ACADEMIC CURRICULA

POST GRADUATE DEGREE PROGRAMMES

Master of Science

(NEP based Flexible Credit System)

Syllabi for M.Sc. in Environmental Science and Technology Programme

Professional Core and Elective Courses

BIRLA INSTITUTE OF TECHNOLOGY, MESRA

(Deemed to be University)

Mesra, Ranchi, Jharkhand, 835215, India

Department of Civil and Environmental Engineering

Birla Institute of Technology, Mesra, Ranchi - 835215 (India)

Institute Vision

- To become a Globally Recognized Academic Institution in consonance with the social, economic and ecological environment, striving continuously for excellence in education, research and technological service to the National needs.

Institute Mission

- To educate students at Undergraduate, Post Graduate Doctoral and Post-Doctoral levels to perform challenging engineering and managerial jobs in industry.
- To provide excellent research and development facilities to take up PhD programmes and research projects.
- To develop effective teaching and learning skills and state of art research potential of the faculty.
- To build national capabilities in technology, education and research in emerging areas.
- To provide excellent technological services to satisfy the requirements of the industry and overall academic needs of society.

Department Vision

- To develop quality intellectuals through education, research and motivation so that they can bring a positive contribution to the society in area of Civil and Environmental Engineering

Department Mission

- To develop professional skills through quality education & research.
- To outreach various sectors of society through interdisciplinary programmes and practical oriented approach.
- To create dynamic, logical and effective leaders with inspiring mindsets.

PEOs and POs for M.Sc. (Environmental Science and Technology)

Programme Educational Objectives (PEOs)

PEO1: Graduates will demonstrate a strong foundation in environmental science and engineering principles, enabling them to pursue successful careers in industry, academia, research, and consultancy.

PEO2: Graduates will be able to identify, formulate, and solve complex environmental problems using modern tools, analytical skills, and interdisciplinary knowledge.

PEO3: Graduates will develop and implement sustainable and practical solutions to address challenges in diverse ecosystems and environmental systems.

PEO4: Graduates will exhibit ethical responsibility, social awareness, and a commitment to environmental stewardship in their professional practices and community engagements.

PROGRAMME OUTCOMES (POs)

PO1: Demonstrate the ability to independently conduct investigations and apply scientific methods to solve complex ecological and environmental problems.

PO2: Exhibit a broad range of skills and professional competencies in environmental science, technology, and sustainability practices.

PO3: Attain advanced knowledge and technical expertise in the Environmental Science and Technology, exceeding the proficiency expected at the undergraduate level.

PO4: Develop and implement comprehensive environmental impact assessments, monitoring strategies, and environmental management plans.

PO5: Effectively communicate scientific information through high-quality reports, research articles, and technical documentation.

PO6: Critically evaluate issues related to environmental sustainability, social governance, engage and sensitize communities, and assess alternative solutions to support informed and responsible decision-making in environmental science.

Department of Civil and Environmental Engineering
Birla Institute of Technology Mesra, Ranchi - 835215, India
M.Sc. Environmental Science and Technology

Course Structure

Semester I

	Course Level	Course Code	Course Name	Delivery Method Lecture – L; Tutorial – T; Practical - P			Credits
				L	T	P	
Semester I	Program Core	MET26501	Ecology and Biodiversity	3	0	0	3
	Program Core	MET26503	Environmental Chemistry and Microbiology	3	0	0	3
	Program Core	MET26505	Water and wastewater Treatment	3	0	0	3
	Program Core	MET26507	Environmental Impact Assessment, Laws and ISO standards	3	0	0	3
	Program Elective	MET26 XXX	PE	3	0	0	3
	Program Core	MET26502	Ecology and biodiversity Laboratory	0	0	3	1.5
	Program Core	MET26504	Water and Wastewater Analysis Laboratory	0	0	3	1.5
	Skill Development Course	MET26509	Skill Development Course I	2	0	0	2
	Total Credits						**20**

Semester II

	Course Level	Course Code	Course Name	Delivery Method Lecture – L; Tutorial – T; Practical - P			Credits
				L	T	P	
Semester II	Program Core	MET26511	Occupational Health and Industrial Safety	3	0	0	3
	Program Core	MET26513	Soil Pollution and Solid Waste Management	3	0	0	3
	Program Core	MET26515	Air Pollution and Global Climate Change	3	0	0	3

	Program Core	MET26517	Application of Remote Sensing in Environment	**3**	**0**	**0**	**3**
	Program Core	MET26519	Sustainability and Environmental Social Governance	**3**	**0**	**0**	**3**
	Program Core	MET26506	Air & Soil Laboratory	**0**	**0**	**3**	**1.5**
	Program Core	MET26508	Remote Sensing Laboratory	**0**	**0**	**3**	**1.5**
	Skill development Course	MET26521	Skill Development Course II	**2**	**0**	**0**	**2**
	Total Credits						**20**

Semester III

Semester III	**Course Level**	**Course Code**	**Course Name**	**Delivery Mehod Lecture – L; Tutorial – T; Practical - P**			**Credits**
				L	**T**	**P**	
	Program Core	MET26523	Earth Science and Energy Resources	**3**	**1**	**0**	**4**
	Open Elective	MET26525	MOOC/OE	**3**	**0**	**0**	**3**
	Program Elective	MET26XXX	PE II	**3**	**0**	**0**	**3**
	Program Core	MET26510	Project Part I				**6**
	Program Core	MET26512	Advance Instrumentation Lab	**0**	**0**	**2**	**2**
	Mandatory Course	MET26514	Industrial Training/Internship in Reputed Institute (Mandatory)*	0	0	0	2
	Total Credits						**20**
	***During summer vacation student should attend the training /internship**						

Semester IV

Semester IV	**Course Level**	**Course Code**	**Course Name**	**Delivery MET26-hod Lecture – L; Tutorial – T; Practical - P**			**Credits**
				L	**T**	**P**	
	Program Core	MET26516	Project Part II	**0**	**0**	**20**	**20**
	Total Credits						**20**

Grand Total of Credits: (40+40=80)

Program Electives:

MET26529 Environmental Toxicology

MET26531 Environmental Statistics and optimization

MET26533 Instrumental method for Analysis of Environmental Samples

MET26535 Disaster Management

MET26537 Advanced Water & Wastewater Treatment

MET26539 Industrial Pollution Control

MET26541 Environmental Biotechnology

MET26543 Natural Resource Management

Teaching and Learning Scheme

As per the new **National Credit Framework**, an account of 30 hours of learning is equivalent to 01 credit. It comprises of Classroom instructions (CI), Lab instructions (LI), Term work + Self Learning (TW + SL) in hours per semester. The division of the components mentioned will be as per the following teaching and learning schemes.

Sl. No.	Total credits	Classroom Instructions (CI) in hours per semester		Lab Instructions (LI) in hours per semester	Term work (TW)and Self Learning (SL) (TW + SL) in hours per semester	Total no. of Hours per semester
		Lectures	Tutorials			
1	**04 (Four) Theory**	42	14	0	64	120
2	**03 (Three) Theory**	28	14	0	48	90
3	**03 (Three) Theory**	42	0	0	48	90
4	**02 (Two) Theory**	28	0	0	32	60
5	**02 (Two) Lab**	0	0	56	4	60
6	**1.5 (One and half) Lab**	0	0	42	3	45
7	**01 (One) Lab**	0	0	28	2	30
8	**02 (Two) Project**	0	0	0	60	60
9	**03 (Three) Project**	0	0	0	90	90
10	**06 (Six) Project**	0	0	0	180	180
11	**03 (Three) Vocational**	14	0	56	20	90

Legend:

CI Classroom Instruction (includes different instructional/ implementation strategies i.e. Lecture (L), Tutorial (T), case method, Demonstrations, video demonstration, problem-based learning etc. to deliver theoretical concepts)

LI Laboratory Instruction (includes experiments/ practical performances, problem-based experiences in laboratory, workshop, field or other locations using different instructional/ implementation strategies)

TW Term Work (includes assignments, seminar micro projects, industrial visits, any other student activities etc.)

SL Self Learning, MOOCs, spoken tutorials, online educational resources etc. (if provided in curriculum structure)

COURSE INFORMATION

Course code	MET26501
Course title	Ecology and Biodiversity
Pre-requisite(s)	B.Sc.
Co-requisite	-
Credits	3 (L:3 T:0 P:0 SL:)
Class schedule per week	3
Class	M.Sc.
Semester / Level	I/5
Branch	Environmental Science & Technology
Name of Teacher	

Course Objectives *This course aims to provide students with:*	
Sl No.	Objectives
1	To develop a comprehensive understanding of the structural and functional attributes of ecosystems and the environment
2	To build awareness of the impacts of climate change and pollution on natural resources, including biodiversity
3	To enable students to critically analyze ecological principles and apply them toward achieving sustainable development goals

Course Outcomes (COs) *Upon successful completion of the course, students will be able to*	
CO	Course Outcomes
CO1	Conceptualize the structure and function of ecosystems and determine ecosystem characteristics through field-based assessments
CO2	Analyze population dynamics, including growth patterns, species interactions, and the influence of environmental factors
CO3	Evaluate the structure, function, and interactions within ecological communities
CO4	Assess the significance, methods of measurement, and strategies for the conservation of biodiversity across diverse ecosystems
CO5	Apply ecological principles to address environmental challenges and promote sustainable development practices

Syllabus

Module No.	*Module name*	*Detailed Contents*	*No. of Lecture*
Module I	**Introduction to Ecology and Evolutionary Concepts**	Definition, Scope, and Branches of Ecology, Levels of Organization: Individual to Biosphere, Concept and Structure of Ecosystems: Producers, Consumers, Decomposers; Trophic Levels and Interconnectedness (e.g., Gaia Hypothesis); Classification of Ecosystems: Natural and Artificial, Terrestrial and Aquatic	8
Module II	**Abiotic Environment and Energetics**	Ecological Laws: Liebig's Law of Minimum, Law of Tolerance, Limiting Factors Energy in Ecological Systems: Solar Radiation, Primary and Secondary Productivity, Laws of Thermodynamics in Ecology, Food Chains, Food Webs, and Ecological Pyramids (Energy, Biomass, Numbers), Concepts of Energy, Exergy, Ascendency, and Ecological Footprint Ecological Efficiency, Models of Energy Flow (Single channel and Y-shaped models); Ecosystem Homeostasis and Stability. Use of simple computational models to study energy flow and ecosystem stability.	8
Module III	**Biogeochemical Cycles and Energy Flow**	Overview and Importance of Biogeochemical Cycles, Major Cycles: Hydrological, Carbon, Nitrogen, Sulphur, Phosphorus; Bioaccumulation, Biotransformation, Biomagnification, Bioconcentration factor, Translocation factor.	8
Module IV	**Population and Community Ecology**	Population Ecology: Characteristics: Density, Natality, Mortality, Age Structure; Growth Models: Exponential and Logistic; Population Regulation Mechanisms; r/K Selection, Niche Concept; Community Ecology: Community Structure: Stratification, Dominance, Diversity, Species Interactions: Interspecific (Predation, Production, Competition, Parasitism) and Intraspecific Ecological Succession: Types, Mechanisms, Climax Communities	8
Module V	**Biodiversity and Conservation Ecology**	Definition, Types, and Levels of Biodiversity, Methods of Measuring Biodiversity: Indices,, Causes and Consequences of Biodiversity Loss; Conservation Strategies: In Situ (National Parks, Sanctuaries, Biosphere Reserves), Ex Situ (Seed Banks,	8

		Zoos, Botanical Gardens); Biodiversity Management and Policy Frameworks: Indian Initiatives (NBA, BSI, ZSI, Biodiversity Act), Global Conventions (CBD, CITES, Ramsar, IUCN, IPBES); Role of Biodiversity Registers, Bioprospecting, and Issues of Biopiracy, , Citizen science and mobile applications for biodiversity documentation.	

Learning Resources	
Text Books	***Reference Books***
1. Fundamentals of Ecology (3rd ed.) - Eugene P. Odum. WB Sunders Company, Philadelphia, 1971 (T1) 2. Ecology and environment – P. D. Sharma (T2) 3. Fundamentals of Ecology- MC Dash, Tata - McGraw Hill, New Delhi, 1996. (T3) 4. Introduction to Environmental Engg. - GM Masters, Prentice Hall of India, 1991. (T4) 5. Biodiversity and Conservation - P. C. Joshi (T5) 6. A Textbook of Environmental Science -Prabhat Patnaik 7. A Textbook of Environmental Sciences-Purohit (T6)	1. Microbiology for Environmental Scientists and Engineers – AF Gaudy (R1) 2. Enzymatic Transformation of Metals - Strains for Enhanced Biodegradation - Improved Biodegradation by Protein. T Gaudy, McGraw-Hill, New York, 1980. (R2) 3. Elements of Ecology (6th edition) – Thomas M. Smith and Robert Leo Smith, Pearson Education, 2007. (R3) 4. Biodiversity and Conservation - M. P. Singh and Aravind Kumar (R4)

Gaps in the Syllabus (to meet Industry/Profession requirements)	Application of real-life industrial problems
Pos met through Gaps in the Syllabus	PO5 and PO6
Topics beyond syllabus/Advanced topics/Design	Application for real-life problems arising in industries through lab-based experiments
Pos met through Topics beyond syllabus/Advanced topics/Design	PO5 and PO6

Course Outcome (Co) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment	***Assessment Tool***	***% Contribution during CO Assessment***				
	Continuous Internal Assessment	50%				
	Semester End Examination	50%				
	Continuous Internal Assessment	***% Distribution***				
	Best 2 Quiz marks out of 3 Quizzes of 15 marks each.	30%				
	Assignment(s)	10%				
	Seminar before a Committee	10%				
	Assessment Components	***CO1***	***CO2***	***CO3***	***CO4***	***CO5***
	Continuous Internal Assessment					
	Semester End Examination					

Indirect Assessment	1. Student Feedback on Faculty
	2. Student Feedback on Course

Mapping Between Course Outcomes and Program Outcomes						
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	1	2	2	1	3
CO2	3	3	3	3	1	2
CO3	3	1	3	3	1	2
CO4	3	2	3	3	3	3
CO5	3	2	3	2	3	3

Course Delivery Methods	
CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning (SL) such as use of NPTEL materials and internets
CD7	Simulation

Mapping Between Course Outcomes and Course Delivery Method	
Course Outcomes	**Course Delivery Method**
CO1	CD1, CD2
CO2	CD1, CD2, CD4, CD5
CO3	
CO4	
CO5	

Course Designers		
Experts from Industry	***Experts from Higher Technical Institutions***	***Internal Experts***
Dr. Susanta Podder, Mr. Sujib Chatterjee	***Prof. Mahabir Panda, Prof Sriman Kr. Bhattacharya, Prof. Rabindra Prasad Sharma***	***Prof. Manjari Chakraborty, Prof. Akhil Sen, Dr. Sukalyan Chakraborty***

COURSE INFORMATION

Course code	MET26503
Course title	Environmental Chemistry and Microbiology
Pre-requisite(s)	B.Sc.
Co-requisite	-
Credits	3 (L:3 T:0 P:0 SL:)
Class schedule per week	3
Class	M.Sc.
Semester / Level	I/5
Branch	Environmental Science & Technology
Name of Teacher	

Course Objectives *This course aims to provide students with:*	
Sl No.	Objectives
1	Describe the fundamentals of environmental chemistry and microbiology
2	Explain the concepts related to chemical and microbial processes in atmosphere, aquatic systems and soil.
3	Develop environmental monitoring and assessment programs for environmental quality monitoring and pollution control.

Course Outcomes (COs) *Upon successful completion of the course, students will be able to*	
CO	Course Outcomes
CO1	Apply the fundamentals of environmental chemistry and microbiology, which are important for practice of environmental science and technology.
CO2	Interpret the chemistry of air, soil and water pollution enabling them to work on its treatment.
CO3	Design and carry out environmental quality management projects.

Syllabus

Module No.	*Module name*	*Detailed Contents*	*No. of Lecture*
Module I	**Basics of Environmental Chemistry**	Units of measurement, mass balance, enthalpy, chemical equilibria, chemical kinetics, and Chemical thermodynamics - work done, internal energy, enthalpy, entropy, Gibbs free energy, specific heat, environmental transformation, and degradation processes.	8
Module II	**Atmospheric and Aquatic Chemistry:**	Atmosphere – structure & composition, reactions and calculations in atmospheric chemistry, solubility of gases in water, chemistry of troposphere – particulate matter, hydrocarbons, CO, oxides of sulfur, oxides of nitrogen, chemistry of stratosphere. Physico-chemical properties of water, organic components in natural waters, estuarine and ocean chemistry, water pollution – deoxygenation, DO & BOD, eutrophication, Eh-pH diagram, chemicals speciation.	8
Module III	**Soil Chemistry and Environmental Sample Analysis**	Soil formation, soil reactions - acid-base, redox, chelation, soil organic matter, soil properties, soil acidity, soil salinity and sodicity, acid sulphate soil. Sampling of water, wastewater, soil and sediments, environmental samples analysis - gravimetric and volumetric methods, spectroscopic techniques, and chromatographic techniques, applications of IoT, and Artificial Intelligence in Environmental Quality Monitoring.	8
Module IV	**Introduction to environmental microbiology**	Classification and characterization of microorganisms, Morphology and structure of bacteria, nutritional requirement, growth of bacteria; Basic microbiology of water and sewage; Basics of analysis of faecal coliforms.	8
Module V	**Microbes in waste treatment**	Aerobic and anaerobic metabolism, kinetics of microbial growth, biological nutrient removal, role of microbes in biological waste treatment -bioremediation, biodegradation, wastewater treatment, Artificial Intelligence in Microbial Waste Management.	8

Learning Resources	
Text Books	***Reference Books***
1. Environmental Chemistry - A global perspective, Gary W. Van Loon and Stephen J. Duffy, Oxford University Press 2. Introduction to Environmental Engineering and Science, G.M. Masters & Wendell Ela, PHI Publishers 3. Microbiology for Environmental Scientists and Engineers – AF Gaudy	1. Environmental Chemistry, Stanley Manahan, Stanley E. Manahan, CRC Press. 2. Chemistry for Environmental Engineering, Clair N. Sawyer, Perry McCarty, Gene F. Parkin, McGraw Hill Inc. New York. 3. Basic Concepts of Environmental Chemistry, DW Conell, CRC Press 4. Standard Methods of Testing of Water and Wastewater" APHA, AWWA, & WPCF 5. Environmental Chemistry – a global perspective. Gary W. Vanloon and Stephen J. Duffy

Gaps in the Syllabus (to meet Industry/Profession requirements)	
POs met through Gaps in the Syllabus	PO4, PO5 & PO6
Topics beyond syllabus/Advanced topics/Design	
Pos met through Topics beyond syllabus/Advanced topics/Design	

Course Outcome (Co) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment	***Assessment Tool***	***% Contribution during CO Assessment***				
	Continuous Internal Assessment	50%				
	Semester End Examination	50%				
	Continuous Internal Assessment	***% Distribution***				
	Best 2 Quiz marks out of 3 Quizzes of 15 marks each.	30%				
	Assignment(s)	10%				
	Seminar before a Committee	10%				
	Assessment Components	***CO1***	***CO2***	***CO3***	***CO4***	***CO5***
	Continuous Internal Assessment					
	Semester End Examination					

Indirect Assessment	1. Student Feedback on Faculty
	2. Student Feedback on Course Outcome

Mapping Between Course Outcomes and Program Outcomes						
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2	2	3	1	1
CO2	3	2	3	3	1	1
CO3	3	3	2	3	1	1

Course Delivery Methods	
CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Seminars
CD4	Mini Projects
CD5	Laboratory experiments/teaching aids
CD6	Industrial/guest lectures
CD7	Industrial visits/in-plant training
CD8	Self- learning (SL) such as use of NPTEL materials and internets
CD9	Simulation

Mapping Between Course Outcomes and Course Delivery Method	
Course Outcomes	**Course Delivery Method**
CO1	CD1, CD2
CO2	CD1, CD2
CO3	CD1, CD2, CD3
CO4	
CO5	

Course Designers		
Experts from Industry	*Experts from Higher Technical Institutions*	*Internal Experts*
Dr. Susanta Podder, Mr. Sujib Chatterjee	***Prof. Mahabir Panda, Prof Sriman Kr. Bhattacharya, Prof. Rabindra Prasad Sharma***	***Prof. Manjari Chakraborty, Prof. Akhil Sen, Dr. R. Naresh Kumar***

COURSE INFORMATION

Course code	MET26505
Course title	Water and Wastewater Treatment
Pre-requisite(s)	B.Sc.
Co-requisite	-
Credits	3 (L:3 T:0 P:0 SL:)
Class schedule per week	3
Class	M.Sc.
Semester / Level	I/5
Branch	Environmental Science & Technology
Name of Teacher	

Course Objectives *This course aims to provide students with:*	
Sl No.	Objectives
1	To understand the basic concept of water supply
2	To characterise and classify the water quality
3	To understand different water treatment techniques
4	To understand the basic concepts of wastewater treatment
5	To understand the wastewater treatment units and their application

Course Outcomes (COs) *Upon successful completion of the course, students will be able to*	
CO	Course Outcomes
CO1	Able to assess the water quality and its sources for different water supply schemes
CO2	Able to calculate water demand for upcoming or existing establishments over time
CO3	Able to understand the existing treatment units and recommend the modern technologies required to meet new standards
CO4	Able to understand and apply the basics of wastewater treatment methods
CO5	Able to evaluate the influence of the different parameters in the design and treatment of a wastewater treatment plant

Syllabus

Module No.	*Module name*	*Detailed Contents*	*No. of Lecture*
Module I	**Water quality**	Physical, chemical, Bacteriological characteristics, water quality standards. Basics of water supply: Design Period, Population Forecast, Factors affecting population growth, Water Demand. WQI, Application of AI in water quality data analysis	8
Module II	**Sources of water and their transportation**	Hydrological cycle, Rainfall and runoff, groundwater sources, Surface sources, intake structures and conduits, and Pumps. Rainfall and runoff data processing using AI, understanding groundwater dynamics using AI	8
Module III	**Water treatment units**	Aeration, sedimentation, coagulation, flocculation, filtration, disinfection, adsorption, water softening, reverse osmosis. Water distribution network, service reservoirs, water supply appurtenances, and smart water systems. AI applications for water treatment, predictive modeling techniques for water system optimisation	8
Module IV	**Basics of wastewater**	Quality of sewage, sewage estimation, stormwater estimation, Flow of sewage, hydraulic considerations of sewage conveyance. Predictive modelling techniques for sewer system optimisation, application of AI in wastewater quality data analysis, and rainfall and runoff data processing using AI for stormwater estimation.	8
Module V	**Sewage treatment**	Preliminary, primary, secondary, and tertiary treatment. Aerobic treatment processes: attached and suspended growth processes. Anaerobic treatment processes: suspended and attached growth. Solids and residuals management: sludge treatment processes, sludge utilization, and AI applications for wastewater treatment.	8

Learning Resources	
Text Books	***Reference Books***
1. Garg, S. K. (2007) Water supply engineering, 18th ed, Vol. I. New Delhi: Khanna Publisher. 2. Chatterjee, A.K. (2010) Water supply, Waste disposal and environmental Engineering, 8th ed. New Delhi: Khanna Publisher. 3. CPHEEO 1999. Manual on Water supply and treatment. 3rd Edition 4. Nathanson, Jerry A. (2009) Basic environmental technology: water supply, waste management and pollution control, 4th ed. New Delhi: PHI Learning. 5. Metcalf & Eddy (2003) Wastewater engineering: treatment and reuse, 4th ed. New Delhi: Tata McGraw-Hill.	1. American Water Works Association, Manual, AWWA 2. Qasim, Syed R., Motley, Edward M., and Zhu, Guang (2000) Water works engineering: planning, design and operation. New Jersey: Prentice Hall. 3. Nathanson, Jerry A. (2009) Basic environmental technology: water supply, waste management and pollution control, 4th ed. New Delhi: PHI Learning. 4. Garg, S.K. (2007) Sewage disposal and air pollution engineering, 20th ed, Vol. II. New Delhi: Khanna Publisher. 5. Chatterjee, A.K. (2010) Water supply, Waste disposal and Environmental Engineering, 8th ed. New Delhi: Khanna Publisher. 6. CPHEEO Manual on Sewerage and Sewage Treatment, latest edition

Gaps in the Syllabus (to meet Industry/Profession requirements)	
Pos met through Gaps in the Syllabus	PO4, PO5 & PO6
Topics beyond syllabus/Advanced topics/Design	
Pos met through Topics beyond syllabus/Advanced topics/Design	

Course Outcome (Co) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment	***Assessment Tool***	***% Contribution during CO Assessment***				
	Continuous Internal Assessment	50%				
	Semester End Examination	50%				
	Continuous Internal Assessment	***% Distribution***				
	Best 2 Quiz marks out of 3 Quizzes of 15 marks each.	30%				
	Assignment(s)	10%				
	Seminar before a Committee	10%				
	Assessment Components	***CO1***	***CO2***	***CO3***	***CO4***	***CO5***
	Continuous Internal Assessment	3	3	3	3	3
	Semester End Examination	3	3	3	3	3

Indirect Assessment	1. Student Feedback on Faculty
	2. Student Feedback on Course

Mapping Between Course Outcomes and Program Outcomes						
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	1	3	3	1	1
CO2	3	1	3	3	1	1
CO3	3	3	3	3	1	1
CO4	3	1	3	3	1	1
CO5	3	1	3	3	1	1

Course Delivery Methods	
CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Seminars
CD4	Mini projects/Projects
CD5	Laboratory experiments/teaching aids
CD6	Industrial/guest lectures
CD7	Industrial visits/in-plant training
CD8	Self learning such as the use of NPTEL materials and the internet
CD9	Simulation

Mapping Between Course Outcomes and Course Delivery Method	
Course Outcomes	**Course Delivery Method**
CO1	CD1
CO2	CD1
CO3	CD1 and CD2
CO4	CD1 and CD2
CO5	CD1 and CD2

Course Designers		
Experts from Industry	***Experts from Higher Technical Institutions***	***Internal Experts***
Dr. Susanta Podder, Mr. Sujib Chatterjee	***Prof. Mahabir Panda, Prof Sriman Kr. Bhattacharya, Prof. Rabindra Prasad Sharma***	***Prof. Manjari Chakraborty, Prof. Akhil Sen, Dr. Jawed Iqbal***

COURSE INFORMATION

Course code	MET26507
Course title	Environmental Impact Assessment, Laws and ISO Standards
Pre-requisite(s)	B.Sc.
Co-requisite	-
Credits	3 (L:3 T:0 P:0 SL:)
Class schedule per week	3
Class	M.Sc.
Semester / Level	III/5
Branch	Environmental Science & Technology
Name of Teacher	

Course Objectives *This course aims to provide students with:*	
Sl No.	Objectives
1	To provide an overview on international conventions, laws and ISO systems for sustainable environment
2	To develop a basic understanding on the process of environmental impact assessment, laws, ISO standards
3	To understand the components of environmental reports and management plans

Course Outcomes (COs) *Upon successful completion of the course, students will be able to*	
CO	Course Outcomes
CO1	Explain the principles, processes, and importance of EIA in project planning and decision-making and Develop Environmental Management Plans (EMPs) and monitoring strategies.
CO2	Identify and apply appropriate EIA methodologies for different environmental components.
CO3	Analyze and interpret national and international environmental laws and policies.
CO4	Understand and apply ISO 14001 and related standards for environmental management systems.

Syllabus

Module No.	*Module name*	*Detailed Contents*	*No. of Lecture*
Module I	**Introduction to Environmental Impact Assessment**	Definition, scope, objectives, and need for EIA, Historical development and legal mandate of EIA in India, Types and classification of EIA (strategic, rapid, comprehensive), EIA process and life-cycle assessment	8
Module II	**EIA Methodologies and Tools**	Screening, scoping, baseline data collection, Impact prediction and evaluation (air, water, land, noise, socio-economic, biological), Checklists, matrices, overlays, network methods, GIS-based methods, public participation and stakeholder consultation, Preparation of Environmental Management Plan (EMP) and mitigation strategies.	8
Module III	**Environmental Clearance and Monitoring**	EIA Notification 2006 and amendments, Categorization of projects (Category A & B), Role of Expert Appraisal Committee (EAC), SEAC, Post-clearance monitoring, compliance, and auditing	8
Module IV	**Environmental Legislation and Governance**	Overview of Indian environmental laws: Environment Protection Act, 1986, Air (Prevention and Control of Pollution) Act, 1981, Water (Prevention and Control of Pollution) Act, 1974, Forest Conservation Act, 1980, Wildlife Protection Act, 1972, Role of Central and State Pollution Control Boards, International conventions: Stockholm, Rio, Kyoto, Paris Agreement	8
Module V	**Environmental Management Standards and ISO**	Concepts of Environmental auditing, Introduction to ISO and environmental management, ISO 14000 family of standards (with focus on ISO 14001:2015), EMS planning, implementation, auditing, and certification, Life Cycle Assessment (LCA) and Environmental Product Declarations (EPD), eco-labels, Case study	8

Learning Resources	
Text Books	***Reference Books***
1. Environmental Impact Assessment: Larry Canter. McGraw Hill Publication. 2. Environmental Impact Assessment- A. K. Shrivastava. APH Pub. India. 3. Environmental Impact Assessment. Theory and Practice. Anji Reddy Mareddy, 1st Edition, eBook ISBN: 9780128112380, Paperback ISBN: 9780128111390, Butterworth-Heinemann. 4. Environmental Audit: A.K.Shrivastava. APH pub Corp. New Delhi. 5. ISO 14000: Environmental Management 1st Edition, David L. Goetsch 6. Stanley Davis. ISBN-13: 978-0130812360. Jenson Books Inc	1. Methods of Environmental Impact Assessment, Graham Wood, Riki Therivel. ISBN-13: 978-1138647671. Routledge; 4 editions. 2. Global Green standards: ISO 14000 and Sustainable Development. IISD pub. Minitoba. 3. ISO 14000 Answer Book: Environmental Management for the World Market (Wiley Quality Management) 1st Edition. by Dennis R. Sasseville W. Gary Wilson, Robert W. Lawson. ISBN-13: 978-0471179337. John Wiley and sons. Canada.

Gaps in the Syllabus (to meet Industry/Profession requirements)	Syllabus is framed according to industrial and professional requirement.
Pos met through Gaps in the Syllabus	
Topics beyond syllabus/Advanced topics/Design	Module 4 covers review of DPRs that will be allow the students to learn and write project reports that require EIA.
Pos met through Topics beyond syllabus/Advanced topics/Design	PO2

Course Outcome (Co) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment	***Assessment Tool***	***% Contribution during CO Assessment***				
	Continuous Internal Assessment	50%				
	Semester End Examination	50%				
	Continuous Internal Assessment	***% Distribution***				
	Best 2 Quiz marks out of 3 Quizzes of 15 marks each.	30%				
	Assignment(s)	10%				
	Seminar before a Committee	10%				
	Assessment Components	***CO1***	***CO2***	***CO3***	***CO4***	***CO5***
	Continuous Internal Assessment	✓	✓	✓	✓	
	Semester End Examination	✓	✓	✓	✓	

Indirect Assessment	1. Student Feedback on Faculty
	2. Student Feedback on Course

Mapping Between Course Outcomes and Program Outcomes						
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2	3	3	3	3
CO2	3	3	2	3	3	3
CO3	2	3	3	1	3	3
CO4	2	3	0	1	3	3

Course Delivery Methods	
CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping Between Course Outcomes and Course Delivery Method	
Course Outcomes	**Course Delivery Method**
CO1	CD1, CD2
CO2	CD1, CD2
CO3	CD1, CD2, CD8, CD6
CO4	CD1, CD2, CD3

Course Designers		
Experts from Industry	***Experts from Higher Technical Institutions***	***Internal Experts***
Dr. Susanta Podder, Mr. Sujib Chatterjee	***Prof. Mahabir Panda, Prof Sriman Kr. Bhattacharya, Prof. Rabindra Prasad Sharma***	***Prof. Manjari Chakraborty, Prof. Akhil Sen, Dr. Tanushree Bhattacharya***

COURSE INFORMATION

Course code	MET26502
Course title	Ecology and Biodiversity Laboratory
Pre-requisite(s)	B.Sc.
Co-requisite	-
Credits	1.5 (L:0 T:0 P:3 SL:)
Class schedule per week	3
Class	M.Sc.
Semester / Level	I/5
Branch	Environmental Science & Technology
Name of Teacher	

Course Objectives *This course aims to provide students with:*	
Sl No.	Objectives
1	To provide hands-on experience collecting, analyzing, and interpreting ecological and biodiversity data through fieldwork and laboratory experiments.
2	To develop skills using various tools and techniques for assessing species diversity, population dynamics, and ecosystem health.

Course Outcomes (COs) *Upon successful completion of the course, students will be able to*	
CO	Course Outcomes
CO1	Effectively collect and record ecological and biodiversity data using field and laboratory techniques.
CO2	Identify and classify various species within different ecosystems accurately.
CO3	Design and conduct ecological experiments, including hypothesis formation, data collection, and statistical analysis.
CO4	Demonstrate the ability to analyze ecological data and interpret results to understand population dynamics and community structures.
CO5	Gain proficiency in using ecological tools and software for biodiversity assessment and data analysis.

Syllabus

List of Experiments
1. To estimate the minimum size of quadrats required for plant community study 2. To estimate the minimum number of quadrats required for plant community study 3. **Transect Line Sampling for Animal Populations** 4. Determination of Importance Value Index of plant species 5. **Species Richness and Evenness in Different Habitats** 6. Productivity analysis of terrestrial plants 7. Productivity analysis of aquatic ecosystem 8. **Microbial Diversity in Different Soil Types** 9. Bird Diversity and Abundance in Different Habitats 10. Leaf Litter Decomposition Study

Learning Resources	
Text Books	***Reference Books***
1. "Ecology and Environment" by P.D. Sharma 2. "Ecology of Tropical Savannas" by J.S. Singh 3. "Experimental Ecology: Issues and Perspectives" by K. Sankaran Unni	

Gaps in the Syllabus (to meet Industry/Profession requirements)	
Pos met through Gaps in the Syllabus	
Topics beyond syllabus/Advanced topics/Design	Local ecology and biodiversity study
Pos met through Topics beyond syllabus/Advanced topics/Design	Through biodiversity and ecological surveys

Course Outcome (Co) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment	***Assessment Tool***	***% Contribution during CO Assessment***				
	Continuous Internal Assessment	60%				
	Semester End Examination	40%				
	Continuous Internal Assessment	***% Distribution***				
	Day-to-day performance and Lab files	30%				
	Quiz	15%				
	Viva	15%				
	Assessment Components	***CO1***	***CO2***	***CO3***	***CO4***	***CO5***
	Continuous Internal Assessment					
	Semester End Examination					

Indirect Assessment	1. Student Feedback on Faculty
	2. Student Feedback on Course

Mapping Between Course Outcomes and Program Outcomes						
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2	3	1	1	1
CO2	3	2	3	1	1	1
CO3	3	2	3	1	1	1
CO4	3	2	3	1	1	2
CO5	3	2	3	1	2	2

Course Delivery Methods	
CD1	Instruction by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments
CD4	Guest lectures
CD5	Visit to different ecosystems
CD6	Self- learning such as use of NPTEL materials and internets

Mapping Between Course Outcomes and Course Delivery Method	
Course Outcomes	**Course Delivery Method**
CO1	CD1, CD2
CO2	CD1, CD2, CD4, CD5
CO3	CD1, CD2, CD6
CO4	CD1, CD3, CD6
CO5	CD1, CD2, CD3

Course Designers		
Experts from Industry	***Experts from Higher Technical Institutions***	***Internal Experts***
Dr. Susanta Podder, Mr. Sujib Chatterjee	***Prof. Mahabir Panda, Prof Sriman Kr. Bhattacharya, Prof. Rabindra Prasad Sharma***	***Prof. Manjari Chakraborty, Prof. Akhil Sen, Dr. Sukalyan Chakraborty***

COURSE INFORMATION

Course code	MET26504
Course title	Water and Wastewater Analysis Laboratory
Pre-requisite(s)	B.Sc.
Co-requisite	-
Credits	1.5 (L:0 T:0 P:3 SL:)
Class schedule per week	3
Class	M.Sc.
Semester / Level	I/5
Branch	Environmental Science & Technology
Name of Teacher	

Course Objectives *This course aims to provide students with:*	
Sl No.	Objectives
1	To describe the concept of water quality concerning different standards
2	To apply different procedures for the physico-chemical and bacteriological analysis of water and wastewater
3	To assess the optimum dosing of chemicals for water treatment

Course Outcomes (COs) *Upon successful completion of the course, students will be able to*	
CO	Course Outcomes
CO1	Explain the importance of water quality and various standards
CO2	Choose different procedures for the physico-chemical and bacteriological analysis of water and wastewater samples.
CO3	Understand and suggest water and wastewater treatment requirements.

Syllabus

List of Experiments
1. Determination of pH, EC and turbidity of water 2. Determination of total solids, total dissolved solids and total suspended solids of wastewater 3. Determination of acidity and alkalinity of water and wastewater 4. Determination of total hardness and Calcium hardness of water 5. Determination of dissolved oxygen (DO) and BOD wastewater 6. Determination of COD of wastewater 7. Determination of chloride and residual chlorine of water 8. Determination of nitrate and sulphate in water and wastewater 9. Determination of phosphate in water and wastewater 10. Coliform count of water and wastewater samples by the MPN method

Learning Resources	
Text Books	***Reference Books***
1. Standard Methods of Testing of Water and Wastewater Use by APHA, AWWA, AND WPCF (USA) 2. Chemistry for Environmental Engineering, Clair N. Sawyer, Perry McCarty, Gene F. Parkin, McGraw-Hill Inc., New York, USA	

Gaps in the Syllabus (to meet Industry/Profession requirements)	Design of real-time industrial projects
Pos met through Gaps in the Syllabus	PO4, PO5 & PO6
Topics beyond syllabus/Advanced topics/Design	
Pos met through Topics beyond syllabus/Advanced topics/Design	PO4, PO5 & PO6

Course Outcome (Co) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment	***Assessment Tool***	***% Contribution during CO Assessment***				
	Continuous Internal Assessment	60%				
	Semester End Examination	40%				
	Continuous Internal Assessment	***% Distribution***				
	Day-to-day performance and Lab files	30%				
	Quiz	15%				
	Viva	15%				
	Assessment Components	***CO1***	***CO2***	***CO3***	***CO4***	***CO5***
	Continuous Internal Assessment	3	3	3		
	Semester End Examination	3	3	3		

Indirect Assessment	1. Student Feedback on Faculty
	2. Student Feedback on Course Outcome

Mapping Between Course Outcomes and Program Outcomes						
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2	2	3	2	2
CO2	3	2	2	3	1	1
CO3	3	3	2	3	1	1

Course Delivery Methods	
CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Seminars
CD4	Mini projects/Projects
CD5	Laboratory experiments/teaching aids
CD6	Industrial/guest lectures
CD7	Industrial visits/in-plant training
CD8	Self-learning, such as the use of NPTEL materials and the internet
CD9	Simulation

Mapping Between Course Outcomes and Course Delivery Method	
Course Outcomes	**Course Delivery Method**
CO1	CD1 & CD2
CO2	CD1 & CD2
CO3	
CO4	
CO5	

Course Designers		
Experts from Industry	***Experts from Higher Technical Institutions***	***Internal Experts***
Dr. Susanta Podder, Mr. Sujib Chatterjee	***Prof. Mahabir Panda, Prof Sriman Kr. Bhattacharya, Prof. Rabindra Prasad Sharma***	***Prof. Manjari Chakraborty, Prof. Akhil Sen, Dr. Jawed Iqbal***

COURSE INFORMATION

Course code	CE26509
Course title	Skill Development - I
Pre-requisite(s)	
Co-requisite	
Credits	Credit 2, L:2 T: 0 P: 0
Class schedule per week	2 Classes/ Week
Class	M.Tech.
Semester / Level	I/ Level 5
Branch	Civil Engineering
Name of Teacher	

Course Objectives

This course aims to provide students with:

Sl No.	Objectives
A	Skills to learn methodology of writing reports, research papers, thesis.
B	Skills to learn document structures and referencing style.
C	Skills to learn formatting text using LaTeX.
D	Skills to learn designing presentations and posters
E	Skills to learn using voice modulation and proper body language during presentation.

Course Outcomes (COs)

Upon successful completion of the course, students will be able to

CO	Course Outcomes
1	Write reports, research papers, thesis.
2	Understand document structure and referencing styles.
3	Format text using LaTeX.
4	Design presentations and posters.
5	Use voice modulation, and proper body language during presentation.

Syllabus

Module No.	*Module name*	*Detailed Contents*	*No. of Lecture*
1	**Fundamentals of Technical Writing**	Structure of reports, papers, thesis and documentation, Clarity and formatting; avoiding plagiarism and using AI writing assistants ethically.	8
2	**Structured Documentation**	Drafting reports, research papers, thesis, understanding document structure and Referencing styles (APA/IEEE basics) and tools.	8
3	**Introduction to LaTeX**	Setting up environments (Overleaf/MiKTeX); document classes, Formatting text, equations, tables, figures, Bibliography and citations.	8
4	**Effective Presentation Design**	Slide design (clarity, visuals, minimal text), Structuring a presentation, data visualization, Presentation Tools (PowerPoint / Google Slides / Canva / LaTeX Beamer / Prezi), Poster designs.	5
5	**Presentation Skills**	Voice modulation, body language, Handling Q&A sessions	8

Learning Resources	
Text Books	***Reference Books***
1. Principles of Scientific and Technical Writing – Pratap K.J. Mohapatra, Sanjib Moulick, McGraw Hill. 2. Typography & Layout Guide – Latex, Ranjit Singh, R T Publications.	1. Art of Thesis Writing- Preparation and Formation, Dr. P. Gopinathan- Friends Publications.

Gaps in the Syllabus (to meet Industry/Profession requirements)	Studying and providing solutions to real-life situations.
Pos met through Gaps in the Syllabus	PO2
Topics beyond syllabus/Advanced topics/Design	Group discussion, Debate
Pos met through Topics beyond syllabus/Advanced topics/Design	PO3. PO5, PO6

Course Outcome (Co) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment	***Assessment Tool***	***% Contribution during CO Assessment***				
	Continuous Internal Assessment	50%				
	Semester End Examination	50%				
	Continuous Internal Assessment	***% Distribution***				
	Best 2 Quiz marks out of 3 Quizzes of 15 marks each.	30%				
	Assignment(s)	10%				
	Seminar before a Committee	10%				
	Assessment Components	***CO1***	***CO2***	***CO3***	***CO4***	***CO5***
	Continuous Internal Assessment	√	√	√	√	√
	Semester End Examination	√	√	√	√	√

Evaluation Pattern Rubrics

S. No.	Components	Marks
1	Technical Report Writing (Structure, Organization, Clarity, flow, plagiarism free)	20
2	LaTex Document Preparation (Use of LaTex features)	20
3	Use of proper referencing tools	10
4	Presentation Design and Poster Making (Clarity, Visual appeal, tool usage)	20
5	Logical flow / data visualization tools used	10
6	Presentation (fluency, confidence, voice modulation, body language), Handling Q & A	20
Total		100

Indirect Assessment	1. Student Feedback on Faculty
	2. Student Feedback on Course

Mapping Between Course Outcomes and Program Outcomes						
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3	1	1	3	1
CO2	3	3	1	1	3	1
CO3	3	3	1	1	3	1
CO4	3	3	1	1	3	1
CO5	3	3	1	1	3	1
If satisfying and < 34% = 1, 34-66% = 2, > 66% = 3						

Course Delivery Methods	
CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Presentations
CD4	Guest lectures
CD5	Group activity
CD6	Self- learning (SL) such as use of NPTEL materials and internets
CD7	Case Studies

Mapping Between Course Outcomes and Course Delivery Method	
Course Outcomes	**Course Delivery Method**
CO1	CD1, CD2, CD3, CD4, CD5, CD6, CD7
CO2	CD1, CD2, CD3, CD4, CD5, CD6, CD7
CO3	CD1, CD2, CD3, CD4, CD5, CD6, CD7
CO4	CD1, CD2, CD3, CD4, CD5, CD6, CD7
CO5	CD1, CD2, CD3, CD4, CD5, CD6, CD7

Course Designers		
Experts from Industry	***Experts from Higher Technical Institutions***	***Internal Experts***
		Dr. Siddharth Sengupta

COURSE INFORMATION

Course code	MET26511
Course title	Occupational Health and Industrial Safety
Pre-requisite(s)	B.Sc.
Co-requisite	-
Credits	3 (L:3 T:0 P:0 SL:)
Class schedule per week	3
Class	M.Sc.
Semester / Level	II/5
Branch	Environmental Science & Technology
Name of Teacher	

Course Objectives *This course aims to provide students with:*	
Sl No.	Objectives
1	To develop a fundamental understanding of industrial hazards and the associated risks present in various occupational settings
2	To introduce students to industrial safety management systems and the methods employed for ensuring worker health and safety
3	To familiarize students with the relevant acts, regulations, and legal frameworks governing occupational and industrial safety

Course Outcomes (COs) *Upon successful completion of the course, students will be able to*	
CO	Course Outcomes
CO1	Understand the development, structure, and necessity of safety management systems in industrial settings.
CO2	Identify potential workplace hazards and risks, and recommend appropriate mitigatory measures.
CO3	Gain knowledge of various hazard control methods, including engineering controls, administrative strategies, and personal protective equipment (PPE).
CO4	Understand and interpret relevant national and international safety standards.
CO5	Analyze and apply key Occupational Safety, Health, and Environment (OSHE) principles within the context of Indian industries, integrating appropriate legal and regulatory frameworks.

Syllabus

Module No.	*Module name*	*Detailed Contents*	*No. of Lecture*
Module I	**Industrial Hazards**	Introduction to Hazards in industries and Classification, Principles of Hazard Identification and Risk Assessment (HIRA), Risk Analysis Tools, Industrial Hygiene: Exposure Pathways, Control Strategies, Threshold Limit Values	8
Module II	**Occupational Health and Safety Management**	Occupational Health and Safety Management Systems (OHSMS):ISO 45001, ILO Guidelines; Structure of Safety Management System; Roles and Responsibilities: Safety Officers, Safety Committees; Occupational Health: Objectives, Common Occupational Diseases, Ergonomics; Safety Training and Behaviour-Based Safety (BBS); Workplace Wellness and Health Surveillance	8
Module III	**Accident Causation, Prevention, and Control**	Accident Theories: Domino Theory, Multiple Causation Theory, Human Error Model; Preventive Measures and Corrective Actions; Economic and Social Liabilities of Industrial Accidents; Emergency Preparedness and Response: On-site and Off-site Emergency Plans, Mock Drills, Fire Safety Systems; Disaster Risk Reduction and First Aid Protocols. Predictive analytics for accident prevention	8
Module IV	**Hazard Control Techniques and Personal Protection**	Hierarchy of Hazard Controls: Elimination, Substitution, Engineering, IoT-based workplace safety monitoring, Administrative, and PPE; Machine Guarding: Principles and Devices; Personal Protective Equipment (PPE): Types (Respiratory and Non-respiratory), Standards (BIS, ISI, ANSI), Use and Maintenance; Fire Detection and Suppression Systems; Control of Noise, Vibration, and Temperature Hazards; Ventilation and Indoor Air Quality in Workplaces	8
Module V	**Environmental Legislation and Sustainable Management**	Indian Environmental and Safety Laws: Factories Act (1948), Environment Protection Act (1986), Public Liability Insurance Act (1991), Contract Labour Act (1970), BOCW Act (1996), Hazardous Waste Management Rules; International Frameworks and Agreements: Basel Convention.	8

Learning Resources	
Text Books	***Reference Books***
1. R.K.Jain and Sunil S.Rao , Industrial Safety, Health and Environment Management Systems, Khanna publishers , New Delhi (2006) (T1) 2. Herman Koren and Michel Bisesi, Handbook of Environmental Health and Safety: Jaico Publishing House, Delhi (1999). (T2) 3. Rao.S /Saluja H.L., Electrical Safety, Fire Safety Engineering and Safety Management, Publishers: Khanna Publishers, 1998 (T3) 4. L.M. Deshmukh, Industrial safety management, Tata Mcgraw Hill, New Delhi, 2006. (T4)	1. "Industrial Safety, Health, and Environment Management Systems" – R. K. Jain & Sunil S. Rao, Covers Indian laws like the OSHWC Code, 2020, The Environment Protection Act, and BIS safety standards. 2. "Occupational Health and Safety Management: A Practical Guide" – Charles D. Reese, Reference for ISO 45001, OSHA standards, and global safety practices.

Gaps in the Syllabus (to meet Industry/Profession requirements)	Exposure to real situations in Industry
Pos met through Gaps in the Syllabus	PO4, PO5 & PO6
Topics beyond syllabus/Advanced topics/Design	Field trips to industries to get exposed to real-life safety management systems
Pos met through Topics beyond syllabus/Advanced topics/Design	PO4, PO5 & PO6

Course Outcome (Co) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment	***Assessment Tool***	***% Contribution during CO Assessment***				
	Continuous Internal Assessment	50%				
	Semester End Examination	50%				
	Continuous Internal Assessment	***% Distribution***				
	Best 2 Quiz marks out of 3 Quizzes of 15 marks each.	30%				
	Assignment(s)	10%				
	Seminar before a Committee	10%				
	Assessment Components	***CO1***	***CO2***	***CO3***	***CO4***	***CO5***
	Continuous Internal Assessment	✓	✓	✓	✓	✓
	Semester End Examination	✓	✓	✓	✓	✓

Indirect Assessment	1. Student Feedback on Faculty
	2. Student Feedback on Course

Mapping Between Course Outcomes and Program Outcomes						
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1	2	3	3	1	2
CO2	2	2	2	3	1	3
CO3	2	2	2	3	1	2
CO4	1	3	2	3	2	3
CO5	1	3	2	3	2	3

Course Delivery Methods	
CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning (SL) such as use of NPTEL materials and internets
CD7	Simulation

Mapping Between Course Outcomes and Course Delivery Method	
Course Outcomes	**Course Delivery Method**
CO1	CD1, CD2, CD4, CD5, CD6
CO2	CD1, CD2, CD4, CD5, CD6
CO3	CD1, CD2, CD4, CD5, CD6
CO4	CD1, CD2, CD4, CD5, CD6
CO5	CD1, CD2, CD4, CD5, CD6

Course Designers		
Experts from Industry	***Experts from Higher Technical Institutions***	***Internal Experts***
Dr. Susanta Podder, Mr. Sujib Chatterjee	***Prof. Mahabir Panda, Prof Sriman Kr. Bhattacharya, Prof. Rabindra Prasad Sharma***	***Prof. Manjari Chakraborty, Prof. Akhil Sen, Dr. Sukalyan Chakraborty***

COURSE INFORMATION

Course code	MET26513
Course title	Soil Pollution and Solid Waste Management
Pre-requisite(s)	B.Sc.
Co-requisite	-
Credits	3 (L:3 T:0 P:0 SL:)
Class schedule per week	3
Class	M.Sc.
Semester / Level	II/5
Branch	Environmental Science & Technology
Name of Teacher	

Course Objectives *This course aims to provide students with:*	
Sl No.	Objectives
1	To study the fundamentals of soil pollution
2	To develop knowledge on remediation of contaminated land
3	To understand the components of a solid waste management system.
4	To study the collection, transfer and transport of municipal solid waste.
5	Examine the treatment options and study operations of various material, resource, and energy recovery facilities.

Course Outcomes (COs) *Upon successful completion of the course, students will be able to*	
CO	Course Outcomes
CO1	Able to assess the levels of soil pollution
CO2	Able to apply different methods for remediation of contaminated land
CO3	Able to review the components and characteristics of a solid waste management system.
CO4	Able to identify municipal solid waste management's various collection, transfer and transport mechanisms.
CO5	Able to design and operate various processing, material and energy recovery facilities.

Syllabus

Module No.	*Module name*	*Detailed Contents*	*No. of Lecture*
Module I	**Soil Pollution**	Sources and chemical nature of soil contaminants, distribution of soil contaminants: Soil–water partition process, soil-organism processes, soil pollution – elements, pesticides, Ecological and health effects of soil contaminants.	8
Module II	**Contaminated Land Remediation**	Contaminated land remediation - physico-chemical, biological and thermal methods, biodegradation of pollutants in land – factors affecting the bioremediation, phytoremediation, bio-stimulation, bio-augmentation, Artificial Intelligence in Contaminated Land Remediation.	8
Module III	**Fundamentals of Solid Waste Management**	Municipal Solid Waste: Sources, types, waste generation rates, factors affecting generation, composition, MSW characteristics, effects of improper disposal, functional elements of solid waste management, the concept of ISWM system.	8
Module IV	**Waste collection, transportation and processing**	Methods of collecting municipal solid wastes, collection vehicles, manpower, collection routes, vehicle routing, transfer station – location and operation. Waste processing, component separation and volume reduction. Zero waste management, AI and ML in MSW collection and transportation.	8
Module V	**MSW energy and resource and ultimate disposal**	Composting, biomethanation, incineration, pyrolysis, sanitary landfill, landfill leachate management and gas control; Landfill closure - environmental monitoring systems for landfill sites.	8

Learning Resources	
Text Books	***Reference Books***
1. Tchobanoglous G., Theisen H., Vigil S.: Integrated Solid Waste Management Engineering Principles and Management Issues. Mc-Graw Hill 2. Khan Iqbal H., Ahsan, N.: Textbook of Solid Waste Management. CBS Publisher and Distributors (P) Ltd. 3. Bhatia S.C.: Handbook of Industrial Pollution & Control Vol. 1 (CBS Publishers) 4. G M Masters and Wendell P Ela, Introduction to environmental engineering and science, Pearson 5. Gary W. Vanloon and Stephen J. Duffy.: Environmental Chemistry – a global perspective.	1. CPHEEO, Ministry of Urban Development: Manual on Municipal Solid Waste Management 2016 2. CPHEEO, Ministry of Urban Development: Manual on Municipal Solid Waste Management 2000

Gaps in the Syllabus (to meet Industry/Profession requirements)	
Pos met through Gaps in the Syllabus	
Topics beyond syllabus/Advanced topics/Design	
Pos met through Topics beyond syllabus/Advanced topics/Design	

Course Outcome (Co) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment	***Assessment Tool***	***% Contribution during CO Assessment***				
	Continuous Internal Assessment	50%				
	Semester End Examination	50%				
	Continuous Internal Assessment	***% Distribution***				
	Best 2 Quiz marks out of 3 Quizzes of 15 marks each.	30%				
	Assignment(s)	10%				
	Seminar before a Committee	10%				
	Assessment Components	***CO1***	***CO2***	***CO3***	***CO4***	***CO5***
	Continuous Internal Assessment	3	3	3	3	3
	Semester End Examination	3	3	3	3	3

Indirect Assessment	1. Student Feedback on Faculty
	2. Student Feedback on Course Outcomes

Mapping Between Course Outcomes and Program Outcomes						
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3	1	2	2	3
CO2	2	3	1	2	1	1
CO3	3	3	1	1	1	2
CO4	3	3	1	1	3	1
CO5	3	3	1	3	3	1

Course Delivery Methods	
CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Seminars
CD4	Mini projects/Projects
CD5	Laboratory experiments/teaching aids
CD6	Industrial/guest lectures
CD7	Industrial visits/in-plant training
CD8	Self- learning such as use of NPTEL materials and internets
CD9	Simulation

Mapping Between Course Outcomes and Course Delivery Method	
Course Outcomes	**Course Delivery Method**
CO1	
CO2	
CO3	
CO4	
CO5	

Course Designers		
Experts from Industry	***Experts from Higher Technical Institutions***	***Internal Experts***
Dr. Susanta Podder, Mr. Sujib Chatterjee	***Prof. Mahabir Panda, Prof Sriman Kr. Bhattacharya, Prof. Rabindra Prasad Sharma***	***Prof. Manjari Chakraborty, Prof. Akhil Sen, Dr. R. Naresh Kumar***

COURSE INFORMATION

Course code	MET26515
Course title	Air Pollution and Global Climate Change
Pre-requisite(s)	B.Sc.
Co-requisite	-
Credits	3 (L:3 T:0 P:0 SL:)
Class schedule per week	3
Class	M.Sc.
Semester / Level	II/5
Branch	Environmental Science & Technology
Name of Teacher	

Course Objectives *This course aims to provide students with:*	
Sl No.	Objectives
1	Understanding the basic concepts of ambient and indoor air pollution.
2	Plan and execute air pollution sampling, monitoring and control.
3	Apply the knowledge of air pollution modeling.
4	Develop scientific reasoning of global climate change issues
5	Execute climate change adaptation and mitigation plan

Course Outcomes (COs) *Upon successful completion of the course, students will be able to*	
CO	Course Outcomes
CO1	Design an air pollution sampling and monitoring plan.
CO2	Air pollutants prediction modeling.
CO3	Suggest suitable air pollution control devices and prepare action plan for control of air pollution
CO4	Evaluate the regional and global impacts of climate change on ecosystems and human systems
CO5	Examine policy responses and international agreements related to climate change mitigation and adaptation and propose effective strategies for climate resilience and sustainable development

Syllabus

Module No.	*Module name*	*Detailed Contents*	*No. of Lecture*
Module I	**Air Pollution and air quality monitoring**	Sources and types of ambient and indoor air pollution; concept of airshed, effects of air pollution in regional and global scale. Ambient and indoor air sampling methods and devices, stack monitoring, CPCB guidelines for air quality monitoring, analysis of air pollutants and interpretation of air pollution data, source apportionment, air pollution standards and indices, IOT based sensors for monitoring of air pollution.	8
Module II	**Atmospheric meteorology and dispersion of air pollutants**	Temperature lapse rates and atmospheric stability, inversions, wind profiles, wind velocity and turbulence, plume behavior, estimation of plume rise, dispersion equations, box model, Gaussian plume model, AI based models for prediction of air pollutant concentration.	8
Module III	**Particulate matter and gaseous pollutants control technologies**	Control methods for air pollution, particulate matter and gaseous air pollution control equipment, vehicular pollution and control, national programs and action plans.	8
Module IV	**Fundamentals of climate change**	Radiation balance, Greenhouse effects, greenhouse gases, radiative forcing and feedbacks, Natural variability: solar cycles, volcanic activity, ocean-atmosphere interactions (ENSO, AMO), anthropogenic causes, Climate change indicators: temperature trends, sea level rise, glacier retreat, ocean acidification, Types of climate models and their components, IPCC scenarios (RCPs, SSPs) and future projections, Climate sensitivity and uncertainty in predictions.	8
Module V	**Impact, adaptation and mitigation of climate change**	Effects on ecosystems, biodiversity, agriculture, water resources, and health, vulnerable regions and communities (e.g., small islands, coastal areas, arid zones), Climate justice and equity issues, Mitigation strategies: renewable energy, carbon sequestration, emission trading, afforestation, Adaptation planning and community-based adaptation, UNFCCC, Kyoto Protocol, Paris Agreement, National policies: NAPCC, SAPCC, climate action plans, concept of net zero.	8

Learning Resources	
Text Books	***Reference Books***
1. Environmental Engineering- Peavy & Rowe. Prentice Hall Pub. 2. Air Pollution Control – Rao and Rao 3. Environmental Pollution and Control – C.S. Rao 4. Houghton, J. (2015). Global Warming: The Complete Briefing. Cambridge University Press 5. Maslin, M. (2021). Climate Change: A Very Short Introduction. Oxford University Press	1. Noel de Nevers, Air Pollution Control Engineering, Mc Graw Hill, New York. 2. Arthur C. Stern, Air Pollution (Vol. I – Vol. VIII), Academic Press 3. Introduction to Environmental Engineering and Science, Gilbert M Masters 4. CPCB manual for Guidelines for ambient air quality monitoring. Published By: Dr. B. Sengupta, Member Secretary, Central Pollution Control Board 5. IPCC Assessment Reports (AR6) – Working Groups I, II, and III 6. Parikh, J., and Parikh, K. (2012). India's Climate Change Policy. Springer 7. Government of India. NAPCC and SAPCC Reports (MoEFCC website)

Gaps in the Syllabus (to meet Industry/Profession requirements)	Design of real-time industrial projects
Pos met through Gaps in the Syllabus	
Topics beyond syllabus/Advanced topics/Design	Air pollution modelling software
Pos met through Topics beyond syllabus/Advanced topics/Design	

Course Outcome (Co) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment	***Assessment Tool***	***% Contribution during CO Assessment***				
	Continuous Internal Assessment	50%				
	Semester End Examination	50%				
	Continuous Internal Assessment	***% Distribution***				
	Best 2 Quiz marks out of 3 Quizzes of 15 marks each.	30%				
	Assignment(s)	10%				
	Seminar before a Committee	10%				
	Assessment Components	***CO1***	***CO2***	***CO3***	***CO4***	***CO5***
	Continuous Internal Assessment					
	Semester End Examination					

Indirect Assessment	1. Student Feedback on Faculty
	2. Student Feedback on Course Outcomes

Mapping Between Course Outcomes and Program Outcomes						
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	3	3	2	2	2
CO2	2	3	3	3	2	3
CO3	2	3	3	2	2	2
CO4	2	3	3	3	3	3
CO5	2	3	3	2	3	3

Course Delivery Methods	
CD1	Lecture by use of boards/LCD projectors
CD2	Tutorials/Assignments
CD3	Seminars
CD4	Industrial visits/in-plant training
CD5	Self- learning such as use of NPTEL materials and internets
CD6	Simulation

Mapping Between Course Outcomes and Course Delivery Method	
Course Outcomes	**Course Delivery Method**
CO1	CD1, CD2, CD3, CD5
CO2	CD1, CD2, CD3, CD5
CO3	CD1, CD2, CD3, CD5
CO4	CD1, CD2, CD3, CD5
CO5	CD1, CD2, CD3, CD5

Course Designers		
Experts from Industry	***Experts from Higher Technical Institutions***	***Internal Experts***
Dr. Susanta Podder, Mr. Sujib Chatterjee	***Prof. Mahabir Panda, Prof Sriman Kr. Bhattacharya, Prof. Rabindra Prasad Sharma***	***Prof. Manjari Chakraborty, Prof. Akhil Sen, Dr. Tanushree Bhattacharya***

COURSE INFORMATION

Course code	MET26517
Course title	Application of Remote Sensing in Environment
Pre-requisite(s)	B.Sc.
Co-requisite	-
Credits	3 (L:3 T:0 P:0 SL:)
Class schedule per week	3
Class	M.Sc.
Semester / Level	II/5
Branch	Environmental Science & Technology
Name of Teacher	

Course Objectives *This course aims to provide students with:*	
Sl No.	Objectives
1	To develop basic understanding of remote sensing and GIS
2	To interpret and develop understandings on satellite image interpretation and indices
3	To be able to apply Remote sensing and GIS in environmental components

Course Outcomes (COs) *Upon successful completion of the course, students will be able to*	
CO	Course Outcomes
CO1	Understand working principles of remote sensing, and spectral responses
CO2	To understand the Procurement process of Data, their interpretation and history of India and global satellite data
CO3	Integrate the applications of Air borne platforms
CO4	Apply processing tools to classify land use and land cover
CO5	Understand GIS concepts and their environmental application

Syllabus

Module No.	*Module name*	*Detailed Contents*	*No. of Lecture*
Module I	**Principles of Remote Sensing**	Definition and Historical overview, Image Procurement, Electromagnetic spectrum, Atmospheric Windows, Physics of Remote Sensing, Spectral Signatures, Spectral Response pattern of soil, Vegetation & water.	8
Module II	**Satellite, Sensors and Image Interpretation**	Imaging & non-imaging sensors, Active & passive sensors, High- and Low-resolution sensors, Sensor Resolutions, Indian and Global Satellites, Fundamentals of Image Interpretation Techniques. Applications of different sensors.	8
Module III	**Platforms and Aerial Vehicles**	Aerial Photography, platforms, UAVs and their applications in environmental management and Biodiversity conservation, AI enabled UAV	8
Module IV	**Image Processing**	Contrast Enhancement, Filtering, Band Ratio and Indices. Supervised Classification and Unsupervised Clustering. Applications of processing tools in environmental management.	8
Module V	**Principles of GIS**	GIS Concepts, Vector Data, Raster Data, Point, line, Polygon, AI enabled GIS, GIS Applications in Environmental Management.	8

Learning Resources	
Text Books	***Reference Books***
1. Jensen, J.R., (2006) "Remote Sensing of the Environment – An Earth Resources Perspective", Pearson Education, Inc. (Singapore) Pvt. Ltd., Indian edition, Delhi. 2. Jensen, J.R., (1996) Introductory Digital Image Processing A remote sensing perspective. Prentice Hall Series in GIS, USA 3. Lillesand, Thomas M. and Kiefer, Ralph, W., (2007) "Remote Sensing and Image Interpretation", 4th Edition, John Wiley and Sons, New York	1. Sabins, F.F. Jr., (2007). 'Remote Sensing – Principles and Interpretation", W.H. Freeman & Co. 2. Reeves, Robert G. (1991), "Manual of Remote Sensing, Vol. I, American Society of Photogrammetry and Remote Sensing, Falls Church, Virginia, USA

Gaps in the Syllabus (to meet Industry/Profession requirements)	Application of real life industrial problems
Pos met through Gaps in the Syllabus	PO5 and PO6
Topics beyond syllabus/Advanced topics/Design	Application for real life problems arising in industries through lab-based experiments
Pos met through Topics beyond syllabus/Advanced topics/Design	PO5 and PO6

Course Outcome (Co) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment	***Assessment Tool***	***% Contribution during CO Assessment***				
	Continuous Internal Assessment	50%				
	Semester End Examination	50%				
	Continuous Internal Assessment	***% Distribution***				
	Best 2 Quiz marks out of 3 Quizzes of 15 marks each.	30%				
	Assignment(s)	10%				
	Seminar before a Committee	10%				
	Assessment Components	***CO1***	***CO2***	***CO3***	***CO4***	***CO5***
	Continuous Internal Assessment					
	Semester End Examination					

Indirect Assessment	1. Student Feedback on Faculty
	2. Student Feedback on Course Outcomes

Mapping Between Course Outcomes and Program Outcomes						
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	1	2	2	1	3
CO2	3	3	3	3	1	2
CO3	3	1	3	3	1	2
CO4	3	2	3	3	3	3
CO5	3	2	3	2	3	3

Course Delivery Methods	
CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping Between Course Outcomes and Course Delivery Method	
Course Outcomes	**Course Delivery Method**
CO1	CD1, CD2
CO2	CD1, CD2, CD4, CD5
CO3	CD1, CD2, CD6, CD7
CO4	CD1, CD3, CD6, CD7
CO5	CD1, CD2, CD3, CD7

Course Designers		
Experts from Industry	***Experts from Higher Technical Institutions***	***Internal Experts***
Dr. Susanta Podder, Mr. Sujib Chatterjee	***Prof. Mahabir Panda, Prof Sriman Kr. Bhattacharya, Prof. Rabindra Prasad Sharma***	***Prof. Manjari Chakraborty, Prof. Akhil Sen, Dr. Neeta Kumari***

COURSE INFORMATION

Course code	MET26519
Course title	Sustainability and Environmental Social Governance
Pre-requisite(s)	B.Sc.
Co-requisite	-
Credits	3 (L:3 T:0 P:0 SL:)
Class schedule per week	3
Class	M.Sc.
Semester / Level	II/5
Branch	Environmental Science & Technology
Name of Teacher	

Course Objectives *This course aims to provide students with:*	
Sl No.	Objectives
1	A comprehensive understanding of the concept of sustainable development and its global significance.
2	To introduce students to the concept and significance of ESG in modern business.
3	To analyze each pillar of ESG—Environmental, Social, and Governance—in detail.
4	To examine ESG investing and reporting frameworks in global and Indian contexts.
5	To critically evaluate real-world ESG practices through case studies.

Course Outcomes (COs) *Upon successful completion of the course, students will be able to*	
CO	Course Outcomes
CO1	Understand ESG concepts and their strategic importance in business sustainability.
CO2	Evaluate environmental, social, and governance risks and opportunities for organizations.
CO3	Interpret ESG reports and investment metrics.
CO4	Apply ESG principles in analyzing corporate behavior and policy-making.

Syllabus

Module No.	*Module name*	*Detailed Contents*	*No. of Lecture*
Module I	**Foundations of ESG and Sustainability**	Historical evolution, Brundtland Report, Sustainable Development Goals (SDGs), principles of sustainable development, challenges, and opportunities. Key definitions: Sustainability, CSR, triple bottom line, Intergenerational Equity, Carrying Capacity, and Ecological Footprint, Planetary Boundaries and Doughnut Economics, Global and National Sustainability Challenges. Importance of ESG in today's business environment, Regulatory frameworks and global standards (UN SDGs, GRI, SASB, TCFD, etc.), Key ESG Rating Agencies and Standards (e.g., GRI, SASB, TCFD, CDP)	8
Module II	**Dimensions and Applications of Sustainability**	Environmental Sustainability: Biodiversity, Ecosystems, Pollution, Climate Change, Resource Use, Social Sustainability: Equity, Education, Public Health, Gender, Community Development, Economic Sustainability: Green Economy, Circular Economy, Responsible Consumption and Production, Tools: Sustainability Indicators, Life Cycle Assessment (LCA), Material Flow Analysis (MFA), Sustainability in Urban Planning, Agriculture, Energy, and Industry.	8
Module III	**Sustainability Strategies**	Sustainability Strategies, Governance, and Innovations, Environmental Governance and International Protocols (UNFCCC, CBD, Rio Conventions), Corporate Sustainability: CSR, ESG, Sustainability Reporting, National Sustainability Policies (India: NAPCC, SDG India Index, State Actions), Technological Innovations in Sustainability: Clean Tech, Smart Cities, Renewable Energy, Public Participation and Stakeholder Engagement, Future Trends: AI for Sustainability, Net Zero Goals, Green Finance, AI in sustainable governance	8
Module IV	**Environmental and Social Dimensions of ESG**	The 'E' of ESG: Climate Change, Energy Use, Waste, Emissions, Biodiversity The 'S' of ESG: Human Rights, Labor Practices, DEI (Diversity, Equity, Inclusion), Community Engagement, Stakeholder Mapping and Materiality Assessment, Environmental and Social Risk Management, The 'G' of ESG:	8

		Corporate Governance, Board Composition, Ethics, Compliance, Principles of Transparency, Accountability, and Anti-Corruption, National Guidelines on Responsible Business Conduct (NGRBC), Role of SEBI and Indian Corporate Governance Codes	
Module V	**ESG Reporting, Investing, and Future Roadmap**	ESG Reporting Standards and Best Practices (GRI, BRSR, CDP, SASB), ESG Rating and Benchmarking (MSCI, DJSI, Sustainalytics), ESG Investing, Green Finance, and Impact Investing., Stakeholder Communication and Avoiding Greenwashing, Corporate Strategy and ESG Integration, Future Trends in ESG: Digital ESG, AI and Sustainability, Circular Economy.	8

Learning Resources	
Text Books	***Reference Books***
1. Sustainable Development: Exploring the Contradictions - John Robinson 2. Our Common Future - World Commission on Environment and Development 3. Sustainable Development Goals: Harnessing Business to Achieve the SDGs through Finance, Technology and Law Reform - Julia Walker et al. 4. The ESG Imperative: How Sustainability and Climate Risk are Changing Business 5. By Robert G. Eccles, Mary Johnstone-Louis, Colin Mayer	1. Sustainability: A Comprehensive Foundation - Tom Theis and Jonathan Tomkin 2. Green Economy and Good Governance for Sustainable Development - José Antonio Puppim de Oliveira 3. Environment and Development: Basic Principles, Human Activities, and Environmental Implications - Stavros G. Poulopoulos and Vassilis J. Inglezakis 4. Sustainable Investing: Revolutions in Theory and Practice, By Herman Bril, Georg Kell, Andreas Rasche (Eds.)

Gaps in the Syllabus (to meet Industry/Profession requirements)	Practical exposure to real-world sustainable development projects
Pos met through Gaps in the Syllabus	
Topics beyond syllabus/Advanced topics/Design	Digital tools and software for sustainable development impact assessment
Pos met through Topics beyond syllabus/Advanced topics/Design	

Course Outcome (Co) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment	***Assessment Tool***	***% Contribution during CO Assessment***				
	Continuous Internal Assessment	50%				
	Semester End Examination	50%				
	Continuous Internal Assessment	***% Distribution***				
	Best 2 Quiz marks out of 3 Quizzes of 15 marks each.	30%				
	Assignment(s)	10%				
	Seminar before a Committee	10%				
	Assessment Components	***CO1***	***CO2***	***CO3***	***CO4***	***CO5***
	Continuous Internal Assessment	✓	✓	✓	✓	✓
	Semester End Examination	✓	✓	✓	✓	✓

Indirect Assessment	1. Student Feedback on Faculty
	2. Student Feedback on Course Outcomes

Mapping Between Course Outcomes and Program Outcomes						
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	3	2	2	1	3
CO2	2	3	2	1	1	3
CO3	2	3	3	2	2	3
CO4	2	2	2	3	1	3
CO5	3	3	2	3	1	3

Course Delivery Methods	
CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping Between Course Outcomes and Course Delivery Method	
Course Outcomes	**Course Delivery Method**
CO1	CD1, CD2
CO2	CD1, CD2
CO3	CD1, CD2
CO4	CD1, CD2
CO5	CD1, CD2

Course Designers		
Experts from Industry	***Experts from Higher Technical Institutions***	***Internal Experts***
Dr. Susanta Podder, Mr. Sujib Chatterjee	***Prof. Mahabir Panda, Prof Sriman Kr. Bhattacharya, Prof. Rabindra Prasad Sharma***	***Prof. Manjari Chakraborty, Prof. Akhil Sen, Dr. Neeta Kumari***

COURSE INFORMATION

Course code	MET26506
Course title	Air and Soil Laboratory
Pre-requisite(s)	B.Sc.
Co-requisite	-
Credits	1.5 (L:0 T:0 P:3 SL:)
Class schedule per week	3
Class	M.Sc.
Semester / Level	II/5
Branch	Environmental Science & Technology
Name of Teacher	

Course Objectives *This course aims to provide students with:*	
Sl No.	Objectives
1	To monitor and analyse the air pollution level of the ambient air.
2	To determine some important soil properties and assess its effect on environmental quality.

Course Outcomes (COs) *Upon successful completion of the course, students will be able to*	
CO	Course Outcomes
CO1	Design and implement ambient air quality monitoring plan.
CO2	Interpret the air quality data and evaluate the air pollution status.
CO3	Examine some of the soil physico-chemical properties.
CO4	Interpret soil environmental quality and fertility status.

Syllabus

List of Experiments
1. Monitoring and analysis of PM10 and PM2.5 in the ambient air. 2. Sampling and analysis of NOx by chemiluminescence method. 3. Sampling and analysis of CO2 and CO by NDIR method. 4. Sampling and analysis of sulphur dioxide in ambient air (Improved West and Gaeke method) 5. Sampling and analysis of Lead, Nickel and Arsenic in ambient air. 6. Determination of particle size distribution in fine aggregates. 7. To determine the soil particle size distribution by hydrometer analysis. 8. To determine the moisture content of soil by gravimetric method. 9. To estimate NPK status of soil. 10. To determine the pH, EC of the soil solution.

Learning Resources	
Text Books	***Reference Books***
1. Soil Testing for Engineers- Lambe T.W., Wiley Eastern Ltd., New Delhi. 5. Manual of 2. Soil Laboratory Testing- Head K.H., (1986)- Vol. I, II, III, Princeton Press, London	1. Guidelines for the Measurement of Ambient Air Pollutants, CPCB, 2013.

Gaps in the Syllabus (to meet Industry/Profession requirements)	Design of real-time industrial projects
Pos met through Gaps in the Syllabus	PO4, PO5 & PO6
Topics beyond syllabus/Advanced topics/Design	
Pos met through Topics beyond syllabus/Advanced topics/Design	PO4, PO5 & PO6

Course Outcome (Co) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment	***Assessment Tool***	***% Contribution during CO Assessment***				
	Continuous Internal Assessment	60%				
	Semester End Examination	40%				
	Continuous Internal Assessment	***% Distribution***				
	Day-to-day performance and Lab files	30%				
	Quiz	15%				
	Viva	15%				
	Assessment Components	***CO1***	***CO2***	***CO3***	***CO4***	***CO5***
	Continuous Internal Assessment	✓	✓	✓	✓	
	Semester End Examination	✓	✓	✓	✓	

Indirect Assessment	1. Student feedback on teaching quality and teaching methods adopted
	2. Student feedback on course syllabus and course outcome

Mapping Between Course Outcomes and Program Outcomes						
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3	2	3	3	2
CO2	3	3	2	3	3	2
CO3	3	3	2	3	3	2
CO4	3	3	2	3	3	2

Course Delivery Methods	
CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Seminars
CD4	Mini projects/Projects
CD5	Laboratory experiments/teaching aids
CD6	Industrial/guest lectures
CD7	Industrial visits/in-plant training
CD8	Self-learning, such as the use of NPTEL materials and the internet
CD9	Simulation

Mapping Between Course Outcomes and Course Delivery Method	
Course Outcomes	**Course Delivery Method**
CO1	
CO2	
CO3	
CO4	
CO5	

Course Designers		
Experts from Industry	*Experts from Higher Technical Institutions*	*Internal Experts*
Dr. Susanta Podder, Mr. Sujib Chatterjee	*Prof. Mahabir Panda, Prof Sriman Kr. Bhattacharya, Prof. Rabindra Prasad Sharma*	*Prof. Manjari Chakraborty, Prof. Akhil Sen, Dr. Tanushree Bhattacharya*

COURSE INFORMATION

Course code	MET26508
Course title	Remote Sensing Laboratory
Pre-requisite(s)	B.Sc.
Co-requisite	-
Credits	1.5 (L:0 T:0 P:3 SL:)
Class schedule per week	3
Class	M.Sc.
Semester / Level	II/5
Branch	Environmental Science & Technology
Name of Teacher	

Course Objectives *This course aims to provide students with:*	
Sl No.	Objectives
1	To interpret and develop understandings on satellite image interpretation and classification
2	To be able to download data sets and use Google earth in basic studies.
3	To be able to prepare maps with attributes and information tables

Course Outcomes (COs) *Upon successful completion of the course, students will be able to*	
CO	Course Outcomes
CO1	Identify features using FCC and ground surveys
CO2	To extract features based in suitable indices
CO3	To classify features and estimate areas based in suitable classifiers
CO4	Apply processing tools in GIS, generate maps and add
CO5	Explore Google earth for basic studies

Syllabus

List of Experiments

1. To perform feature identification using keys to Image Interpretation.
2. Feature Validation using Image interpretation keys, Ground truthing surveys and Geotagging of locations.
3. To perform Vegetation assessment of an area using multiple indices.
4. To perform Water resource assessment of an area using multiple indices.
5. To perform Built-up Area assessment of an area using multiple indices.
6. To perform Elevation profiling Study using Google Earth Pro.
7. To perform Unsupervised Land Use and land Cover Classification
8. To perform Supervised Land Use and land Cover Classification using Arc GIS and AI methods
9. To download satellite data sets from USGS sites.
10. To prepare a point line polygon map with attributes using ARC GIS

Learning Resources	
Text Books	***Reference Books***
1. Jensen, J.R., (2006) "Remote Sensing of the Environment – An Earth Resources Perspective", Pearson Education, Inc. (Singapore) Pvt. Ltd., Indian edition, Delhi 2. Sabins, F.F. Jr., (2007). 'Remote Sensing – Principles and Interpretation", W.H. Freeman & Co.	

Gaps in the Syllabus (to meet Industry/Profession requirements)	
Pos met through Gaps in the Syllabus	
Topics beyond syllabus/Advanced topics/Design	Drone survey, Exposure to LiDAR Survey.
Pos met through Topics beyond syllabus/Advanced topics/Design	

Course Outcome (Co) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment	***Assessment Tool***	***% Contribution during CO Assessment***				
	Continuous Internal Assessment	60%				
	Semester End Examination	40%				
	Continuous Internal Assessment	***% Distribution***				
	Day-to-day performance and Lab files	30%				
	Quiz	15%				
	Viva	15%				
	Assessment Components	***CO1***	***CO2***	***CO3***	***CO4***	***CO5***
	Continuous Internal Assessment	✓	✓	✓	✓	✓
	Semester End Examination	✓	✓	✓	✓	✓

Indirect Assessment	1. Student feedback on faculty
	2. Student feedback on course course

Mapping Between Course Outcomes and Program Outcomes						
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2	3	1	1	1
CO2	3	2	3	1	1	1
CO3	3	2	3	1	1	1
CO4	3	2	3	1	1	2
CO5	3	2	3	1	2	2

Course Delivery Methods	
CD1	Instruction by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments
CD4	Guest lectures
CD5	Visit to different ecosystems
CD6	Self- learning such as use of NPTEL materials and internets

Mapping Between Course Outcomes and Course Delivery Method	
Course Outcomes	**Course Delivery Method**
CO1	CD1, CD2
CO2	CD1, CD2, CD4, CD5
CO3	CD1, CD2, CD6
CO4	CD1, CD3, CD6
CO5	CD1, CD2, CD3

Course Designers		
Experts from Industry	***Experts from Higher Technical Institutions***	***Internal Experts***
Dr. Susanta Podder, Mr. Sujib Chatterjee	***Prof. Mahabir Panda, Prof Sriman Kr. Bhattacharya, Prof. Rabindra Prasad Sharma***	***Prof. Manjari Chakraborty, Prof. Akhil Sen, Dr. Neeta Kumari***

COURSE INFORMATION

Course code	CE26519
Course title	Skill Development - II
Pre-requisite(s)	
Co-requisite	
Credits	Credit 2, L:2 T:0 P:0
Class schedule per week	2 Classes/ Week
Class	M.Tech.
Semester / Level	II/ Level 5
Branch	Civil Engineering
Name of Teacher	

Course Objectives

This course aims to provide students with:

Sl No.	Objectives
A	Knowledge of ethics and ethical theories.
B	Knowledge of values in sustainable development.
C	Knowledge of concept and scope of entrepreneurship development.
D	Knowledge of entrepreneurship opportunities and selection process.
E	Knowledge of business preparation idea.

Course Outcomes (COs)

Upon successful completion of the course, students will be able to

CO	Course Outcomes
1	Understand meaning of ethics and ethical theories
2	Understand importance of values in sustainable development.
3	Understand concept and scope of entrepreneurship development.
4	Understand entrepreneurship opportunities and selection process
5	Understand business preparation idea.

Syllabus

Module No.	*Module name*	*Detailed Contents*	*No. of Lecture*
1	**Meaning of Ethics and Ethical Theories**	Introduction, why should a professional study ethics, Professional Ethics, Difference between Ethics and Law, Branches of Ethics, Utilitarianism, Cost-Benefit analysis, Duty Ethics and Right Ethics, Virtue Ethics.	8
2	**Values and Sustainable Development**	Important Human Values, Values in professions, Occupational safety and Health, Indian Constitution on Occupational Health and Safety, Ethical Dilemmas, Unethical behaviour/ Conduct, Professional Skills/ Behaviourial Competencies, Values and the Environment.	8
3	**Entrepreneurship Development – Concept and Scope**	Introduction, Importance of Entrepreneurship in different professions, Skills required, Steps to start a business, Challenges faced, Intrapreneurs and Entrepreneurs traits, Local and Global markets,	8
4	**Entrepreneurship Opportunities and Selection Process**	Product/ Service selection process in Entrepreneurship, Product/Service life cycle, Mortality Curve in Entrepreneurship, Factors affecting process selection, Location for an industry, Material handling, Market study procedure-Questionnaire design,	8
5	**Business Preparation Idea**	Prefeasibility study, Ownership, Capital, Budgeting, Evaluation criteria, Unique selling proposition, Risk Management, Incubation, Start-up.	8

Learning Resources

Text Books	*Reference Books*
1. Ethics and Values in Engineering Profession – UPSC Engineering Services Exam, Made Easy Publications.	1. Construction Management & Entrepreneurship – Dr. D.S. Rajendra Prasad, Sapna Book House.

2. Entrepreneurship in Civil Engineering – Kshitij Diwakar Thate, Nandini Naresh Raut; Orange Books Publication.	

Gaps in the Syllabus (to meet Industry/Profession requirements)	Replicating and studying real-life scenarios in Entrepreneurship.
Pos met through Gaps in the Syllabus	PO1
Topics beyond syllabus/Advanced topics/Design	Learning to establish a Environmental Start-up.
Pos met through Topics beyond syllabus/Advanced topics/Design	***None***

Course Outcome (Co) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment	***Assessment Tool***	***% Contribution during CO Assessment***				
	Continuous Internal Assessment	50%				
	Semester End Examination	50%				
	Continuous Internal Assessment	***% Distribution***				
	Best 2 Quiz marks out of 3 Quizzes of 15 marks each.	30%				
	Assignment(s)	10%				
	Seminar before a Committee	10%				
	Assessment Components	***CO1***	***CO2***	***CO3***	***CO4***	***CO5***
	Continuous Internal Assessment	√	√	√	√	√
	Semester End Examination	√	√	√	√	√

Evaluation Pattern Rubrics

	Evaluation Mode	Marks
1	Quiz from Part – I (Module 1 and 2)	15
2	Quiz from Part – II (Module 3, 4 and 5)	15
3	Group Assignment for Part- I (Module 1 and 2)	20
4	Group Assignment for Part- II (Module 3, 4 and 5)	20
5	Individual Seminar presentation for Part – I (Module 1 and 2)	15
6	Individual Seminar presentation for Part – II (Module 3, 4 and 5)	15
Total		100

Indirect Assessment	1. Student Feedback on Faculty
	2. Student Feedback on Course

Mapping Between Course Outcomes and Program Outcomes						
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	2	2	2	3	2
CO2	2	2	2	2	3	2
CO3	2	2	2	2	3	2
CO4	2	2	2	2	3	2
CO5	2	2	2	2	3	2
If satisfying and < 34% = 1, 34-66% = 2, > 66% = 3						

Course Delivery Methods	
CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Presentations
CD4	Guest lectures
CD5	Group activity
CD6	Self- learning (SL) such as use of NPTEL materials and internets
CD7	Case Studies

Mapping Between Course Outcomes and Course Delivery Method	
Course Outcomes	**Course Delivery Method**
CO1	CD1, CD2, CD3, CD4, CD5, CD6, CD7
CO2	CD1, CD2, CD3, CD4, CD5, CD6, CD7
CO3	CD1, CD2, CD3, CD4, CD5, CD6, CD7
CO4	CD1, CD2, CD3, CD4, CD5, CD6, CD7
CO5	CD1, CD2, CD3, CD4, CD5, CD6, CD7

Course Designers		
Experts from Industry	***Experts from Higher Technical Institutions***	***Internal Experts***
		Dr. Siddharth Sengupta

COURSE INFORMATION

Course code	MET26523
Course title	Earth Science and Energy resources
Pre-requisite(s)	B.Sc.
Co-requisite	-
Credits	4 (L:3 T:1 P:0 SL:)
Class schedule per week	4
Class	M.Sc.
Semester / Level	III
Branch	Environmental Science & Technology
Name of Teacher	

Course Objectives *This course aims to provide students with:*	
Sl No.	Objectives
1	To understand the origin and internal structure of the Earth and the fundamental processes shaping the planet's surface and atmosphere.
2	To develop knowledge of the principles of hydrology and hydrogeology including groundwater movement, quality, and contamination.
3	To explore geochemical processes controlling the distribution and cycling of elements in the Earth's system including soils and sediments.
4	To identify and evaluate various geological and climatic hazards and understand prediction and mitigation strategies.
5	To recognize the environmental implications of natural resource exploitation and the need for conservation and sustainable management.

Course Outcomes (COs) *Upon successful completion of the course, students will be able to*	
CO	Course Outcomes
CO1	Explain the formation and structure of Earth, and analyze the processes governing energy balance, atmospheric circulation, and climatic patterns.
CO2	Describe geochemical cycles, soil formation processes, and classify soils and minerals based on their chemical and physical characteristics.
CO3	Apply hydrogeological principles to understand groundwater behavior, pollution risks, and assess aquifer properties using Darcy's law and related parameters.
CO4	Identify and evaluate natural hazards such as earthquakes, floods, and landslides, and propose mitigation and risk reduction measures.
CO5	Assess the impact of natural resource exploitation and advocate for responsible, sustainable environmental practices.

Syllabus

Module No.	*Module name*	*Detailed Contents*	*No. of Lecture*
Module I	**Earth Systems and Geodynamic Processes**	Origin and evolution of Earth: primary geochemical differentiation, plate tectonics and formation of the core, mantle, crust, atmosphere, and hydrosphere. Fundamentals of minerals and rocks; formation processes of igneous and metamorphic rocks, Earth's energy budget and thermal regime; concept of steady state and equilibrium, Atmospheric forces: Coriolis force, pressure gradient, frictional force, geostrophic and gradient winds, Earth's climate systems: Indian monsoon, western disturbances, droughts, El Niño and La Niña Climates of India and seasonal variations, Concept of residence time and rates of geochemical and natural cycles, Geophysical fields and their significance, Paleoclimate studies and reconstruction of past environments	10
Module II	**Weathering, minerals and Soil Science and oceanography**	Minerals and their classifications, Marine mineral resources: oceans and new frontiers. Natural resource exploration and exploitation and related environmental concerns. National Mineral Policy and best management practices in mining. Processes of weathering: physical, chemical (including weathering reactions), and biological, Erosion, sediment transport, and depositional mechanisms, Soil formation: soil-forming minerals, pedogenic processes, and climatic control, Soil classification, types, and physical–chemical characteristics. Oceanography: Reliefs of the ocean, temperature, salinity and density of the ocean water, ocean tides, currents, coral and marine resources.	10
Module III	**Hazards, and Natural Resource Management**	Distribution of water on Earth: surface and subsurface, Principles of hydrology and hydrogeology, major river basins and groundwater provinces of India, Darcy's Law and its applicability in groundwater flow, Groundwater dynamics: fluctuations, hydraulic conductivity, tracers, Groundwater contamination and quality	8

		parameters, Effects of over-extraction: land subsidence and saltwater intrusion (Ghyben-Herzberg relation), Geological and climatic hazards: floods, earthquakes, landslides, volcanism, avalanches, tsunamis, cloudbursts, Hazard prediction techniques and mitigation strategies. Natural Hazards: Catastrophic geological hazards - floods, landslides, earthquakes, volcanism, avalanche, tsunami and cloud bursts. Prediction of hazards and mitigation of their impacts.	
8Module IV	**Conventional Energy Resources and Environmental Impact**	Concept and classification of energy sources: Renewable vs. Non-renewable, Conventional vs. Non-conventional; Fossil fuels: classification, composition, physico-chemical characteristics and energy content of coal, petroleum and natural gas. Shale oil, Coal bed Methane, Gas hydrates. Gross-calorific value and net-calorific value, exploration, extraction, and usage; Fossil-fuel-based power plants and environmental effects; Nuclear energy: Nuclear fission and fusion, nuclear fuel cycle and waste management.	10
Module V	**Renewable Energy Resources and Emerging Technologies**	Solar energy: Passive and active solar systems, Solar collectors, solar ponds, photovoltaic cells; Wind energy: generation, technology, and limitations; Ocean energy: Ocean Thermal Energy Conversion (OTEC), Tidal and wave energy; Geothermal energy: sources, extraction, and utilization; Biomass and bioenergy: Types of biomass and conversion methods (e.g., gasification); Biogas, algae, petro-crops, and aquatic weeds; Environmental benefits of renewable energy; Future prospects of renewable and bioenergy systems; National and global renewable energy initiatives and policies.	10

Learning Resources	
Text Books	***Reference Books***
1. Press, F., & Siever, R. (2001) – Understanding Earth, W.H. Freeman 2. Strahler, A.N., & Strahler, A.H. (2005) – Physical Geography: Science and Systems of the Human Environment, Wiley 3. Todd, D.K., & Mays, L.W. (2005) – Groundwater Hydrology, Wiley	1. Karanth, K.R. (1987) – Groundwater Assessment, Development and Management, Tata McGraw-Hill 2. Selley, R.C. (2000) – Applied Sedimentology, Academic Press 3. Lutgens, F.K., Tarbuck, E.J., & Tasa, D. (2019) – Essentials of Geology, Pearson 4. Thorpe, A. (2012) – The Elements: A Very Short Introduction, Oxford University Press 5. Mason, B., & Moore, C.B. (1982) – Introduction to Geochemistry, Wiley 6. Ritter, D.F., Kochel, R.C., & Miller, J.R. (2011) – Process Geomorphology, Waveland Press 7. Bryant, E. (2005) – Natural Hazards, Cambridge University Press

Gaps in the Syllabus (to meet Industry/Profession requirements)	
Pos met through Gaps in the Syllabus	
Topics beyond syllabus/Advanced topics/Design	Drone survey, Exposure to LiDAR Survey
Pos met through Topics beyond syllabus/Advanced topics/Design	

Course Outcome (Co) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment	***Assessment Tool***	***% Contribution during CO Assessment***				
	Continuous Internal Assessment	60%				
	Semester End Examination	40%				
	Continuous Internal Assessment	***% Distribution***				
	Day-to-day performance and Lab files	30%				
	Quiz	15%				
	Viva	15%				
	Assessment Components	***CO1***	***CO2***	***CO3***	***CO4***	***CO5***
	Continuous Internal Assessment	✓	✓	✓	✓	✓
	Semester End Examination	✓	✓	✓	✓	✓

Indirect Assessment	1. Student Feedback on Faculty
	2. Student Feedback on Course

Mapping Between Course Outcomes and Program Outcomes						
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2	3	1	1	1
CO2	3	2	3	1	1	1
CO3	3	2	3	1	1	1
CO4	3	2	3	1	1	2
CO5	3	2	3	1	2	2

Course Delivery Methods	
CD1	Instruction by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments
CD4	Guest lectures
CD5	Visit to different ecosystems
CD6	Self- learning such as use of NPTEL materials and internets

Mapping Between Course Outcomes and Course Delivery Method	
Course Outcomes	**Course Delivery Method**
CO1	CD1, CD2
CO2	CD1, CD2, CD4, CD5
CO3	CD1, CD2, CD6
CO4	CD1, CD3, CD6
CO5	CD1, CD2, CD3

Course Designers		
Experts from Industry	***Experts from Higher Technical Institutions***	***Internal Experts***
Dr. Susanta Podder, Mr. Sujib Chatterjee	***Prof. Mahabir Panda, Prof Sriman Kr. Bhattacharya, Prof. Rabindra Prasad Sharma***	***Prof. Manjari Chakraborty, Prof. Akhil Sen, Dr. Tanushree Bhattacharya***

COURSE INFORMATION

Course code	MET26529
Course title	Environmental Toxicology
Pre-requisite(s)	B.Sc.
Co-requisite	-
Credits	3 (L:3 T:0 P:0 SL:)
Class schedule per week	3
Class	M.Sc.
Semester / Level	I/5
Branch	Environmental Science & Technology
Name of Teacher	

Course Objectives *This course aims to provide students with:*	
Sl No.	Objectives
1	Understand the fundamental principles of toxicology, including dose-response relationships and toxicity mechanisms
2	Analyze the sources, transport, transformation, and environmental fate of various toxicants
3	Examine the ecotoxicological impacts of pollutants at multiple biological levels, from organisms to ecosystems

Course Outcomes (COs) *Upon successful completion of the course, students will be able to*	
CO	Course Outcomes
CO1	Explain key toxicological principles
CO2	Assess the sources, transport, transformation, and fate of environmental toxicants
CO3	Analyze ecotoxicological effects at different biological levels
CO4	Evaluate occupational toxicology risks and exposure limits
CO5	Apply ecotoxicity assessment methods and safety regulations

Syllabus

Module No.	*Module name*	*Detailed Contents*	*No. of Lecture*
Module I	**Introduction to Environmental Toxicology**	Definition, scope, and importance of environmental toxicology; Routes of exposure: ingestion, inhalation, dermal; Dose-response relationship: key terms (LD_{50}, LC_{50}, NOEL, threshold dose); Types of toxicity: Acute vs. Chronic, Systemic vs. Local; Factors influencing toxicity: age, sex, genetics, other chemical interactions; Concept of bioaccumulation, biomagnification, bioconcentration, , Role of digital databases and toxicity prediction tools.	8
Module II	**Environmental Pollutants and Their Fate**	Major classes of pollutants: Inorganic, organic, organometallic, radioactive, gaseous; How pollutants enter and move through the environment: Soil, air, water pathways; Fate and distribution of metals, radioactive materials, and organic pollutants in ecosystems; Behaviour of pollutants inside living organisms: uptake, storage, transformation	8
Module III	**Toxicity Evaluation and Environmental Risk**	Concept and need for toxicity evaluation in environmental science; Pollutant interactions: additive, synergistic, antagonistic effects; Steps in environmental risk assessment: Hazard identification, exposure assessment, dose-response, risk characterization; Safety limits and exposure standards (e.g., TLV, PEL); Use of Material Safety Data Sheets (MSDS)	8
Module IV	**Biological and Ecological Effects of Pollutants**	Effects at molecular, cellular, organ, and organism level, Common toxic effects: Liver damage, reproductive toxicity, respiratory issues, carcinogenicity; Detoxification mechanisms and protective enzymes; Biomarkers of exposure and effect; Changes in plant/animal communities and ecosystem functions due to pollution	8
Module V	**Environmental Toxicology**	Combined effects of pollutants: additive, synergistic, antagonistic, potentiation; Emerging contaminants: Microplastics, endocrine disruptors, nanoparticles; Molecular mechanisms of toxicity: DNA damage, enzyme inhibition; Tools and techniques: ELISA, Comet assay, Immunofluorescence (basic overview); Ethical considerations in toxicity testing: animal welfare, alternatives (CRED)	8

Learning Resources	
Text Books	***Reference Books***
1. Environmental Toxicology set of 3 volumes- Peter Gomes 2. Aquatic Environment and Toxicology-Pawan Kumar Bhart 3. Toxicology: Principles and Methods-Second Revised Edition - M A Subramanian 4. Toxicology: A Manual for Students and Practitioners. - Edwin Welles Dwigh 5. Toxicology - Vijayan Kannampilly	1. Modern Toxicology Vol I, II and III edited by P.K. Gupta and D.K. Salunkhe, Metropolitan Book Co. Pvt. Ltd. 2. Environmental Toxicology: Biological and Health Effects of Pollutants, Third Edition by Ming-Ho Yu (Author), HumioTsunoda (Author), Masashi Tsunoda (Author) CRC Press; 3 edition (14 December 2011) ISBN-13: 978-1439840382

Gaps in the Syllabus (to meet Industry/Profession requirements)	
Pos met through Gaps in the Syllabus	PO5 & PO6
Topics beyond syllabus/Advanced topics/Design	
Pos met through Topics beyond syllabus/Advanced topics/Design	PO5 & PO6

Course Outcome (Co) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment	***Assessment Tool***	***% Contribution during CO Assessment***				
	Continuous Internal Assessment	50%				
	Semester End Examination	50%				
	Continuous Internal Assessment	***% Distribution***				
	Day-to-day performance and Lab files	30%				
	Quiz	10%				
	Viva	10%				
	Assessment Components	***CO1***	***CO2***	***CO3***	***CO4***	***CO5***
	Continuous Internal Assessment	✓	✓	✓	✓	✓
	Semester End Examination	✓	✓	✓	✓	✓

Indirect Assessment	1. Student Feedback on Faculty
	2. Student Feedback on Course

Mapping Between Course Outcomes and Program Outcomes						
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	2	2	3	2	2
CO2	3	3	2	3	1	1
CO3	3	3	2	1	1	2
CO4	2	2	2	2	2	3
CO5	2	2	2	3	2	3

Course Delivery Methods	
CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping Between Course Outcomes and Course Delivery Method	
Course Outcomes	**Course Delivery Method**
CO1	CD1, CD2, CD3, CD6
CO2	CD1, CD2, CD3, CD6
CO3	CD1, CD2, CD3, CD6
CO4	CD1, CD2, CD4, CD6
CO5	CD1, CD2, CD4, CD6

Course Designers		
Experts from Industry	***Experts from Higher Technical Institutions***	***Internal Experts***
Dr. Susanta Podder, Mr. Sujib Chatterjee	***Prof. Mahabir Panda, Prof Sriman Kr. Bhattacharya, Prof. Rabindra Prasad Sharma***	***Prof. Manjari Chakraborty, Prof. Akhil Sen, Dr. Sukalyan Chakraborty***

COURSE INFORMATION

Course code	MET26531
Course title	Environmental Statistics and Optimization
Pre-requisite(s)	B.Sc.
Co-requisite	-
Credits	3 (L:3 T:0 P:0 SL:)
Class schedule per week	3
Class	M.Sc.
Semester / Level	
Branch	Environmental Science & Technology
Name of Teacher	

Course Objectives *This course aims to provide students with:*	
Sl No.	Objectives
1	Develop a general understanding of environmental statistics and optimization
2	Identify the areas of application of statistics in Environmental Science and Engineering. Also understand the principles of optimizing the natural resources
3	Apply the knowledge of statistical ideas and tools of optimization to solve problems in industry, management and other engineering fields.

Course Outcomes (COs) *Upon successful completion of the course, students will be able to*	
CO	Course Outcomes
CO1	Able to demonstrate the applications of statistical and optimization techniques in Environmental Science and Engineering.
CO2	Able to understand the necessity of frequency distribution in environmental samples.
CO3	Able to plan and design surveys and experiments.
CO4	Able to statistically analyse the relation and variability in environmental data and significance of optimization.
CO5	Able to identify the components of statistical data structure needed for various environmental data collection and identify the tools for optimization.

Syllabus

Module No.	*Module name*	*Detailed Contents*	*No. of Lecture*
Module I	**Introduction to Environmental Statistics**	Objective and scope of Environmental Statistics, sources of environmental statistics, Environmental information, data, statistics and indicators, Spatial, temporal, geospatial information and environmental statistics. Collection and representation of data- Primary and Secondary data, collection and scrutiny of data, frequency and non-frequency data, diagrammatic representation of data.	8
Module II	**Frequency Distributions and sampling theory**	Attribute and variable, Discrete and continuous variable, frequency distribution of an attribute and variable. Measures of dispersion, measures of skewness and kurtosis. Hypothesis testing	8
Module III	**Correlation and regression and Analysis of Variance**	Correlation analysis, covariance, correlation coefficient, distribution of correlation coefficient and its statistical significance. Regression analysis, Analysis of variance – One-way and two-way Classifications	8
Module IV	**Introduction to optimization and its tools**	Definition of global and local optima, optimal problem formulation, Linear and nonlinear programming methods and their application in environmental systems	8
Module V	**Introduction to modern statistical and optimization tools**	Statistical tools like SPSS, R software, Optimization tools like Neural network based optimization, Genetic algorithms, Application of GIS in optimization	8

Learning Resources	
Text Books	***Reference Books***
1. Johnson, R. A. and Gupta, C. B., "Miller & Freund's Probability and Statistics for Engineers", Pearson Education, Asia. 2. Devore, J.L., "Probability and statistics for Engineering and the Sciences", Thomson and Duxbury, Singapore. 3. Johnson, R.A., and Wichern, D.W., "Applied Multivariate Statistical Analysis", Pearson Education, Asia. 4. Gupta, S.C., and Kapoor, V.K., "Fundamentals of Mathematical Statistics", Sultan Chand and Sons. 5. Gupta A. M., Goon M. K., Dasgupta B. Fundamentals of Statistics-I. World Press. 6. J.K.Sharma-Operation research , 3/e, Mcmillan, India Ltd, 2007	1. Framework for the Development of Environment Statistics. United Nations Publications.

Gaps in the Syllabus (to meet Industry/Profession requirements)	Design of real-time industrial projects.
Pos met through Gaps in the Syllabus	PO4, PO5 & PO6
Topics beyond syllabus/Advanced topics/Design	Computer based modeling, introduction of statistical software
Pos met through Topics beyond syllabus/Advanced topics/Design	PO4, PO5 & PO6

Course Outcome (Co) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment	***Assessment Tool***	***% Contribution during CO Assessment***				
	Continuous Internal Assessment	50%				
	Semester End Examination	50%				
	Continuous Internal Assessment	***% Distribution***				
	Day-to-day performance and Lab files	30%				
	Quiz	10%				
	Viva	10%				
	Assessment Components	***CO1***	***CO2***	***CO3***	***CO4***	***CO5***
	Continuous Internal Assessment	✓	✓	✓	✓	✓
	Semester End Examination	✓	✓	✓	✓	✓

Indirect Assessment	1. Student Feedback on Faculty
	2. Student Feedback on Course

Mapping Between Course Outcomes and Program Outcomes						
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	1	3	1	2	3
CO2	1	2	1	3	2	2
CO3	1	2	1	3	2	2
CO4	1	2	3	3	3	3
CO5	3	1	2	3	2	3

Course Delivery Methods	
CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping Between Course Outcomes and Course Delivery Method	
Course Outcomes	**Course Delivery Method**
CO1	CD1, CD2, CD6
CO2	CD1, CD2, CD6
CO3	CD1, CD2, CD6
CO4	CD1, CD2, CD6
CO5	CD1, CD2, CD6

Course Designers		
Experts from Industry	***Experts from Higher Technical Institutions***	***Internal Experts***
Dr. Susanta Podder, Mr. Sujib Chatterjee	***Prof. Mahabir Panda, Prof Sriman Kr. Bhattacharya, Prof. Rabindra Prasad Sharma***	***Prof. Manjari Chakraborty, Prof. Akhil Sen, Dr. Neeta Kumari***

COURSE INFORMATION

Course code	MET26533
Course title	Instrumental Methods for Analysis of Environmental Samples
Pre-requisite(s)	B.Sc.
Co-requisite	-
Credits	3 (L:3 T:0 P:0 SL:)
Class schedule per week	3
Class	M.Sc.
Semester / Level	5
Branch	Environmental Science & Technology
Name of Teacher	

Course Objectives *This course aims to provide students with:*	
Sl No.	Objectives
1	Understand the developments in the field of instrumentation for quantitative and qualitative analysis of environmental samples
2	Know the applications of spectroscopy, chromatography and electroanalytical methods
3	Select and finalize the instruments for different analysis of environmental samples
4	Carry out in situ and continuous environmental monitoring and assessment studies

Course Outcomes (COs) *Upon successful completion of the course, students will be able to*	
CO	Course Outcomes
CO1	Capable to select appropriate instrumental method for chemical analysis of air, water and soil
CO2	Apply spectroscopic, electro-chemical and chromatographic techniques for environmental samples analysis
CO3	Design studies related to in situ and continuous monitoring of atmospheric and aquatic systems

Syllabus

Module No.	*Module name*	*Detailed Contents*	*No. of Lecture*
Module I	**Environmental samples analysis**	Conventional methods and their limitations, Modern instrumental methods, selection of method, precision and accuracy, error in measuring signals, quality assurance and quality control, sample preservation, sample preparation and analyte isolation.	8
Module II	**Spectroscopy**	Principles, techniques and applications of spectroscopy, fluorimetry, nephelometry and turbidimetry, Atomic Absorption Spectrometry (Flame, graphite furnace, cold vapour and hydride generation), Inducted Coupled Plasma Optical Emission Spectroscopy (ICP OES).	8
Module III	**Chromatography**	Principles, techniques and applications of chromatography, Gas chromatography, GC-Mass spectroscopy, High performance liquid chromatography, LC - Mass spectroscopy, and Ion chromatography.	8
Module IV	**Electro-analytical methods**	Conductometry, potentiometry, coulometry, AOX analyzer amperometry, polarography, Neutron Activation Analysis, X-ray Fluorescence and X-ray Diffraction.	8
Module V	**In situ and continuous monitoring systems**	Principles, techniques and applications of CO analyser, NOx analyser, SO2 analyser, particulate matter sampling and analysis, aethalometer, auto analyzer for water quality using flow injection analysis, in situ water quality parameter loggers. AI based sensors and analyzer.	8

Learning Resources	
Text Books	***Reference Books***
1. Chemistry for Environmental Engineering, Clair N. Sawyer, Perry Mccarty, Gene F. Parkin, McGraw Hill Inc. New York (T1) 2. Willard H. Merritt, L. Dean, D.A. and Settle, F.A. Instrumental analysis methods Edn. Words Worth, New York (T2) 3. Paul R. Loconto Trace Environmental Quantitative Analysis: Principles, Techniques, and Applications, Marcel Dekker (T3)	1. Instrumental Methods of Chemical Analysis, Ewing, McGraw-Hill, New York. (R1)

Gaps in the Syllabus (to meet Industry/Profession requirements)	
Pos met through Gaps in the Syllabus	
Topics beyond syllabus/Advanced topics/Design	
Pos met through Topics beyond syllabus/Advanced topics/Design	

Course Outcome (Co) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment	***Assessment Tool***	***% Contribution during CO Assessment***				
	Continuous Internal Assessment	50%				
	Semester End Examination	50%				
	Continuous Internal Assessment	***% Distribution***				
	Day-to-day performance and Lab files	30%				
	Quiz	10%				
	Viva	10%				
	Assessment Components	***CO1***	***CO2***	***CO3***	***CO4***	***CO5***
	Continuous Internal Assessment	✓	✓	✓	✓	✓
	Semester End Examination	✓	✓	✓	✓	✓

Indirect Assessment	1. Student Feedback on Faculty
	2. Student Feedback on Course

Mapping Between Course Outcomes and Program Outcomes						
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3	3	0	2	1
CO2	3	3	3	0	2	1
CO3	3	3	3	0	2	1

Course Delivery Methods	
CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping Between Course Outcomes and Course Delivery Method	
Course Outcomes	**Course Delivery Method**
CO1	CD1
CO2	CD1, CD2, CD3
CO3	CD1

Course Designers		
Experts from Industry	***Experts from Higher Technical Institutions***	***Internal Experts***
Dr. Susanta Podder, Mr. Sujib Chatterjee	***Prof. Mahabir Panda, Prof Sriman Kr. Bhattacharya, Prof. Rabindra Prasad Sharma***	***Prof. Manjari Chakraborty, Prof. Akhil Sen, Dr. Neeta Kumari***

COURSE INFORMATION

Course code	MET26535
Course title	Disaster Management
Pre-requisite(s)	B.Sc.
Co-requisite	-
Credits	3 (L:3 T:0 P:0 SL:)
Class schedule per week	3
Class	M.Sc.
Semester / Level	I/5
Branch	Environmental Science & Technology
Name of Teacher	

Course Objectives *This course aims to provide students with:*	
Sl No.	Objectives
1	To understand the basic concept of disaster management
2	To characterise and classify the types of disasters and hazards
3	To understand different mitigation and management plans
4	To understand the basic concepts of roles and responsibilities
5	To understand the disasters from the case studies

Course Outcomes (COs) *Upon successful completion of the course, students will be able to*	
CO	Course Outcomes
CO1	Able to define and classify disasters and hazards
CO2	Able to analyse the impacts of disasters over time
CO3	Able to plan mitigation measures and recommend the modern tools and strategies required to manage the disaster

Syllabus

Module No.	*Module name*	*Detailed Contents*	*No. of Lecture*
Module I	**Definitions**	Disasters, hazards, risk, vulnerability, resilience, disaster cycle, prevention, mitigation, relief and response, recovery and rehabilitation, and management. Natural and man-made disasters: earthquakes, floods, drought, landslides, land subsidence, cyclones, volcanoes, tsunamis, avalanches, and global climate extremes. accidents, leakages, waste disposal, oil spills, and forest fires. Artificial intelligence (AI)	8
Module II	**Consequences and impact of disasters**	Floods, cyclones, tsunamis, earthquakes, landslides, volcanic eruptions, desertification, drought, and salinity ingress. Hazards: Primary, secondary, and tertiary effects. Social economics and environmental impact of disasters. Application of AI in disaster impact assessment	8
Module III	**Mitigation and Management Techniques of Disaster**	Disaster and its management: Disaster Management Structures, components, cycle, mitigation, risk reduction, mitigation plan, mitigation plan at national level, mitigation plan at international level, Contingency Plan, Emergency Planning, Risk assessment, Early warning signal and detection, application of AI in emergency prediction, preparedness, and mitigation	8
Module IV	**Role and Responsibilities**	Role of the government, role of non-governmental organisations, role of citizen, state disaster response force, National disaster response force, role of media and social media, role of community, disaster responsibility, administrative responsibility, community action plan, disaster preparedness, rescue, rehabilitation, disaster recovery plan, application of AI in disaster preparedness, and recovery	8
Module V	**Case studies**	The National Disaster Management Plan: Biological and chemical disasters – epidemics, pandemics, and industrial accidents. Case studies of disasters: earthquakes, landslides, cyclones, floods, droughts, volcanoes. Application of AI in disasters studies	8

Learning Resources	
Text Books	***Reference Books***
1. A.K. Shrivastava, Textbook of Disaster Management, Scientific Publishers, 2024, ISBN: 9789389412451 2. Edward A Keller and Robert H Blodgett. 2008. Natural hazards. Pearson Prentice Hall.	1. National Disaster Management Authority, Government of India, https://ndma.gov.in/Resources/booklets 2. Disaster Management Guidelines, GOI-UND Disaster Risk Program (2009-2012) 3. Murthy D.B.N. (2012) Disaster Management, Deep and Deep Publication PVT. Ltd. New Delhi. 4. Modh S. (2010) Managing Natural Disasters, Mac Millan publishers India LTD. 5. Donald Hyndman and David Hyndman. 2009. Natural hazards and disasters. Brooks/Cole. 6. Gupta A.K., Niar S.S and Chatterjee S. (2013) Disaster management and Risk Reduction, Role of Environmental Knowledge, Narosa Publishing House, Delhi.

Gaps in the Syllabus (to meet Industry/Profession requirements)	
Pos met through Gaps in the Syllabus	
Topics beyond syllabus/Advanced topics/Design	
Pos met through Topics beyond syllabus/Advanced topics/Design	

Course Outcome (Co) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment	***Assessment Tool***	***% Contribution during CO Assessment***				
	Continuous Internal Assessment	50%				
	Semester End Examination	50%				
	Continuous Internal Assessment	***% Distribution***				
	Day-to-day performance and Lab files	30%				
	Quiz	10%				
	Viva	10%				
	Assessment Components	***CO1***	***CO2***	***CO3***	***CO4***	***CO5***
	Continuous Internal Assessment	3	3	3		
	Semester End Examination	3	3	3		

Indirect Assessment	1. Student Feedback on Faculty
	2. Student Feedback on Course

Mapping Between Course Outcomes and Program Outcomes						
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	1	3	3	1	1
CO2	3	1	3	3	1	1
CO3	3	3	3	3	1	1

Course Delivery Methods	
CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Seminars
CD4	Mini projects/Projects
CD5	Laboratory experiments/teaching aids
CD6	Industrial/guest lectures
CD7	Industrial visits/in-plant training
CD8	Self, learning such as the use of NPTEL materials and internet
CD9	Simulation

Mapping Between Course Outcomes and Course Delivery Method	
Course Outcomes	**Course Delivery Method**
CO1	CD1
CO2	CD1
CO3	CD1 and CD2

Course Designers		
Experts from Industry	***Experts from Higher Technical Institutions***	***Internal Experts***
Dr. Susanta Podder, Mr. Sujib Chatterjee	***Prof. Mahabir Panda, Prof Sriman Kr. Bhattacharya, Prof. Rabindra Prasad Sharma***	***Prof. Manjari Chakraborty, Prof. Akhil Sen, Dr. Jawed Iqbal***

COURSE INFORMATION

Course code	MET26537
Course title	Advanced Water and Wastewater Treatment
Pre-requisite(s)	B.Sc.
Co-requisite	-
Credits	3 (L:3 T:0 P:0 SL:)
Class schedule per week	3
Class	M.Sc.
Semester / Level	5
Branch	Environmental Science & Technology
Name of Teacher	

Course Objectives *This course aims to provide students with:*	
Sl No.	Objectives
1	To understand advanced wastewater treatment methods
2	To learn the advanced techniques to treat wastewater to meet stringent disposal standards
3	To understand the wastewater reclamation techniques

Course Outcomes (COs) *Upon successful completion of the course, students will be able to*	
CO	Course Outcomes
CO1	Able to assess the need for advanced water treatment schemes
CO2	Able to choose the different physico-chemical, nutrient and other removal schemes
CO3	Able to recommend the advanced technologies required to meet different standards

Syllabus

Module No.	*Module name*	*Detailed Contents*	*No. of Lecture*
Module I	**Introduction**	Advanced wastewater treatment, the need for advanced wastewater treatment, methods of advanced water and wastewater treatment.	8
Module II	**Nutrient removal from wastewater**	Nitrogen & Phosphorus Removal: Nitrification, Denitrification Simultaneous nitrification and denitrification, Phosphorus Removal: Phosphorus removal by Chemical Precipitation, Chemistry of phosphorus precipitation, Process configuration, Phosphorus removal by Biological Precipitation, Microorganisms involved in the process, Process configurations	8
Module III	**Physicochemical processes**	Adsorption, Type of adsorbents, Development of adsorption isotherms: Freundlich, Langmuir, BET Activated carbon adsorption, Granular carbon adsorption. Ion Exchange, Types of Ion Exchange Resins, Theory of Ion Exchange Applications, Removal and recovery of heavy metals, Removal of nitrogen, Removal of phosphorus, Organic chemical removal	8
Module IV	**Membrane Filtration**	Membrane Process Classification, Microfiltration, Ultrafiltration, Nanofiltration, Reverse Osmosis, Electrodialysis Membrane Fouling, Application of membrane processes: Microfiltration, Ultrafiltration, Nanofiltration, Reverse Osmosis Membrane Bio Reactor: MBR Process, MBR System Features Membrane Module, Process Applications: Industrial Wastewater Treatment, Municipal Wastewater	8
Module V	**Electrochemical Treatment Processes**	Electro-coagulation, Factors affecting Electrocoagulation, Electrode materials, Reactor configurations Electro-floatation: Factors affecting electro floatation Comparison with other technology, Reactor configurations Electro-oxidation: Electro oxidation process, Reactor configurations. Advanced Oxidation Processes: Theory of advanced oxidation, Types of oxidising agents, Fenton and photo-Fenton Oxidation Solar Photo Catalytic Treatment Systems	8

Learning Resources	
Text Books	***Reference Books***
1. Metcalf & Eddy (2003) Wastewater engineering: treatment and reuse, 4th ed. New Delhi: Tata McGraw-Hill. 2. Qasim, Syed R., Motley, Edward M., and Zhu, Guang (2000) Water works engineering: planning, design and operation. New Jersey: Prentice Hall.	1. Metcalf & Eddy (2006), Water Reuse: Issues, Technologies, and Applications, Edition 1, McGraw-Hill Professional Publishing 2. Mackenzie L Davis, 2010, Water and Wastewater Engineering, Edition 1, McGraw-Hill Professional Publishing 3. Nathanson, Jerry A. (2009) Basic environmental technology: water supply, waste management and pollution control, 4th ed. New Delhi: PHI Learning. 4. AMERICAN WATER WORKS ASSOCIATION, MANUAL, AWWA, 5. CPHEEO Manual on Sewerage and Sewage treatment, latest edition

Gaps in the Syllabus (to meet Industry/Profession requirements)	
Pos met through Gaps in the Syllabus	
Topics beyond syllabus/Advanced topics/Design	
Pos met through Topics beyond syllabus/Advanced topics/Design	

Course Outcome (Co) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment	***Assessment Tool***	***% Contribution during CO Assessment***				
	Continuous Internal Assessment	50%				
	Semester End Examination	50%				
	Continuous Internal Assessment	***% Distribution***				
	Day-to-day performance and Lab files	30%				
	Quiz	10%				
	Viva	10%				
	Assessment Components	***CO1***	***CO2***	***CO3***	***CO4***	***CO5***
	Continuous Internal Assessment	3	3	3		
	Semester End Examination	3	3	3		

Indirect Assessment	1. Student Feedback on Faculty
	2. Student Feedback on Course

Mapping Between Course Outcomes and Program Outcomes						
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3	3	3	1	1
CO2	3	3	3	3	1	1
CO3	3	3	3	3	1	1

Course Delivery Methods	
CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Seminars
CD4	Mini projects/Projects
CD5	Laboratory experiments/teaching aids
CD6	Industrial/guest lectures
CD7	Industrial visits/in-plant training
CD8	Self, learning such as the use of NPTEL materials and internet
CD9	Simulation

Mapping Between Course Outcomes and Course Delivery Method	
Course Outcomes	**Course Delivery Method**
CO1	
CO2	
CO3	

Course Designers		
Experts from Industry	***Experts from Higher Technical Institutions***	***Internal Experts***
Dr. Susanta Podder, Mr. Sujib Chatterjee	***Prof. Mahabir Panda, Prof Sriman Kr. Bhattacharya, Prof. Rabindra Prasad Sharma***	***Prof. Manjari Chakraborty, Prof. Akhil Sen, Dr. Neeta Kumari***

COURSE INFORMATION

Course code	MET26539
Course title	Industrial Pollution Control
Pre-requisite(s)	B.Sc.
Co-requisite	-
Credits	3 (L:3 T:0 P:0 SL:)
Class schedule per week	3
Class	M.Sc.
Semester / Level	5
Branch	All
Name of Teacher	

Course Objectives *This course aims to provide students with:*	
Sl No.	Objectives
1	To develop a comprehensive understanding of the types, sources, and characteristics of industrial pollution affecting air, water, and soil environments
2	To analyze the causes and impacts of industrial pollution and to formulate appropriate mitigation, control, and site reclamation strategies.
3	To understand the significance of occupational health and industrial safety measures in minimizing risks to workers and ensuring sustainable industrial operations.

Course Outcomes (COs) *Upon successful completion of the course, students will be able to*	
CO	Course Outcomes
CO1	Identify and classify different types of industrial pollutants and understand their sources and characteristics
CO2	Analyze the environmental and health impacts of industrial pollution on ecosystems and human populations.
CO3	Evaluate and design effective pollution mitigation techniques and site reclamation measures for contaminated environments.
CO4	Understand and interpret the principles and practices of occupational health and industrial hygiene.
CO5	Apply industrial safety standards and develop risk management strategies to ensure worker safety and environmental compliance.

Syllabus

Module No.	*Module name*	*Detailed Contents*	*No. of Lecture*
Module I	**Industrial Air Pollution**	Overview of industrial pollution and major air pollutants; Sources and types of air pollutants from industries, Industrial emission control technologies: Mechanical (cyclones, filters), Chemical (scrubbers, absorbers), Thermal (afterburners, incinerators); Industrial air pollution disasters and key case studies, Air pollution laws and standards: The Air (Prevention and Control of Pollution) Act, 1981; CPCB guidelines, Real-time air quality monitoring systems , Sensor-based emission monitoring.	8
Module II	**Industrial Water Pollution**	Industrial water usage and characteristics of effluents; Major water pollutants, Impacts on aquatic ecosystems and public health; Effluent Treatment Plants (ETPs): Primary, secondary, tertiary treatment processes and Advanced technologies, Industry-specific case studies, Legal framework: Water (Prevention and Control of Pollution) Act, 1974; zero liquid discharge (ZLD) concept	8
Module III	**Industrial Solid Waste and Hazardous Waste Management**	Classification of solid wastes: process wastes, hazardous wastes, biomedical, e-waste; Sources of industrial solid waste, Collection, storage, transportation, and disposal methods; Waste minimization strategies: reuse, recovery, recycling, co-processing; Treatment technologies: composting, incineration, landfilling, pyrolysis; Overview of waste-to-energy concepts; Regulatory policies: Hazardous Waste Management Rules (2016), Solid Waste Management Rules (2016), E-waste Rules (2022)	8
Module IV	**Land Degradation and Control Measures**	Types of land degradation caused by industrial activities: contamination, erosion, subsidence; Reclamation of degraded lands, Principles of cleaner production and industrial ecology; Sustainable industrial practices: waste audit, green belt development, eco-industrial parks; Case studies: ash pond reclamation, mining belt restoration, National policies and programs for land rehabilitation	8

Module V	**Industrial Pollution Control Strategies and Legislation**	Pollution control in specific sectors: cement, iron & steel, petroleum, fertilizer, tanneries; Role of Environmental Management Systems (EMS), ISO 14001; Introduction to Environment Impact Assessment (EIA) in industries; Legal provisions: Environment (Protection) Act, 1986, Public Liability Insurance Act, 1991, EIA Notification 2006, Role of CPCB, SPCBs, MoEFCC in enforcement	8

Learning Resources	
Text Books	***Reference Books***
1. Introduction to Environmental Engineering – Gilbert and Masters v. Wastewater engineering: Metcalf & Eddy, et.al., Mcgraw Hill Pub. (T1) 2. Textbook of Environmental Sudies – by E. Bharucha. (T2)	1. Handbook of Industrial pollution & Control- Vol 1 & 2, S. C. Bhatia, CBS Publishers. (R1) 2. Industrial waste treatment Handbook- Woodward and Cirran, Elsevier Pub (R2) 3. Industrial Pollution Control Handbook- Edited by Herbert, F. Lund, McGrawhill Pub (R3)

Gaps in the Syllabus (to meet Industry/Profession requirements)	
Pos met through Gaps in the Syllabus	
Topics beyond syllabus/Advanced topics/Design	
Pos met through Topics beyond syllabus/Advanced topics/Design	

Course Outcome (Co) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment	***Assessment Tool***	***% Contribution during CO Assessment***				
	Continuous Internal Assessment	50%				
	Semester End Examination	50%				
	Continuous Internal Assessment	***% Distribution***				
	Day-to-day performance and Lab files	30%				
	Quiz	10%				
	Viva	10%				
	Assessment Components	***CO1***	***CO2***	***CO3***	***CO4***	***CO5***
	Continuous Internal Assessment					
	Semester End Examination					

Indirect Assessment	1. Student Feedback on Faculty
	2. Student Feedback on Course

Mapping Between Course Outcomes and Program Outcomes						
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1	1	3	3	2	3
CO2	1	1	3	3	2	2
CO3	1	1	3	3	2	2
CO4	1	2	1	1	1	1
CO5	2	3		3	2	1

Course Delivery Methods	
CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping Between Course Outcomes and Course Delivery Method	
Course Outcomes	**Course Delivery Method**
CO1	CD1, CD2
CO2	CD1, CD2
CO3	CD1, CD2
CO4	CD1, CD2
CO5	CD1, CD2
CO6	CD1, CD2
CO7	CD1, CD2

Course Designers		
Experts from Industry	***Experts from Higher Technical Institutions***	***Internal Experts***
Dr. Susanta Podder, Mr. Sujib Chatterjee	***Prof. Mahabir Panda, Prof Sriman Kr. Bhattacharya, Prof. Rabindra Prasad Sharma***	***Prof. Manjari Chakraborty, Prof. Akhil Sen, Dr. Sukalyan Chakraborty***

COURSE INFORMATION

Course code	MET26541
Course title	Environmental Biotechnology
Pre-requisite(s)	B.Sc.
Co-requisite	-
Credits	3 (L:3 T:0 P:0 SL:)
Class schedule per week	3
Class	M.Sc.
Semester / Level	5
Branch	Environmental Science and Technology
Name of Teacher	

Course Objectives *This course aims to provide students with:*	
Sl No.	Objectives
1	To develop basic knowledge of environmental biotechnology
2	To apply the knowledge acquired on environmental biotechnology in environmental quality monitoring and pollution control
3	To know about various bioremediation processes
4	To apply the environmental biotechnology developments for cleaner production

Course Outcomes (COs) *Upon successful completion of the course, students will be able to*	
CO	Course Outcomes
CO1	Understanding the basic concept of environmental biotechnology for applications in environmental protection
CO2	Able to apply environmental biotechnology to develop solutions for air pollution control
CO3	Able to know the importance of environmental biotechnology for environmental cleanup

Syllabus

Module No.	*Module name*	*Detailed Contents*	*No. of Lecture*
Module I	**Overview of Environmental Biotechnology**	Environmental Biotechnology - scope and importance. present status, enzyme technology and their environmental applications.	8
Module II	**DNA Technology**	Concept of DNA technology, safety, social, moral and ethical aspects; applications of recombinant technology for enhanced biodegradation; detection of pathogens and parasites in wastewater	8
Module III	**Air pollution Control Through Biotechnology**	Biotechnology in reduction of CO2 emission, Bioscrubbers, Biobeds, Biotrickling filters and their applications.	8
Module IV	**Bioremediation**	Types of bioremediation, Phytoremediation, Bioaugmentation, Bioreactors, Bioremediation of herbicides, pesticides, hydrocarbons, oil spills, metal removal processes	8
Module V	**Cleaner Biotechnological Processes**	Biobleaching in pulp and paper industries; bioleaching, cleaner biotechnologies in agro-industries, biological fuel generation: biogas, hydrogen, methane and alcohol production	8

Learning Resources	
Text Books	***Reference Books***
1. Microbial Biotechnology: A. N. Glazer and H. Nikaids 2. Molecular Biotechnology: Gleek and Pasternack 3. Biotechnology: A Textbook of Industrial Microbiology, T. D. Brock 4. Industrial Microbiology: Prescott and Dunn.	1. Microbiology, Michael Pelczar Jr., ECS Chan, NR Kreig, Tata McGraw-Hill Education 2. Brock Biology of Microorganisms, Michael T. Madigan, John M. Martinko, Kelly S. Bender, Daniel H. Buckley, David A. Stahl, Thomas Brock

Gaps in the Syllabus (to meet Industry/Profession requirements)	Application of real-life industrial problems
Pos met through Gaps in the Syllabus	PO6
Topics beyond syllabus/Advanced topics/Design	
Pos met through Topics beyond syllabus/Advanced topics/Design	PO5 and PO6

Course Outcome (Co) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment	***Assessment Tool***	***% Contribution during CO Assessment***				
	Continuous Internal Assessment	50%				
	Semester End Examination	50%				
	Continuous Internal Assessment	***% Distribution***				
	Day-to-day performance and Lab files	30%				
	Quiz	10%				
	Viva	10%				
	Assessment Components	***CO1***	***CO2***	***CO3***	***CO4***	***CO5***
	Continuous Internal Assessment					
	Semester End Examination					

Indirect Assessment	1. Student Feedback on Faculty
	2. Student Feedback on Course

Mapping Between Course Outcomes and Program Outcomes						
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2	2	2	1	1
CO2	3	2	2	1	1	1
CO3	3	3	3	2	1	1

Course Delivery Methods	
CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping Between Course Outcomes and Course Delivery Method	
Course Outcomes	**Course Delivery Method**
CO1	CD1, CD2
CO2	CD1, CD2
CO3	CD1, CD2, CD3
CO4	
CO5	
CO6	
CO7	

Course Designers		
Experts from Industry	***Experts from Higher Technical Institutions***	***Internal Experts***
Dr. Susanta Podder, Mr. Sujib Chatterjee	***Prof. Mahabir Panda, Prof Sriman Kr. Bhattacharya, Prof. Rabindra Prasad Sharma***	***Prof. Manjari Chakraborty, Prof. Akhil Sen, Dr. R. Naresh Kumar***

COURSE INFORMATION

Course code	MET26543
Course title	Natural Resource and Management
Pre-requisite(s)	B.Sc.
Co-requisite	-
Credits	3 (L:3 T:0 P:0 SL:)
Class schedule per week	3
Class	M.Sc.
Semester / Level	I/5
Branch	Environmental Science and Technology
Name of Teacher	

Course Objectives *This course aims to provide students with:*	
Sl No.	Objectives
1	To develop a comprehensive understanding of the classification, distribution, and significance of natural resources.
2	To familiarize students with ecological principles and sustainability concepts governing resource use and conservation.
3	To equip students with tools and techniques for ecological restoration, climate change risk assessment, and environmental management.
4	To evaluate the interlinkages between natural resource exploitation, climate change, and sustainability transitions.
5	To build competence in applying regulatory, economic, and technical frameworks for sustainable resource governance and management.

Course Outcomes (COs) *Upon successful completion of the course, students will be able to*	
CO	Course Outcomes
CO1	Analyze the types, uses, and degradation causes of natural resources through ecological and sustainability principles.
CO2	Evaluate ecological restoration strategies and develop community-inclusive rehabilitation plans for degraded ecosystems.
CO3	Assess climate change impacts on natural resources using risk and vulnerability assessment tools, and interpret national policies.
CO4	Differentiate between renewable and non-renewable resources and propose sustainable extraction, reclamation, and transition pathways.
CO5	Apply environmental management tools (EIA, LCA, ISO 14001, etc.) to enhance sustainability in resource use and industry practices.

Syllabus

Module No.	*Module name*	*Detailed Contents*	*No. of Lecture*
Module I	**Natural Resources and Ecological Principles**	Classification and importance of natural resources, Resource scarcity and degradation – causes and consequences, Ecosystem services and natural capital, Population and community ecology; carrying capacity, Principles of ecological sustainability, Laws of ecology and resource optimization.	8
Module II	**Ecological Restoration and Rehabilitation**	Concept and need for ecological restoration, Passive vs. active restoration methods, Techniques for restoring degraded ecosystems (forests, grasslands, wetlands), Indicators for ecological monitoring and evaluation, Socioeconomic dimensions and community-based restoration, National Mission on Ecosystem Restoration (India-specific examples)	8
Module III	**Climate Change and Natural Resource Risk Assessment**	Climate change science and IPCC framework, Impacts of climate change on soil, forests, minerals, and land productivity, Vulnerability and risk assessment of natural resources, Resource depletion under climate stress: heatwaves, droughts, floods; Carbon budgeting and climate-smart resource management; Natural hazard mapping, GIS tools, and early warning systems; India's National Action Plan on Climate Change (NAPCC) and resource missions (e.g., National Mission on Sustainable Agriculture, Green India Mission)	8
Module IV	**Mineral and Renewable Resource Management**	Classification of mineral resources: fuel vs. non-fuel; Techniques of mineral extraction and their environmental implications, Mine reclamation, rehabilitation, and sustainable extraction practices; Renewable energy sources: solar, wind, biomass, geothermal; India's energy transition: missions, targets, and regulatory frameworks; Environmental impacts and life cycle emissions; Resource efficiency, energy audits, and circularity in practice.	8

Module V	**Sustainability and Environmental Management Tools**	Concept and frameworks of sustainable development; Environmental impact assessment (EIA) and strategic environmental assessment (SEA); Corporate social responsibility (CSR) and sustainability reporting; Environmental management systems (EMS) and ISO 14001; Life cycle assessment (LCA) and material flow analysis; Circular economy principles and resource productivity; National and international environmental standards and protocols.	8

Learning Resources

Text Books

1. Odum, E. P. & Barrett, G. W. (2005). Fundamentals of Ecology (5th Edition). Thomson Brooks/Cole.
2. Miller, G. T., & Spoolman, S. (2020). Living in the Environment (19th Edition). Cengage Learning.
3. Chiras, D. D. (2013). Environmental Science (9th Edition). Jones & Bartlett Learning.
4. UNEP. (2012). Global Environment Outlook (GEO-5): Environment for the Future We Want. United Nations Environment Programme.
5. Gadgil, M. & Guha, R. (2000). The Use and Abuse of Nature. Oxford University Press.

Reference Books

1. National Action Plan on Climate Change (NAPCC) – Government of India Reports.
2. IPCC Assessment Reports (AR6 and earlier) – Intergovernmental Panel on Climate Change.
3. India's State of Forest Reports (FSI) – Forest Survey of India.
4. MEA (Millennium Ecosystem Assessment) – Ecosystems and Human Well-being: Synthesis.
5. MoEFCC Guidelines on EIA & Ecological Restoration – Ministry of Environment, Forest and Climate Change, Government of India.

Gaps in the Syllabus (to meet Industry/Profession requirements)	Application of real-life industrial problems
Pos met through Gaps in the Syllabus	PO6
Topics beyond syllabus/Advanced topics/Design	Real life experiments conducted in lab and large scale
Pos met through Topics beyond syllabus/Advanced topics/Design	PO5 and PO6

Course Outcome (Co) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment	***Assessment Tool***	***% Contribution during CO Assessment***				
	Continuous Internal Assessment	50%				
	Semester End Examination	50%				
	Continuous Internal Assessment	***% Distribution***				
	Day-to-day performance and Lab files	30%				
	Quiz	10%				
	Viva	10%				
	Assessment Components	***CO1***	***CO2***	***CO3***	***CO4***	***CO5***
	Continuous Internal Assessment					
	Semester End Examination					

Indirect Assessment	1. Student Feedback on Faculty
	2. Student Feedback on Course

Mapping Between Course Outcomes and Program Outcomes						
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1	2	1	3	2	2
CO2	1	2	1	2	3	1
CO3	1	3	1	3	2	3
CO4	1	2	1	3	1	2
CO5	1	3	1	2	2	2

Course Delivery Methods	
CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping Between Course Outcomes and Course Delivery Method	
Course Outcomes	**Course Delivery Method**
CO1	CD1, CD2
CO2	CD1, CD2
CO3	CD1, CD2, CD3
CO4	
CO5	
CO6	
CO7	

Course Designers		
Experts from Industry	***Experts from Higher Technical Institutions***	***Internal Experts***
Dr. Susanta Podder, Mr. Sujib Chatterjee	***Prof. Mahabir Panda, Prof Sriman Kr. Bhattacharya, Prof. Rabindra Prasad Sharma***	***Prof. Manjari Chakraborty, Prof. Akhil Sen, Dr. Tanushree Bhattacharya***