issue, and methodology adopted for the study. Chapter III: Experimental: Presentation of data collected and detailed analysis of results. Chapter IV: Result and Discussion: Discussion on the data and results obtained and Presentation of the method suggested to solve the problem. Chapter V: Summary and Conclusions: A summary of the dissertation and important conclusions drawn at the end of the investigation. Bibliography or References: A list of references cited in the text. The Field Project Report should be typed on A4 size bond paper with 1.5 line spacing. Illustrations and photographs should be of high quality. The report should be flawless without any spelling mistakes or grammatical errors. Students will have to submit their field project report one month Before the practical examination at the end of Semester. The field work report will carry 100 marks (Internal marks 20 and External marks 80). Assessment of the report will be done at the end of the year. Students have to present a Power Point Presentation. Assessment of the field work shall be done by the external examiner appointed by HOD, Integral University.	CO1,2,3,

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	2	2	2	1			1			2	1		1	2				
CO2	3	2	1	1					1		1		1	1				
CO3	3	2	2	2	2	2					2		1	1	1			

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HOD**

Department of Environmental Science

Effective from Session:2025-2026							
Course Code	**B150805R/ ES422**	**Title of the Course**	**Internship/Research Project (Research Project V)**	**L**	**T**	**P**	**C**
Year	**4th**	**Semester**	**VIII**	**0**	**0**	**0**	**4**
Pre-Requisite	**10+2**	**Co-requisite**	**Nil**				
Course Objectives	Upon finishing the course students will be able to come up with a gain of professional work in industry and research project experience.						

Course Outcomes	
CO1	To apply theoretical concepts learned in degree course work to a practical situation
CO2	To obtain experience with relevant materials and methodologies.
CO3	Achieve/complete assigned target(s)/ task(s) given by the person to whom the intern or apprentice is reporting (Supervisor)

Unit No.	**Title of the Unit**	**Content of unit**	**Mapped CO**
1	**Internship/(Research Project V)**	Students are encouraged to undergo summer/winter in plant training in a suitable industry, consultancy, research laboratory, institute, Protected Areas etc. So as to get firsthand experience of corporate environmental management and of natural habitat. Candidates will write a field project report on issues related to Environmental Science under the guidance of their respective guides. Each student will work independently on the topic. The field project must consist of a review of the literature and produce a deep insight of the subject based on personal research. Field project work will be initiated at the start of Semester. The students will undertake fieldwork in terms of the collection of data and surveys. The field project will have to be submitted for appraisal and acceptance by the University. The students should submit their field project report in the following format: Chapter I: Introduction with Aims and Objectives: A background with historical information and a review of existing material or data on the subject along with the aims and objectives of the study. Chapter II: Methodology with Material and Methods: Description of the issue, methodology adopted for the study. Chapter III: Experimental: Presentation of data collected and detailed analysis of results. Chapter IV: Result and Discussion: Discussion on the data and results obtained and Presentation of method suggested to solve the problem. Chapter V: Summary and Conclusions: A summary of the dissertation and important conclusions drawn at the end of the investigation. Bibliography or References: A list of references cited in the text. The Field Project Report should be typed on A4 size bond paper with 1.5 line spacing. Illustrations and photographs should be of high quality. The report should be flawless without any spelling mistakes or grammatical errors. Students will have to submit their field project report one month Before the practical examination at the end of Semester. The field work report will carry 100 marks (Internal marks 20 and External marks 80). Assessment of the report will be done at the end of the year. Students have to present a Power Point Presentation. Assessment of the field work shall be done by the external examiner appointed by HOD, Integral University.	CO1,2,3,

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

PO-PSO CO	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	2	2	1		2	3						3	2	2	3	3	
CO2	2	1	1		3	3						3	1	2	3	3	
CO3	2	2	2	2	2	2						2	2	2	3	3	

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HOD**